UNIVERSITY OF SOUTHAMPTON

MANAGING CHANGE AND REFORM IN THE GREEK EDUCATIONAL SYSTEM: RESTRUCTURING PRIMARY SCIENCE

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ABSTRACT

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This research examines recent reform of the primary science curriculum in Greece - introduced in 2000 (YPEPTH, 2000) - and examines the likelihood of the reform being 'systemic and sustainable', as Fullan (2001) and others have suggested it should be. The aim of the reform is to promote modern learning approaches and pedagogies, which research in science education and school management suggests leads to more effective and improved science teaching. More specifically, it aims to promote a constructivist approach in science lessons; integrating activities and transforming traditional teachers into teacher-managers who do not simply transmit new knowledge, but help pupils critically to self-approach problem solving. In this way, the reforms were expected to trigger a transformation of schools from 'traditional' to 'modern learning' organisations in accordance with the demands of modern society (YPEPTH, 2000). Notwithstanding the aspiration, according to most of the research literature, educational reforms in Greece have not been successful historically. The highly centralised character of the educational system and its focus on highly competitive general examinations used primarily to filter university admissions, have prevented the effective implementation of reform over the years (Kazamias & Zambeta, 2000). As the current reform in the primary science curriculum does not offer or claim to offer any hope of restructuring this examination-centred culture, it is doubtful that it will prove to be either systemic or sustainable.

Generally, the method used in the collection of qualitative data for this research was the interview. Through interviews, the agents of reform - teachers and others involved in education at the core of the change process - gave their thoughts about the new curriculum and its implementation. Some data from interviews was triangulated with documents and observations (Cohen, Manion & Morrison, 2000). In particular, teachers, head-teachers, school consultants, university tutors, policy-makers, pupils, parents and secondary science teachers from different parts of Greece give their thoughts about: (a) the reasons for the reform; (b) their attitudes towards the reform; (c) the dimensions of the reform; and (d) the way the reform was managed and its impact on the public's understanding of science. All data was transcribed and analysed with the help of NVivo (qualitative data analysis) software (Richards, 1999).

The findings of the research show that the reform was not implemented as required despite the fact that all stakeholders acknowledged its necessity. Barriers to reform appeared to emerge, such as teachers' inability to change their ways of working, teachers' inability to cope with difficulties that accompany reform implementation, schools' inability to restructure its functions, the sheer pressure of examination competition on pupils and the lack of appropriate support for agents of reform from the government. The findings show that a change limited to curriculum and reform of textbooks does not influence or take into consideration many of these barriers to effective implementation and is ultimately unlikely to impact deeply on science teaching and the Greek educational system going forward. Trying to fit a new curriculum into an unchanged and inflexible school context affects negatively the implementation of reform. Necessary though reform might be, it cannot of itself change school culture and be successful, systemic and sustainable (Fullan, 2001).

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CHAPTER I:
INTRODUCTION

CHORUS OF THEBAN ELDERS:
There are many strange and wonderful things,
but nothing more strangely wonderful than man.
He moves across the white-capped ocean seas
blasted by winter storms, carving his way
under the surging waves engulfing him.

.....

He's taught himself speech and wind-swift thought,
trained his feelings for communal civic life,
learning to escape the icy shafts of frost,
volleys of pelting rain in winter storms,
the harsh life lived under the open sky.
That's man—so resourceful in all he does.
There's no event his skill cannot confront—
other than death—that alone he cannot shun,
although for many baffling sicknesses
he has discovered his own remedies.

The qualities of his inventive skills
bring arts beyond his dreams and lead him on,
sometimes to evil and sometimes to good.

[Sophocleous, Antigone, Lines 331-334, 341-350]

INTRODUCTION

1. THE TOPIC

This study examines practical and theoretical issues around the implementation of change in primary science education in Greece. It investigates the conditions under which the change is implemented and how it can be effective and sustainable. It aims at analysing the assumptions on the basis of which a particular reform can contribute to the improvement of learning outcomes, classroom and school structure, and the cultural spirit of educational community (Fullan, 2001a).

2. THE TASK OF EDUCATIONAL CHANGE

This thesis is based on the assumption that dealing with educational change effectively is a complex and multidimensional attempt to 're-culture' school environment (Fullan, 2001a). Related to this is the development of strategies for people involved, to share the meaning of change and participate in shaping new directions for learning, at all levels of educational communities. To the extent that this assertion is correct, then change becomes a deep and lasting achievement that holds various parts of the organization together in creative relationships with each other, and promotes a common culture of expectations around the aims of education, inside and outside school (Fullan, 2001a).

All aspects of educational change are oriented towards the improvement of learning. They are related to meaningful reconsideration of educational practice, which is conceived as a range of intelligible activities, embodying social values, reflecting beliefs and understandings, and being united by common expectations. In the context of knowledge society, change initiation and implementation are regarded as processes that need to make sense, to be refined continually through reflective action, to be tested against the increasingly available information in the literature or research fields, to cope with diversity, to be clear, coherent and widely comprehended or recognizable. Thus, construction of knowledge about educational change and researching into the multiple realities of the management of change, is a complex process that involves study of the subjective world of personal conceptions, attitudes and understandings, taking into account that the development of individuals' thinking about educational situations, lies in

a constant negotiation of meanings between people who influence or are influenced by the change process. It involves also acknowledgement of the objective reality of change, which refers to new or revised instructional materials and technologies, to the possible use of new teaching strategies, and the possible alteration of pedagogical beliefs and roles (Pring, 2000; Fullan, 2001a).

Educational change is often associated with specific, small scale, reforms of curriculum, but it can also be a dynamic part of broader sociopolitical processes involving all kinds of interacting factors, individual and institutional, local and national. For schools, effective change implementation is associated with the development of their intellectual capital for the pursuit of worthwhile learning, in the face of changing contexts. From a practical perspective, change refers to multidimensional procedures through which instructional resources, teaching approaches, utilization of technology, professional development and pedagogical assumptions are reformed (Kelly, 2004a). From a theoretical perspective, change involves the reconsideration of the cultural framework within which educational, scientific and ethical values, patterns of human relationships, and standards of political behaviors are shaped. Thus, any small or large scale reform is a challenging force against current systems, which are usually held together in many interdependent ways. Under conditions of cultural, economic and political globalization and high technological development, change is associated expectations for the development of the social capital of humanity, that is, for the empowerment of the norms of civility, fairness, collaborative engagement and constructive criticism (Coleman, 1990; Fullan, 2001a).

Greece, a small country in the south eastern part of the European continent, is a place where development in all branches, hence also in education, takes place along two main axes, one related to its links to a brilliant ancient civilization and the other affected by its strong will to adapt to a modern European profile. Though not necessarily independent from one another, the coordinates of these two forces are decisive for their final outcome. In such a place, it is expected that educational change is welcome in general by the society while creating strong inertia against it. As a consequence educational change becomes an issue of general interest, a theme of continuous criticism, a topic of political challenge. These characteristics usually shorten the time horizon for educational reforms most of which are implemented with the aim to last while the reality is that they are implemented with the certainty of a short life (Tsakloglou & Antoninis, 1999; Kazamias & Zambeta, 2000).

3. THE OUTLINE OF THE STUDY

The research is completed in seven chapters. The first is this introductory one.

The second chapter, which is developed in six sections, contains a review of the relevant theory. The first section identifies the dynamic, philosophical and socio-economic trends that shape the context within which the current educational system operates, in an interactive, and multidimensional way and which Fullan (2001a) considers indications of the need for change at all levels of the system.

The second section examines the mechanisms and procedures through which ideas about desired change can be put into action. In current social systems, where developments, movements and evolutions are diffused and realized through institutions and organizations, the framework for such processes is formed and unformed by fundamental principles of management and transformed into practice through the fundamental functioning of managers (Crainer, 1998).

The third section focuses on management of educational change, as a concept that can be examined using Complexity Theory. It describes the characteristic and generic elements of educational reform: the incorporation of new learning approaches; the reculturing of teaching; the broadening of the scope of school leadership; the response of the whole system to cultural, philosophical and societal needs (Borron, 1999).

The fourth section analyses the principal functions of system management that lead to sustainable change and examines the fundamental parameters of effective implementation of reform: the appropriate designing of procedures; the organisation of human and material resources; the motivation of staffing; the coordination of all sectors of the educational community; and the control of the outcomes (Fullan, 2001a).

The fifth section investigates issues about primary science education in the context of systemic reform. It concludes that a reform in primary science can be a stimulus for broader change, which may positively affect the learning outcomes of students, the public understanding of science, the general school improvement, the interaction of various sectors of the educational system and the community in general, assuming that the management of the particular change will take into consideration the existing and potential internal or external links of the system.

The sixth section summarizes the findings from relevant research in the field which reflect current ways of thinking about change in primary science and attempts at solving educational problems related to resistance to change, and to the sharing of the meaning of change and effectiveness and sustainability of particular reforms(Driver *et al*, 2000; Davis, 2002).

Chapter 3 introduces the research questions. Firstly, it describes the Greek educational system and analyses the current social economic and cultural trends affecting the Greek educational policies and the underlying factors that characterize its functioning and development. Finally, it summarises the literature review and defines the directions of the study. The research centres on needs and reasons for change, the attitudes of the agents of change, the parameters and dimensions of change and the management of systemic change and its impact on public understanding of science. So, the empirical work focuses on the following research questions:

- What are the societal, educational, cultural and scientific changes that create the need for educational reform particularly in primary science? **(why)**
- What are the attitudes of the various factors of the educational community who are involved in the process of implementation and need to share the meaning of change? **(who)**
- In which way can school management design, organize, coordinate and control the implementation of a reform in a systemic and sustainable way? **(how)**
- To what extent do the procedures regarding primary science learning, curriculum, assessment, professional development BD investment in Information Technologies, enhance the public understanding of science and are they affected by the particular change? **(what)**

The research aims to prove that regardless of the positive attitudes of the members of educational community towards the particular change, the reform will not be sustainable since it has not been designed and organized in the framework of the principles of systemic management (Fullan, 2001a).

Chapter 4 describes the research methodology. Firstly, it describes the general debate around the quantitative and the qualitative approaches, which reflects a liaison

between positive and non - positive philosophy (Cohen & Manion, 1994). The analysis concentrates on the qualitative approach, on the assumption that it is a more appropriate strategy to investigate the subjective meaning of educational change, describing the main schools of thought that direct qualitative research, and some common techniques and procedures that lead to non-numerical findings. The chapter finally describes the methods and the tools used during data collection and analysis.

Chapter 5 describes the empirical research. On the basis of a mainly phenomenological approach (Cohen, Manion & Morrison, 2000), the chapter presents the findings.

Chapter 6 discusses the findings of chapter 4 giving emphasis to participants' statements and thoughts, conflicts and dilemmas, concerns and suggestions. Specifically, the chapter relates these responses to the theoretical framework as developed in Chapter 2, within which the issues of change management, school management and the goals of science education are conceived and developed. Evidence is provided of participants' awareness of the issues involved in educational reform and their willingness and readiness to overcome barriers to improvement.

Chapter 7 generalises the conclusions which to further insight into the findings, arguing the extent to which current educational communities have internalised the complex character of educational reform, the commitment to Science for All (Driver *et al*, 2000), the constructivist approach to children's learning generally and the special case of scientific literacy. The chapter concludes by describing how pedagogical trends, ideas and research findings are expected to reflect on schooling interactions, teaching processes and classroom activities and suggests further opportunities for research.

4. DISSEMINATION OF THE RESEARCH

During the period when the research was being carried out, parts of it were disseminated in conferences about educational studies and research. The titles of these presentations where:

- "Managing Curriculum Change in Greece" This paper was presented on the 6th of January, 2004 in the conference organised by the International Congress for School Effectiveness and Improvement in Rotterdam, the Netherlands (ICSEI, 2004).

- "Teachers' Attitudes towards Curriculum Change". This paper was presented on the 28th November, 2004, in the 4th Pan-Hellenic Conference on Science and Technology Education, organised by the University of Athens, Greece (Tselfes, Kariotoglou & Patsadakis, 2004).
- "Re-designing Time Management in Response to Educational Change". This paper was presented on the 3rd January, 2005 in the conference organised by the International Congress for School Effectiveness and Improvement in Barcelona, Spain (ICSEI, 2005).
- "Interaction, Communication and Co-operation in School as an Essential Condition for Systemic and Sustainable reform". This paper was presented on the 8th April, 2005 in the conference about "Educational Reform: The role of Teachers and Schools" organised by the University of Patras, Greece (Mpagakis, 2006).

CHAPTER II:
MANAGING CHANGE AND REFORM IN PRIMARY SCIENCE EDUCATION

"Until philosophers are kings, or the kings and princes of this world have the spirit and power of philosophy, and political greatness and wisdom meet in one, and those commoner natures who pursue either to the exclusion of the other are compelled to stand aside, cities will never have rest from their evils - no, nor the human race, as I believe - and then only will this our State have a possibility of life and behold the light of day."

[Plato, The Republic, Book 5]

MANAGING CHANGE AND REFORM IN PRIMARY SCIENCE EDUCATION

INTRODUCTION

This chapter provides an analysis of literature, theories and concepts that relate to the management of change in schools and science education. It is developed in six sections. The first one refers to change generally as a phenomenon in the current world. The second one is about management generally and its functions. Then the third section is about management of educational reform. The fourth specialised in managing a systemic and sustainable reform in schools (Fullan, 2001a). The fifth section provides description of the literature around primary science education and current pedagogies. Finally, the sixth section summarises relevant research projects that have been carried out so far and their outcomes.

1. CHANGE IN SOCIAL AND PHILOSOPHICAL HUMAN CONDITION AS AN EDUCATIONAL CHALLENGE OF KNOWLEDGE SOCIETIES

A Current Changing World

Giddens (1999) claims that educational reform, as a phenomenon to manage is strongly affected and related to the context and the society, in which it is happening. At the beginning of the 21st century, the world seems to have taken human thinking by surprise, in the sense that it is a world to which significant changes are happening which do not look like the ones anticipated by underlying intellectual traditions that, have hold a simple but powerful precept about the relationships between human knowledge, science technology and reality: a strong belief that nature can be controlled and human history directed.

The idea that human intelligence can subject the world to greater control has been the driving principle shaping the cultural trends of the last two centuries. Scientific and rational knowledge was expected to replace tradition and dogmatic truths in most spheres of society. According to the vision of Enlightenment and the dominant theories of the last

century, the world is tightly controlled, highly organized and predictable system (Giddens, 1999).

However, recent social transformations suggest the current world to be marked by great uncertainties and new levels of unpredictability and risk. Some uncertrainties are the very sources that were previously supposed to make the world predictable like science and technology. Today, science is much closer to uncertainty that intellectuals ever before imagined. The development of knowledge makes the future increasingly unpredictable (Giddens, 1999). This does not mean that people should before renounce the aim of trying to introduce more government. Mastering the debate about changes that occur in the cultural context is still a major responsibility of contemporary intellectual thinking.

Change is an important area for study because a full understanding of politics, science and economics is rooted in the idea of contextual change. Change is a highly complex self-organizing process involving many factors, some of which are coincidental and non systematic, others are derived from political, philosophical, social or economic foundations, in accordance with Complexity or Chaos Theory and indicate that coping with the apparent reflections of unpredictability and conflict is a fundamental step in the attempt to organize human life intelligently. Change is an uncertain balance between stability and excitement, which demands from all involved, that they share its meaning and feel a common stake in the future (Fullan, 2001a).

The Concept of Globalisation

The central driving force behind most of the major economic, cultural, social and political changes currently affecting the worlds' people today is globalisation. Globalisation can be thought of as initially "widening, deepening and speeding up of worldwide interconnectedness in all aspects of contemporary social life, from the cultural to the criminal, the financial to the spiritual" (Held *et al.*, 1999, p.2). More precisely, globalisation is a set of processes, which embody a transformation in the spatial organisation of social relations and transactions assessed in terms of their extensity, intensity, velocity and impact-generating networks of activity, and exercise of power. It is the consequence of closely interlinked processes of change in the areas of technology, economic activity, governance and communication, whose development is mutually reinforcing or reflexive, so that no clear distinction can be drawn between cause and effect. Current patterns of cross-border flows of investment, trade, immigration, culture

and environmental impact, integrate all countries into a larger global system, thus bringing about major social transformation.

According to Guillen (2001), globalisation, is defined as the rapid increase in cross-border economic, social, technological and cultural exchange is far from a uniform, irreversible and inexorable trend. Globalisation is a fragmented, incomplete, discontinuous, contingent and in many ways contradictory and puzzling process. But whatever its nature, global perspectives can be used by organisations in addressing problems. Business – and increasingly other institutions as well – can no longer define their pursuit in terms of nation states and national boundaries. They must adapt their strategies to a global economy and to the universal availability of information, operating at the same time within the cultural, economic and political framework of their particular communities, under particular rules and local conditions (Drucker, 1999).

Giddens (1999) considers that acceptance of the idea of a 'new epoch', implies an acceptance of not only major economic and political change, but also the need for new philosophical principles and cultural values appropriate to the new type of 'civilisation'. These changes are as major as those between the medieval and the modern world. They have effects on local culture and influence individual identities and relationships. Everyone now has to live a more reflexive life towards an open future with more options to create is or her own identity, rather than accepting what is given within a specific traditional culture.

Globalisation is a complex historical process, not necessarily leading to the emergence of a single world society. It implies the development of new forms of global stratification in which individuals, communities, countries and regions become integrated into global networks of power and prosperity, while others are excluded and marginalised. As a consequence, new forms of governance emerge at national, regional and global level, but the military and economic power of dominant nations still playing decisive roles, creating conditions for social transformation at national and local levels (Castels, 2000; Zembylas & Vrasidas, 2005).

As with any force, that produces significant changes in sectors of social and cultural life, globalisation must be approached and investigated through a framework of research principles capable of leading to the theorization of the social transformation process as a whole. Social transformation concerns aspects of social existence. In order to understand fully any specific issue of globalisation, researchers need to understand its relationships with broader social processes. In addition, globalisation must be studied

historically and comparatively to reveal the relationship between the global and the local. Comparison can only be carried out effectively on the basis of detailed expert knowledge about local cultures and societies. Analysis of local factors is vital to understanding their responses to global influence. As forces of globalisation appear as threats to the livelihoods and values of marginalized groups, it is necessary to look beyond prevailing dualisms between the objective and the subjective, between the modern and the traditional (Castels, 2000).

The Concept of Sustainability

Two of the most prominent discourses in the management of human affairs, which operate at all levels from the global to the personal, are the creation of wealth and the joy that people gain by being in harmony with themselves and with their social, cultural and natural environments. Seeking harmony with their fellows, people try to co-operate rather than compete; they endeavour neither to exploit nor to be exploited. Being in harmony with their inner selves, for some means embracing a spiritual world, and to seek to understand their own rationality and emotions in order to develop themselves and the society and experience the joy of convivial life (Bassey, 2001).

There is a strong tendency in the literature to suggest that there is the belief that worthwhile education arises from joined-up thinking about people and the society. This is at the case of the nation and sustainability, which is seen as the only way of avoiding a chaotic future. According to Bassey (2001a) it is argued that all countries need to learn how to achieve this, in their own different ways: any significant review of educational policy cannot be based solely on consideration of schools. It needs to be embedded in wider issues involving future economic, environmental and social development, and it needs to focus on sustainability.

The difference between a sustainable future and a chaotic one, is 'transformative learning' based on an ecological, participative worldview in which change in education and change in society interact and support each other. Education should replicate culture and promote citizenship, while training people for employment, developing the individual potential, and encouraging a fairer life. Sustainable education is about reconciling these four aims as education necessarily should embrace the concept of ownership of learning by educators, learners and communities rather than by governments and corporations. A modern sustainable society can provide convivial work opportunities and will achieve a

high quality of living for all, but requires creative interaction between education and society. It entails unshackling ideas about progress from the creation of wealth and encouraging teachers to use their creativity to prepare the next generation for the challenges ahead (Sterling, 2001).

Current research shows that, in most developed countries, the teaching profession has been demoralized by continuous political intervention. Teachers according to research need more autonomy in classroom action, not only to retain their status but also to free their imaginations and creativity in preparing for the future (Pollard, 2001; Richards, 2001; BERA, 2001; Horne, 2001; William, 2001). Government-induced change and centralized control exhaust teachers. While it may have been appropriate twenty years ago for politicians to shake up the education system in response to changing economic needs the continuing process of political intervention has become a barrier to improvement and innovation (Bassey, 2001).

The efficacy of reorienting education for sustainability depends partly on the capability of those who lead the effort and the readiness of those who must implement it. One of the reasons that education has not already reoriented to itself address sustainability is that the need for change is not readily apparent. The central issue becomes whether to change rather than how to change. The initial step in implementing change for sustainability is developing awareness within the educational community and the public that reorientation is essential (Bassey, 2001).

The Concept of Intellectual Capital

According to Dewey (1916), what distinguishes human beings from other organisms, is their capacity to adapt to new situations through conceptualising emerging problems and possible solutions. Since education, being concerned with the life of the mind, aims at the ability to develop and produce knowledge, to understand and to criticise current social trends that call for change are in fact educational challenges. Consequently, educational organizations, where individuals and groups are engaged in learning, have the greatest potential for initiating implementing and accelerating successful change processes (Fullan, 2001a; 2001b).

As Kelly (2004a) states, the potential within educational organizations for generating, transferring and utilizing knowledge, as well as for managing and responding effectively to change consists of their intellectual capital. Intellectual capital represents

not only the knowledge and utility that emerges from human interactions, but the cultural influences, social relationships, skills, experiences, transferable competencies and ability of the educational institutions to meet demands for improvement. It is associated with the organizational infrastructure, routine activities, symbolisms, human networks and the capacity of personnel to strive towards future targets. Of course, responding to change does not mean being concerned with change for change sake, but it means promoting strategies for improving outcomes and driving the organization forward (Kelly, 2004a).

Fullan (2001b) claims that the development of intellectual capital has a moral purpose for organizations in a changing world context. The goal of that moral purpose has to be addressed productively, to achieve adjustment to new social conditions, understanding the forces that drive change, sharing its meaning and accomplishing desired objectives while dealing with the chaotic complex reform (Fullan 2001a).

2. MANAGEMENT AND EDUCATIONAL ORGANISATIONS IN A CHANGING ENVIRONMENT

Definitions and History

Defining management is a very difficult task, not only because of the breadth of its meaning, but because of the interpretations by its nature. There are many different definitions given for it, but the uncertainties and disagreements are even more numerous (Crainer, 1998).

A basic question about management is whether it should be considered an art or a science. On the one hand, managers regard management as a set of actions rather than ideas. Specifically, confirmed by the goals of commercial and financial achievement and since their attentions are focused on sales managers generally conclude that management is not theoretical but a practical activity. It is simply developing and working with people and the achievement of objectives and outputs (Crainer, 1998). On the other hand, it does not seem to be possible to separate management from ideas. According to the psychologist Kurt Lewin (1936), there is nothing as practical as a good theory; every action and decision should be the result of clear and careful thought but based ideas on instinct as well. Those managers who ignore ideas are likely to end in crisis, as they cannot be sure of where they are headed or why (Crainer, 1998).[1]

Concentrating on the Single Best Way

It is widely acknowledged that there is no single approach for managers by which they can solve all the problems they come across. The fundamental ideas that have shaped and still shape management today are frequently inflexible and unstable in some situations. Ideas count, but they are not panacea. Whenever a manager is faced with a crisis, it is high unlikely for him or her to find, in a relatively short period of time, the optional strategy to implement and for that the desired strategy to have effects immediately. Some managers

[1] A good example of the application of ideas is the post-war development of the Japanese motor industry, based on the ideas and research of the Americans W. Edwards Deming and Joseph Juran, which the Japanese took to function (Crainer, 1998). The Japanese have a tradition of revering ideas and translating them into practice. Early management thinkers such as Frederick Taylor and Mary Parker Follett were acknowledged in Japan before they were being recognised in their home countries. In the Western world, there was then a widespread perception that ideas were distracting, and that instant solutions were be definition impractical (Crainer, 1998).

behave as addicted to the idea of quick fix. The way, in which managers come across new ideas and adopt them, is not very clear. Trends and fashions emerge quickly, but disappear just as quickly (Crainer, 1998).

People have an inclination to consume, ideas and fashions, and doing so corporations are mainly as a result, ironically of the professionalisation of management[2]. Historically the consideration of management as a profession is underpinned by the assumption that there is a set of skills and ideas that must be obtained by someone who wants to become a professional manager, like bag of clubs held by a golfer. The professional manager chooses the most suitable skill from his or her collection and uses it, and whenever that was necessary, new skills can be included in the managerial 'bag'. However, the latest thinking is that management processes are not that straightforward and simplifying the management complex can sometimes be dangerous. There is no simple best way to manage, other than a use of experience and being flexible (Crainer, 1998).

From Machine Age to Information Age

Modern management has its roots in the Machine Age of the 19th century. As the world moved on to what is now called the Information Age, the traditional practices and precepts of management were questioned, leading to a considerable change in the form and norms of traditional management:

- Command and control; in the sense that management was applied to people in the form of "benign dictatorship" (Crainer, 1998, p.2).
- The belief that there was one right way to accomplish tasks successfully.
- Subjugation not subversion. Subjugation was a major characteristic of the Machine Age. Nowadays, there is a tension to plain subversion.
- Labour not human resources. The workforce of a company used to be considered as labour, consisting of people who were expected to devote themselves to the company, which in return did not owe them anything.

[2] The MIT professor Peter Senge, having enjoyed a period of international fame as the inspiration of the notion the Learning Organisation which emerged as a fad in the early 1990s saw his ideas lose popularity from about 1995.

- National not global. The Modern Age perspectives were generally limited to national level.
- Security not insecurity. In the Machine Age, the companies had a feeling of stability and permanence, dominating towns and local economies. The future appeared predictable, as did their place in it (Crainer, 1998).

The term 'scientific management' (Crainer, 1998, p.3) is attributed to the American inventor Frederick Winslow Taylor (1856–1917), who introduced it after observing the way tasks can be undertaken and accomplished. In scientific management, managers plan and control the work, as Taylor (1947) observed and component workers spend considerable amount of time studying the pace and rate at which they work to convince employers that the productivity is at a high good level. He also observed that workers worked solely and exclusively according to instructions and orders given to them.

Taylors' philosophy suggests that the role of managers goes beyond the role of supervisors who just pay attention to the stop-watch in order to categorise workers and as useful or useless.

There are five steps in scientific management.

- Firstly, a group of people skilful in the work to be done is assembled.
- Secondly, a study of the operations, decisions and personnel is carried out.
- Thirdly, a stopwatch is used to assess the time required to complete each elementary movement, so that the quickest way of completing each element of the work is found and selected.
- Fourthly, all movements which are found to be slow or not required are eliminated.
- Finally, the quickest, best and movements are adopted, along with the best tools for implementation (Taylor, 1947).

In spite of the fact that Taylor's ideas referred to a past era, they constitute a useful guidance for present managers. The importance of his work lies in the fact that he was the first person to investigate the actual 'act of work' and the skills and phenomena relevant to it.

Contemporaneously with Taylor, an effort to define management was made in Europe, by Henri Fayol (1841–1925). Fayol's main work was, *General and Industrial Management*

(1916), which was first published in French and then in the 1940s was translated in English. In this work he emphasised 14 principles of management. These were:

- The Division of Labour. Any task can and should be divided to sub-tasks and employees should specialise in a specific set of tasks and skills. This way, expertise can be developed and productivity increased.
- Authority and responsibility should be co-located. Authority refers to the right to give orders to employees and entails the responsibility to reinforce them with rewards and penalties when necessary.
- Discipline is crucial for a problem-free performance. It is strongly dependent on efficient leadership, clear and fair argument and the application of penalties.
- Unity of command. Employees should receive orders from only one superior, whatever the action concerned. If that does not happen, authority, discipline, order and stability become unbalanced.
- Unity of direction. A set of tasks and activities, concerned with a specific objective, must be co-ordinated by a specific plan under one leader.
- The subordination of individual interest to general interest. The objectives of an individual or a group within the organisation should not undermine or overpass the objectives of the organisation.
- Remuneration of personnel. Workers should be fairly remunerated and compensated when necessary. The methods for remuneration should be chosen carefully. It should encourage effort and avoid leading to overpayment.
- Centralisation. The level at which orders are given and issued only from the head and the managers of the organisation is difficult to be identified. It is a problem that should take into consideration various characteristics of the organisation as size and the capabilities of the personnel.
- Scalar chain or line of authority. In an organisation, communication should only flow up and down the scalar chain. Communication between employees of an equivalent rank in different departments can be accepted provided that superiors are informed and approve.
- Order. Materials and personnel should be kept in good order. People should be allocated appropriate and suitable tasks. There should be precise organisation of work and careful selection of personnel.
- Equity. Treatment of personnel should always be kind and fair.

- Stability of tenure. Turnover and replacement of personnel should be avoided, whenever possible. The development of staff and new employees takes time and costs money.
- Initiative. Employees should be encouraged to exercise initiative within limits imposed by the requirements of authority and of the job.
- *L' Esprit de Corps*. Efforts should be made to promote harmony within the organisation (Fayol & Gray, 1987).

It is the emphasis on the *Esprit de Corps*, that differentiates the ideas of Fayol from the principles outlined by Taylor. Indeed, the latter believed that the identification of workers with fellow-workers is likely to act as distraction, and create problems.

Fayol and Taylor also differ in the issue of division. Fayol advocated dividing commercial organisations' activities into six elements: technical, commercial, financial, security, accounting and management. And according to Fayol, the element of management includes five different dimensions: planning, organising, commanding, coordinating and controlling. Even today it is notable that practicing managers identify similar elements as core to their activities (Crainer, 1998).

The New Challenges of Information Technologies

According to Drucker (1999) a new revolution regarding the flow of information has already started. It is not a revolution in technology, machinery, techniques, software or speed; it is an information revolution that introduces new ways of valuing concepts and affects soon all social institutions, reorienting radically the ways in which individuals and organisations conceive the meaning of the term information.

Historically, Information Technology systems have concentrated on the collection, organisation, dissemination and presentation of data: that is, they have focused on the technical aspects of IT. Today there is a practicing tendency to think about the meaning, essence and purpose of information itself, which is leading a questioning of the contribution of IT to the individual and organisational development. In fact, as far as high-level management is concerned, computers might be capable of producing and organising data but they cannot contribute as in the area of decision- making. Information Technologies cannot themselves provide original or alternative planning strategies (Drucker, 1999). Management theorists have also realised that people who are involved in

an organisation's decision-making need to determine what constitutes a necessary or a worthwhile flow of information. They need new clarifications not only of the basic concepts regarding the nature of information but, also, of new methods of systematic collection of information. In the new approach, information is more closely related to external reality, contextual situations, and community interactions and cultural differentiations (Drucker, 1999; Zembylas & Vrasidas, 2005).

These trends have become apparent principally in the business world, but they are expected, soon to affect the field of educational management. It is already known that changes in educational technologies are followed by changes in the fundamental structures of educational systems. The expansion of distance education, the increasing emphasis on the necessity for the professional re-training, the importance of offering educational opportunities to mature people and the creation of new centres of education outside schools eventually leading to conceptual changes regarding the essence of education and the mission of educational organisations.

The Emerging Knowledge Society

In the economic order of the recent society, knowledge, not labour, raw material or financial capital is the key resource and by a social order in which inequality based on knowledge is a major challenge. Allied to this is the emergence of a polity in which government can no longer be relied upon to solve social and economic problems (Drucker, 1994a). Social transformations of the preceding decade have changed society and its policy. As a result knowledge, acquired practically through schooling, has become the key resource for the nation and its community as well as the main factor in individual development. Many jobs require knowledge qualifications. They require a greater content of formal education and the ability to acquire and apply theoretical and analytical knowledge. They require a different approach to work and a different mind-set. New jobs can offer great opportunities, but at the same time they require 'jobbers' to develop a habit of continuous learning. The newly emerging dominant group in the labour forces of developed countries is knowledge workers whose rise is grounded in a change in people's basic attitudes, values and beliefs (Drucker, 1994a). This is true whether knowledge workers command advanced elementary knowledge. In either case it is the knowledge investment that determines whether employees are productive or not. In the knowledge society, knowledge is a tool of production. Employees own the tools of production as true

investment is no longer in machines and technical material but in human knowledge. Without it the machines would be unproductive, advanced and sophisticated though they might be (Drucker, 1994a).

Of course, knowledge of a new type is always fundamentally different from old knowledge. Changes in society will always have profound impact on what counts as knowledge, how it should be treated and why it is valued. In fact, modern trends question the premise that there is a secure knowledge base. The new conception of knowledge is no longer linked with certainty and does not depend exclusively on the intellectual ideal of a complete and scientific explanation of reality (Pring, 2000).

The Post-Modern Philosophy as Applied to Management and Organisations

Managers, bring different people together for joint performance to make human strengths productive and human weaknesses irrelevant. They have to think through the kind of desired results of the organisation and define objectives. They also decide about strategies, through which these results become achievable, define the organisational values, system of rewards and punishments, spirit and culture (Drucker, 1994a).

Current ways of thinking consider management not only as a mere bundle of techniques, such as budgeting and human relations. The profound essence of current management, though, is to make the knowledge productive. It is a social function with humane, socially responsible and ecologically sound practices and organisation designs (Palloff & Pratt, 1999).

Moreover, a challenge to the kind of management that current intellectual or business communities desire, comes from the post-modern embrace. Postmodernism is characterized culturally and intellectually by wide-spread questioning of the dominance of any view of the world and by a fundamental assumption that in approaching human and social condition there are always different perspectives within which, what counts as reasonable is defined differently (Pring, 2000).

In the complex and pluralistic societies there is not only diversity in culture, but diverse modes of rationality and of perspective. After all reason is a social construct. What counts as rational depends on the agreement between people, which usually is reached through "negotiation" (Pring, 2000, p.111). Consequently, the managerial tasks, which have been traditionally defined within particular perspectives, as those of the business world of developed countries, have to be continuously worked-out. At present,

there is a necessity for redefinition of the scope of management since it there is no one right way to manage people neither a type of right organisation (Drucker, 1999).

According to the post-modern way of thinking, the management scope in the context of the knowledge society goes beyond the organisation. Knowledge became the key resource for social economic and cultural development, so managers need systematic work on the quality and the productivity of knowledge, on which performance, capacity and survival of organisations in the knowledge society depend.

Production and acquisition of new knowledge are processes intrinsic to the willingness and ability to change. Within the post-modern philosophical framework, where knowledge is always being tested out against further experience and criticism, change is inevitable. Current management priorities include the intelligent abandonment of established practices and policies, which need to be replaced as change and continuity are poles rather than opposites that need to be balanced (Drucker, 1999).

Recent managers must become change agents. Being concerned with the production and effective use of new knowledge, they attempt to change the situations in which, for a time, the knowledge claims were true. In fact, managers should stay ahead of change. As change leaders, they act within shared ethical frameworks of ideas and values, look for change, know how to find the right changes and know how to make them effective both outside the organisation and inside it (Drucker, 1999).

3. MANAGING EDUCATIONAL CHANGE: THE IMPORTANCE OF DEVELOPING SHARED MEANINGS

The main Principles of the Concept

Fullan (2001a) states that any study around change needs to be based on principles related both its meaning of change, its theoretical dimensions and to its process. Educational change is a socio-political process associated with specific values and goals that involves all kinds of individuals, classroom, school, local, regional, and national factors at work in interactive ways. Those involved in change need to understand what should change and how this can be best accomplished. Consequently, this study, which is about educational change, should take into consideration that:

- Change must be viewed in relation to particular values, goals and outcomes it serves. Educational Change should be directed towards the improvement of the educational practice. Therefore, theories of change and theories of pedagogy must be integrated in action settings to attain effective learning, which is considered to be the guide of the development of individual minds through many minds working together.

- Change is a multidimensional entity with at least three components: the use of new instructional materials, the use of new teaching approaches, and the alteration of beliefs and attitudes. Although the classroom or teaching activities are closest to instruction and learning, change in practice occurs in many levels, including school administration, policy making and the community environment. All aspects are necessary because together they represent the means of achieving a particular educational goal.

- Educational change above all is a people-related phenomenon. Students, teachers, parents, community members and school administrators, are participants in any process of change in organizational life. Unless all participants have some meaningful role in the process, most educational change will fail.

- The overall purpose of educational change is the creation of new knowledge. All learning organizations should be considered to be energy and knowledge creators. They must interact to produce shared commitment and to constantly worry about what is worth-learning. New knowledge, associated with educational change, should be disseminated and embodied in the educational practice, provided that change is meaningful, relevant and substantial (Fullan, 2001a).

- Change should lead to the improvement of the educational system as a whole. Small-scale improvement will not last if people involved in the processes of change do not identify and help improve the surrounding system. The route to both personal and social betterment is the "outward identity" (Fullan, 2001a, p. 271) where every individual, school, community or district is equally concerned both with its own success and with the success of others.

- Educational change has a strong moral component. There are deep reasons to believe that society will be stronger if the introduction of educational change serves to enable people to work together to achieve higher purposes that serve both the individual and the collective good. Working through the complexities of until all participants, getting shared meaning and commitment is the only way to get substantial improvement.

The Phases of the Change Process

The process of educational change leading to the raising of learning outcomes and to the improvement of learning organizations is a complex action affected by various factors. However, research has managed to provide, a simplified overview of its direction, indicating that the process consists of three broad phases: initiation, implementation and institunalisation of change. Phase I refers primarily to the decision to adopt a change. Phase II refers to the attempts to put the change into practice. Phase III refers to the incorporation and continuation of change "as an ongoing part of the educational system" (Fullan, 2001a, p.50).

This is a general image of a complicated and more detailed non-linear procedure, in which countless factors and determinants affect the different stages in a continuous,

interactive way. The single most important indication arising from this image is that change is a process, not an event. Its scope, depth, sustainability and success depend on the interplay between the individuals' roles and the educational trends, within the context of a particular system. More specifically, studying a process of change in primary science involves the investigation of the attitudes of teachers, leaders and members of the community toward change, the learning objectives to which the change is supposed to head and the particular characteristics or limitations of an educational system within which change is initiated.

Studying the Management of Educational Change through the Perspectives of Complexity Theory

Investigating an educational situation, such as the management of school science as an activity in the fields of social sciences, is usually inspired by the current philosophical trends referred to the acquisition of knowledge and the exploration of social reality.

Over the last decades some of the most important world-views that provided ideas, which were fundamental to scientific endeavour, have been deeply questioned and essentially reviewed under perspectives of new ways of thinking about approaching and exploring social conditions.[3]

The innovations in the physical sciences and mathematics led to the latest theoretical developments of the way of thinking, about human condition. The intellectual trends tend to accentuate the importance of non–linear over the linear, the complexity over simplification, the impossibility of complete isolation of the observer from the phenomenon observed and the superiority of qualitative interpretations over qualitative precision (Gulbenkian Commission, 1996).

The new orientation in more advanced scientific thought proposes the act of crossing the artificial boundaries erected in the past between the different disciplines in the fields of knowledge (Boron, 1999). The interpretation of social reality calls for human

[3] First of all, the Newtonian supposition that there was an absolute symmetry between past and future that permitted the establishment of essential certainties for the nascent natural sciences has entered into crisis. In addition, the Cartesian view that stressed the duality between human kind and Nature, between the physical and spiritual world, has been profoundly challenged. The weakening of Newtonian and Cartesian paradigms has also affected, negatively, the phenomena of professionalisation and specialisation, according to which, a series of specialised disciplines have been established that were associated with specific aspects of human behaviour and human thought (Boron, 1999).

capacity to cross-interdisciplinary boundaries that impose restrictions on the analysis of social situations. Current theories do not conceive societies as collections of parts of isolated fragments organised by the laws of positivism and institutional orders or factors that act as social agents. Current ways of thinking rejects the fragmentation and reification of social relations leading to the formation of economics, politics, culture, and society as so many separate spheres distinct from social life, each one claiming its own specific knowledge independent of the others. In opposition to this operation, "dialectics states the specific unity of all things" (Lukacs, 1971, p.12). Accordingly, political, economic, intellectual activities cannot be attributed to some socially constructed and historically limited institutors. Any attempt to interpret social conditions needs to be capable of capturing totality, according to Boron (1999).

Nowadays, the concepts and statements derived from chaos theory are questioning the deterministic models according to which, every event happens of necessity. Chaos theory rejects the claim that all natural phenomena can be predicted with sufficient knowledge of the current state of the universe. Current scientific thinking conceives the world as much more unstable and complex with disruptions to play an extremely important role in it (Gulbenkian Commission, 1996). The stable systems of Newtonian science, which are only temporarily reversible, represent merely a limited segment of reality. It serves the understanding of the equilibrium of systems, or situations close to it but not systems far from the equilibrium, which are related to the more frequent conditions.

Educational systems are highly complex organisations of an inherent evolutionary and historical character in the sense that they change over time and usually they change by becoming more complex in an irreversible way. They involve sharing of ideas, methods and experience across a number of fields. They have emergent properties, which are not supposed to be understood by reduction analysis of the lower order components. The non–linear and emergent character of educational systems means that they cannot be explored on the basis of certain established general non–contextual laws. Besides, educational activities cannot be approached through the perspective of the two–valued logic, in which order and disorder are dichotomous and opposites (Byrne, 1997).

In studying education systems, conceptions of order and disorder are not conceived as antagonistic and fixed states but rather in a process of dynamic and transformational becoming. On one hand, educational changes are not reversible over time. An account of educational progress centres on non–linear changes in the properties

of educational systems as a whole rather than the linear trajectories of the elements, which are located within these systems. In addition, the historical and evolutionary properties of education permits a proper understanding of the relationship between the temporal and the social through the conceptualisation of the factor of time (Byrne, 1997).

On the other hand educational systems have so far demonstrated a series of regularities in both their structures and their historical course of evolution. Educational situations of diverse societies have proved to be consistent with the stipulations of certain theoretical models (Boron, 1999). There are valuable theories and generalisations, referring to learning and pedagogical models that can be proved to be helpful in the description or the prediction of certain aspects of educational phenomena. Theories inspired by chaos models are often unlikely to explain foreseeable systematic tendencies exhibited by educational behaviour, under various sorts of social conditions.

While describing current philosophical perspectives in social science, it seems accurate to concentrate on Prigogines' idea of the open and non–predetermined nature of history. The idea, which derived from the fields of science, rejects any kind of dogmatism (Prigogine & Strengers, 1984; Boron, 1999), focusing on the dynamic system, which undergoes the sudden transformation from apparently chaotic to apparently ordered on the other side of the bifurcation point. Moreover, Prigogines' mathematical model can specify when such order lines are not just possible but high likely to arise (Prigogine & Strengers, 1984; Porush, 1991).

Finally, when studying educational systems, it is important to take into consideration that any complex social situation is abstract, if not conceived together with its "basis and superstructure" (Kosik, 1967, p.74) in its reciprocal relationships, its movement and development. Furthermore, it is well–known that within this system, men and women are concrete, real historical subjects who, in the process of social production and reproduction, create both the basis and the superstructure, construct social reality, institutions and the ideas of their time and that in this creation of social reality, the subjects create and recreate themselves as historical and social beings.

The Learning Process as the Generating Factor of Educational Change

There is no doubt that a new environment is replacing the productivity-centred model in the area of education. Schools today are at the edge of great democratic possibilities, if educators are to play a major part in the evolution of the emerging knowledge society.

The development and maintenance of knowledge requires institutional support. Educational institutions, primarily, are responsible to carry out and support the teaching-learning procedures. They also have to investigate social reality, examining particular social settings and seeking for general truths (Pring, 2000).

Through educational research institutions can develop theoretical perspectives or bodies of knowledge about practices, policies, achievements and human relations. Pring (2000) supports the need of these theoretical perspectives to be refined constantly in the light of more detailed studies. They will need to adapt to the new changing social context, which affects the nature of the social connections and conditions. Theoretical perspectives concerned with social reality "need to be more tentative, more to cope with exception, more adaptable to the changing consciousness of those who are part of that reality" (Pring, 2000, p.117).

Learning, at all levels and sectors of the educational system, is a continual process of making meaning. The generating model of understanding is in line with the new pedagogy of constructivism, which underpins modern approaches to learning. This model supports the inner workings of educational change processes. Meaning making requires a radically new way of approaching learning, that guides the individual mind through the process of many minds co-working. According to the perspectives of constructivism, educational change is a knowledge-base process and a promising features of the new knowledge about change is that it makes sense (Fullan, 2001a).

The new emphasis in educational change is not based on transforming the existing structures but on creating the conditions to develop the capacity of both organisations and individuals to learn. It focuses on changing the culture of the classrooms and schools, emphasizing the importance of relationships and values. Fullan (2001a) believes that future change needs to be characterized by coherence, connected, synergic, alignment and capacity for continuous improvement.

Change is appreciated to involve usually anxiety and struggle and difficulty to be assimilated unless meaning is shared by all individuals or groups involved. Real change involves passing through the "zones of uncertainty, of being lost or of confronting more information that can be handled" (Schon, 1971, p.12). Schools world wide, following a decade of top down reform are now suffering from overload. Predictable, rational imposed solutions that ignore the culture and the specific character of each individual school cannot be effective. As each school is unique, solutions cannot be simply transferred from one learning organisation to another (Sarason, 1971; 1990).

People should not develop new ideas until they are involved in the process and the context. Ownership, in the sense of clarity and commitment, is a progressive process achieved gradually, until a critical mass is achieved. The developmental process applies to an individual, a class and to school. According to Fullan (2001a), educational change, desired or not, represents a set of personal and collective experiences, characterized by ambivalence and uncertainty. If the change works out it can result in a sense of "mastery, accomplishment, and professional growth" (Fullan, 2001a, p.32). The anxiety of uncertainty and the joy of mastery are important to the subjective meaning of educational change.

Inspirational School Leadership for a Fair and Inclusive Society

The main agents of educational change are teachers and school principals. Principals are in the middle of the relationship between teachers and external ideas and people. They are also at the edge between the old world that demands the running of a smooth school and the new world that demands improvement. These demands will be fulfilled, if principals understand the reality from the point of view of people involved, facing all kinds of conflicts and dilemmas. Only this way, are they able to contribute effectively to the development of learning organisations (Fullan, 2001a).

School leaders, occupy various roles in the school and provide direction and exert influence in order to achieve the school's goals. They do not merely impose goals on followers, but work with others to create a shared sense of purpose and direction. Leaders primarily work through and with other people contributing, this way, to the establishment of the conditions that enable others to be effective. Thus, leadership effects on school goals are indirect as well as direct (Riehl, 2000; Leithwood & Jantzi, 1999).

Educational leaders guide their schools through the challenges posed by an increasing complex environment. Curriculum standards, achievement benchmarks, programmatic demands and other policy directives from many sources generate complicated and unpredictable requirements for schools. Principals must respond to increasing diversity in student characteristics, including cultural background and immigration status, income disparities, physical and mental disabilities, and variation in learning capacities. They must manage new collaborations with other social agencies that serve children. Rapid developments in technologies for teaching and communication require adjustments in the internal workings of schools (Riehl, 2000; Leithwood & Jantzi,

1999). Every single study of school effectiveness has shown both primary and secondary leadership to be the key factor (Sammons, 1999; Bryk *et al.*, 1998).

Successful school leaders respond productively to the opportunities and challenges of educating diverse groups of students. They can promote equity and justice for all students by establishing school climates where patterns of discrimination are challenged and negated. In highly diverse contexts, school leaders must focus their efforts on four sets of tasks:

- Building powerful forms of teaching and learning that both monitor progress and motivate students, ensuring ambitious and equitable performance.

- Creating strong communities in school by establishing communal cultures and structures or personalised learning environments.

- Expanding the proportion of students' social capital valued by the school. Social capital, which consists of the knowledge, habits, dispositions and preferences that culturally diverse children bring to school, may become an educational asset and a considerable potential for influencing learning.

- Nurturing the development of families' educational cultures. School leaders should promote trust and communication by helping to provide resources to families, by educating and supporting families and by adjusting school practices to accommodate to the educational practices that families do have (Leithwood & Jantzi, 1999; Riehl, 2000).

Sophisticated educational leadership is a complex art. It is a function more than a role and what is at stake, is the "reculturing" of a school (Fullan, 2001a, p.147) that is a deep and more lasting change, affecting positively the school values and principles creating harmony and forging consensus between the learning community and the orientations of an open, democratic, multicultural, fair society.

In almost all educational contexts, a core set of leadership practices have been identified as important for leadership success: setting directions; developing people and developing the organisation. Each category encompasses specific competencies,

orientations, and considerations aiming at providing intellectual stimulation, individualized support, effective collaborative processes and positive interactions with the environment. These practices usually contribute to the strengthening of the school culture and to the monitoring and adjusting of the structural organisation of the school toward the improvement of the conditions for teaching and learning (Leithwood & Riehl, 2003).

Operating within a broad framework of standards and expectations, thinking leaders can blend knowledge of local context and personalities with new ideas from the outside areas. Thus, they can act as energy creators in the process of change, realizing that above all, "educational change is a people-related phenomenon for each and every individual" (Fullan, 2001a, p.151) and if people cannot find meaning in any reform it cannot have an impact upon the development of the learning organisation and in consequence, of the society in general.

Re-Culturing the Teaching Profession

Successful educational procedures depend primarily on the knowledge and skills of each individual teacher. The biggest revolution is the act of "re-culturing" the teaching profession that is "the process of creating and fostering purposeful learning communities" (Fullan, 2001a, p.136). Teaching needs to become a highly intellectual as well as a highly caring profession. This means understanding what an effective teacher and teaching profession is, and working at creating it at all levels in the system.

Nowadays, as thought by Fullan (2001a), change is needed to make teaching procedures more interesting and more exciting to teachers themselves. At the teacher level the degree of change is strongly related to collegiality that is to the extent to which teachers interact with each other providing technical help and mutual support. Besides, significant educational change consists of changes in beliefs, teaching style, and materials, which can come about only through a process of personal development.

Personal contacts and participation in skill-training programs may provide teachers with opportunities to receive and give help and to converse about the meaning of change. Collegiality is the basis of "purposeful interaction" (Fullan, 2001a, p.124) and continuous improvement, as it helps teachers to learn how to use an innovation and to judge its value.

Interaction is a significant trait of the professional learning community within which, teachers and principals collaborate in goal-setting activities. In effective schools, collaboration is linked with norms and opportunities for continuous improvement and career-long learning. Since improvement in teaching is a collective rather than an individual task, teachers who collaborate with each other are more likely to trust, value and legitimise sharing experience in cases where they have to decide upon accepting, modifying, or rejecting externally developed ideas and innovations (Rosenholtz, 1989; Perryman, 2005).

According to Newman and Wehlage (1995) the professional learning community should be linked with students' performance. In successful schools, teachers take collaborative responsibility for student learning, concern about the level of classroom pedagogy and affect the level of social support, which in turn affect student performance. Teachers as a group or as subgroups examine together how well students are doing, relate this to how they are teaching, and then make improvements.

Hargreaves and Fullan (1998) diagnose a need for teachers to become assessment literate. Assessment literacy involves the ability to examine student performance data and results and to make critical sense of it. It also involves the capacity to develop classroom improvement plans and to make the kind of changes needed to increase performance. Teachers are expected to be proactive and open about school performance data and participate actively in the continuous debate about the uses and misuses of achievement data in an era of high-stakes testing.

The development of interactive and collaborative professional learning communities can improve profoundly the quality of learning, which is necessary for students. The important fact is that these communities may integrate development and accountability in new cultures of improvement providing everyone involved in educational practices and policies with opportunities to participate actively in the processes of change (Fullan, 2001a).

Educational Management Approaching the Demands for Change

Understanding the Culture of the Organisation

The accelerating pace of changes in contemporary western society requires from each institution, the ability to be responsive to an ever-changing environment, to interpret the meaning of the main ongoing transformations, to draw implications in order to understand missions, to bring goods and courses of action up to date, while taking advantage of new opportunities or prevailing conditions.

These duties are mandatory for institutions designed to educate, not for today but for tomorrow, as is the case of any school and educational system. However, even if the national community understands the urgency of the change and is capable of establishing a development strategy this need for change gathers consensus, questions that inevitably arise are whether a particular educational system has the ability to change and whether there are appropriate conditions to implement it (Fullan, 2001a; Parker, 2005).

Reform efforts are usually based on the assumption that proactive, intentional change in educational organisations can succeed despite the predilection for tradition and maintaining the existing culture. Culture is a critical component in understanding the process of planned change and transformation since institutional transformation tends: a) to alter the culture of the institution by changing select underlying assumptions and institutional behaviours, processes and products; b) to be deep and pervasive affecting the whole system being; c) to be intentional; and d) to occur over time (Eckel, Hill & Green, 1998; Perryman, 2005).

An organisation's culture can be understood as the sum of assumptions, beliefs, and values that its members' share and is expressed through "what is done, how it is done, and who is doing it" (Farmer, 1990, p. 8). In most cases the members of an organisation do not truly evaluate the cultures' impact on decisions, behaviours, and communication or consider the symbolic and structural boundaries of organisational culture until external forces test it.

Therefore, when initiating transformation efforts it becomes critical to understand and explicate the values and personal meanings that define organisational culture[4]. Organisational culture can either facilitate or inhibit institutional transformation, depending on the relationship between existing culture and the proposed change.

[4] "Failure to understand the way in which an organisation's culture will interact with various contemplated change strategies may mean the failure of the strategies themselves" (Farmer, 1990, p. 8).

Organisational culture is closely related to basic aspects of the change process: readiness for, and responsiveness to institutional transformation; resistance to planned change; and the results of the transformation process (Farmer, 1990; Fullan, 2001a).

Relevant case studies reveal the importance of understanding organisational culture. Organisations characterized by collegial values, - teamwork, participation, commitment, and high levels of affiliation - view change enthusiastically. On the contrary, organisations characterized by elite, autocratic, or leadership-like value structures are more likely to view change negatively (Kabanoff, Waldersee & Cohen, 1995; Kezar & Eckel, 2000).

An important cultural condition for effective change is the existence of trust among the various members of the campus community. Trust is always enhanced when decisions and strategies reflect a clear and sensitive understanding of the culture of the campus (Farmer, 1990). Another necessary condition is the use of planning strategies that are open, participative, aligned with campus culture and goals and long-term. Strategies abided by these values facilitate the development of trust and reflect the scope for innovative educational change (Steeples, 1990; Perryman, 2005).

Managing Flexibility Conditions and Facing Resistance to Change

Resistance and lack of flexibility are important cultural components of institutional transformation. They are often associated with longstanding traditions and with a variety of customs, beliefs and practices of the context that is due to change. Educational environments are often characterized by sub-cultures, which resist change, especially when the proposed innovations appear to threaten privileges in the hierarchy level or in resource management (Kashner, 1990).

To address the needs for flexibility in implementing change, several factors should be taken into consideration:

- Compatibility, which is the degree of congruence between the paradigms and requirements of change and the norms, values and goals of the institution (Levine, 1980).
- The cultures, sub-cultures and structures that hinder or favour the change (Kashner, 1990).
- The old habits, points of view and opinions of people involved, who are, students, parents, teachers, staff, administrators, political leaders, and local authorities (Eckel, Hill & Green, 1998).

- The conflicting priorities and values that can occur between administrators – who are usually the initiators of change – and the faculty, the body frequently charged with implementing changes (Kashner, 1990; Swenk, 1999).
- Profitability, which is the measure of effectiveness of an innovation in satisfying the adopter's need (Levine, 1980).

In practice, there seem to be doubts as to the capacity of the currents system to develop more flexible forms of management of human and material resources. The growing number of researching staff with zero timetable and the difficulty to promote more favourable student/teacher rates to improve the quality of teaching are significant examples of common dysfunctions in educational systems. Other dysfunctions could be:

- Excessive legislation weight.
- Failure to implement approved legislation
- Insufficient attention to knowledge resources, as lack of knowledge banks to support teachers, regarding questions for tests and exams.
- Difficulties in articulating human resources, material resources and real demand as it happen with teachers with zero timetable.
- Scarcely improved selection model as access to public higher education.
- Insufficient completion of continuing education and in-service training
- Almost complete lack of clarifications given to higher education or professional education candidates
- Disparity of costs per initial education student and continuous training student
- Conflicts and contradictions in assessment policies throughout basic and secondary education
- Absence of performance indicators in basic secondary and higher education schools and corresponding benchmarking
- Insufficient articulation and flexibility as regards initial and continuous education and training (Valadares-Tavares, 2000).

In the modern word of organisations there are no change processes without objection; frameworks of requirements without leadership; methods to evaluate transformations without confrontation between supply and the primacy of demand. However, despite its' difficulties, human reality of schools seems to offer good grounds for the improvement of its management. Thus, by maximizing profitability and

congruence, educational organisations may implement effectively the planned changes (Levine, 1980).

Sometimes, the cultural boundaries of the institution need to be expanded in order to include a worthwhile innovation. Other times the boundaries of an innovation need to be enveloped and become completely absorbed by the boundaries of the institution. In any case, the outcomes and results of innovation and change are embedded in the culture of organisations (Levine, 1980).

Shifting the Goals and Orientations

Reorienting education to address challenges often requires reform at every level of education. This reform can require more funding than that currently available in national budgets. However if the new model is addressed to cultural and moral orientations rather than to financial programming, the efforts of existing institutions –ministries, departments, universities- can contribute greatly toward reorienting education.

Simsek and Louis (1994) present a model of transformation built upon the notion that the results of innovation and planned change efforts are related to organisational culture. In their paradigm-shift model, the outcome of successful transformation is an alteration of organisational culture in the direction of the desired change. The model includes five phases of change: normalcy; confronting anomalies; crisis; selection and renewed normalcy. Similarly to Levine (1980), they acknowledge the importance of organisational culture and institutional values, myths, metaphors, and symbolic boundaries throughout the process of organisational change (Simsek & Louis, 1994).

According to Meadows (1991, p. 250)

> "*the most effective way you can intervene in a system is to shift its goals. You don't need to fire everyone, or replace all the machinery, or spend more money, or even make new laws if you can just change the goals of the feedback loops. Then all the old people, machinery, money, and laws will start serving new functions, falling into new configurations, behaving in new ways, and producing new results*".

Leithwood and Riehl (2003) emphasise the importance of leader's task to set directions, which includes policies and actions aimed at developing goals for schooling and inspiring others with a vision of the future, such as:

- Identifying and articulating a vision that embodies the best thinking about teaching and learning.

- Creating shared meanings to ensure that both internal members and the broader community share clear understandings about the need for change.
- Creating high performance expectations helping others to see the challenging nature of the goals pursued and sharpening perceptions of the gap between what the school aspires to and what is presently being accomplished.
- Fostering the acceptance of group goals promoting cooperation toward common goals.
- Monitoring organisational performance using multiple indicators to evaluate critically and constructively both teaching and learning progress, and
- Communicating the visions clearly and convincingly in ways that will lead to productive discourse and decision-making.

Incorporating the organisational culture and tradition into the newly adopted world-view rather than undergoing a revolutionary cultural change contributes to the creation of an atmosphere of trust, readiness and responsiveness that may lead to the successful implementation of the desired change. However, the management of the organisation needs to think about which aspects of the culture, are most conductive to change, and which aspects of cultures are themselves in need of change (Kashner, 1990).

From Vision to Reality: Program Policy and Practices

According to Kelly (2001), change is driven by a shortfall between what an organisation aspires to and what it is achieving. However, even if the need for change has been generally accepted, this doesn't mean that all resistance has been overcome. All organisations have, to a greater or lesser extent, "a natural inertia, which is sometimes made manifest by a pride in what is perceived to be stability" (Kelly, 2001, p.51). Besides, other impediments to change progress may appear such as:

- Lack early stage planning regarding time and resources,
- Lack of commitment on the part of senior managers,
- Lack of the proper resources,
- Lack of willingness to change at all levels of the organisation.

Program changes evolve from local responses to specific problems or needs, provided that the system is not highly centralized. Innovators use their expertise to

develop a programmatic change within their own institutions to address this need. Others hear about the innovation and adapt it or develop their own versions to fit the needs of their institution settings.

Policy is an overall plan embracing the general goals and acceptable procedures of a government body or authoritative groups. Policy by itself will not affect change. It is just the next step after innovative practices have proven worthy of the time, effort, and resources expended. Once the innovation becomes policy those who have pioneered the change feel validated and those who have not been involved must either become involved or be prepared to explain why they are not following the policy.

According to Hopkins and Mackeown (2002), in order to assure that policy changes become firmly entrenched, the changes need to be supported in the standard practices of the system. Current programs can be solidified through changes in on going practices. Management should follow a seven-step process to bring about change in a school system:

- Make the decision to act: New trends and ideas are always passing through the educational community and they should concern administrators and teachers. They have to consider if they make their job easier and make a positive difference in the performance and behaviour of their students. New trends will not be readily adopted if they do not interest the general teaching faculty.

- Back up the decision with a rationale: The decision to adopt a new trend must be announced internally and externally and be accompanied by a rationale that is easy to understand. The rationale must convince teachers, parents and administrators that the change is worth the investment of time and effort and should include an explanation on how the reform is good for the students and the community (Hopkins & Mackeown, 2002).

- Prepare a communication strategy: After writing the rationale the school has to create a communication strategy to announce the new program to a variety of audiences. Thanks to public dialogue, the number of unfounded rumours is reduced and the vision of change is shared with the wider community.

- Prepare goals and milestones: Faculty and administration should cooperate to plan change implementation and progress assessment. Responsibilities should be assigned. Reporting methods should be created. The temptation is to start all the projects that interest the staff having in mind that usually large scale successes come from smaller ones (Hopkins & Mackeown, 2002).

- Establish accountability and methods of evaluation, which means to assure that the new program becomes ingrained into the school system. Methods of evaluation must change correspondingly, otherwise there is little progress.

- Review and revise goals and milestones: Designing a new program requires professional experience and imagination, which add imprecision and uncertainty to the process. Opportunities for revision should be built from the beginning. Usually there is a need for mid-course corrections to the program. Specific dates should be set for program revision. With review, anxiety decreases and opportunities for collaboration and ideas exchange are offered to those involved.

- Rewards and celebrations: Academic departments should recognize and reward teachers and students who run a new program successfully and celebrate their accomplishment. All schools that meet or exceed previously set criteria should be rewarded. These awards should be tangible enduring past the moment of public recognition (Hopkins & Mackeown, 2002).

An institutional transformation that alters culture by changing underlying assumptions, behaviours, processes and products, should always be in harmony with the organisational culture and tradition as well as with the culture of the community within which the organisation acts. At the same time, organisational culture and cultural change can prepare an environment for transformation and a ground for assessing if transformation has really contributed to the organisational development and improvement (Eckel, Hill & Green, 1998).

Realising the need for Systemic Educational Reform

The new schooling image consists of a dynamic view of a learning community. In it teachers guide students through individual and collaborative activities that encourage

inquiry and the construction of knowledge. There is also an analogous shift in the conception of how organisations change and the relevant role of policy.

Teaching and learning reform needs school organisation transforming. This new view of parallel organisational and institutional transformation shifts the role of teachers and policymaker. Change policy is no more considered to be tool to prescribe and control behaviour, but means to empower people to continually learn, improve and facilitate transformation (Conley, 1993; Thompson, 1994; Ellsworth, 2000).

The system must be fundamentally changed at local and state level. Systemic reform is a proposed alternative to tinkering and add-on programs that cannot meet the demands of business, parents, communities and students and significant improvements in schools (Ellsworth, 2000).

Reformers hope that a total reconsideration of the structure of the educational system will help schools be better prepared to meet the needs of all children and the communities which they serve. Systemic reform is not a detailed prescription for improving education as a philosophy advocating reflecting, rethinking, and restructuring. Nor is it limited in scope. It pervades every aspect of schooling beginning with the nature of teaching and learning, educational relationships, and school-community interactions (Conley, 1993; Thompson, 1994).

Common themes in systemic reform include a great emphasis on knowledge depth, new people relationships, more flexible physical arrangements and restructured time schedules (Lewis, 1989). Within this context, several dimensions of educational restructuring are conceived, such as learner outcomes, curriculum, instruction and assessment, learning environment, technology, school-community relations and time. Others are not directly related with classroom activities, such as governance, teacher leadership, personnel structures and working relationships (Conley, 1993).

The greatest promise of systemic reform can be its potential to overcome inequalities (O' Day & Smith, 1993). Systemic government approach along with greater local professional responsibility can provide structures that promote education for all children. Thorough understanding of academic content, complex thinking and problem solving are considered necessary for students to become responsible citizens.

Systemic change in education is concerned about system change, the nature of attitudes, processes, constraints and orientations that influence the system. The instructional environment can sometimes disrupt the change process or distort the way in which innovation appears to educational community. Understanding the system can

illuminate goals for the proposed innovations or concerns for the resistance to change and can indicate emerging issues. This is crucial for diagnosing system's needs and the ways in which an innovation serves or impedes them (Ellsworth, 2000).

Approaching systemic reform means accepting the main idea that neither the top-down reforms nor their antithesis, the bottom-up reforms will improve schools or learning. "Systemic barriers to educational change" (O' Day & Smith, 1991, p.236) exist in the form of a fragmented, complex, multi-layered system. Policy fragmentation and diffuse allocation of responsibility for goal setting, curriculum and textbook adoption, materials production and distribution as well as the disjuncture that sometimes exists between teacher knowledge and teaching practice, are often the generating factors of resistance to proposed change.

A coherent systemic strategy that takes advantage of the resources of each level of the educational system is needed. This adds content to school restructuring and establishes expectations that all students will acquire deep understanding of subject matter and complex thinking skills (O' Day & Smith, 1991).

4. SYSTEMIC MANAGEMENT FOR A SUSTAINABLE EDUCATIONAL REFORM

School Leadership Focusing on Improved Learning

Dimensions of Educational Change

According to current way of thinking, successful educational reform should be characterized by three key elements: depth, length and breadth. Change has to be deep if it is to improve important rather than superficial aspects of student learning. Similarly, it has to be sustainable over long period of time as well as extended beyond a few subjects or schools. The three dimensions of educational change should interact and inform all strategies (Hargreaves & Fink, 2000).

Educational reformers focus upon deep, powerful, high-performance learning for understanding that prepares young people to participate in the knowledge society. Deep learning is improved achievement and not just cognitive or psychological. It involves constructivism, multiple intelligences, metacognition and problem-solving. At the same time, deep learning is cultural and emotional. It establishes cultural connections and creates emotional bonds with and among students taking into consideration feelings of empathy, tolerance and civic duties. It also involves emotional understanding that is the ability to read instantaneously how well students are engaged in learning. In addition, deep learning means addressing students' diverse cultural backgrounds and sharing the meaning of educational reforms with parents and members of the community, in order to bring learning to higher levels (Hargreaves, 1998).

Educational change requires ways to anticipate and overcome obstacles and to sustain reform over time. A school's failure to sustain innovation and improvement is often associated with problems about leadership succession, staff recruitment and retention, separation of old staff from newcomers, development of bureaucracy in schools where student population grows, district and policy context, and community support. Government policies, often, in order to make extensive educational economies, to tighten curriculum and assessment control and to introduce changes at high speed, have dramatic consequences for school sustainable reform (Hargreaves & Fink, 2000).

Sustainability does not simply mean that something can last. It also addresses how particular initiatives can be developed without compromising the development of others in the surrounding environment at present and in future. Sustainable change is not only a

question for individual schools. It extends to whole districts, states and nations, which are not all alike. Variations exist in the social and cultural characteristics of the learning communities, concerning the extent to which schools involve teachers in decision-making, the characteristics of leadership, and the strategies of change implementation. Transferring a successful initiative in one group of schools to others often means transforming them (Hargreaves & Fink, 2000).

During the last decades, in the educational world many initiatives have been developed, which introduce models of changing structures, cultures, teaching methods, and learning conditions of schools. Such a model is called by Slavin (1998, p. 1300) 'the challenge of scaling up', which aims at building networks of technical assistance and support to the schools that choose to implement the specific model. In addition, efforts at district level, have emphasized persistently on teaching, learning, student performance, extensive professional development, the stringent selection of teachers and leaders, and on assessment or accountability factors (Elmore & Burney, 1998), However, such initiatives are associated with shifts in political control and have no proven record of sustainability. They have breath and even depth but no duration (Fullan, 2000).

As Sergiovanni (1999) argues a three-dimensional school reform needs to focus on deep learning, taking into consideration significant social and cultural factors, such as poverty, disadvantage and racial inequality. It also involves making strong connections with families and changes in the structures and curricula of schools. It relates learning to the context in a deep way. Literacy, numeracy and standards are parts of the improvement programs but in general, better achievements do not necessarily mean deeper learning.

A three-dimensional school reform should reculture, not just restructure the system. The goal of educational reform must be to establish the entire program of change and to treat the wider policy context as integral to school and district reform efforts (Hargreaves, Earl & Ryan, 1996). Educators should make their practices and improvement efforts highly visible and help create a broad social movement for large-scale, deep and sustainable transformation in education (Hargreaves, 2000).

Strengthening the Interactive School's Infrastructure

The key reason why reform often fails to become widespread and sustained is that the infrastructure of the system is weak, unhelpful, or working at cross-purposes. According to Fullan (2001a), infrastructure refers to the next layer above whatever the introduced change is focusing on. For example, in terms of successive levels, teachers cannot sustain

change if they are working in a negative school culture. In addition, the school cannot sustain an already initiated and implemented change, if it operates in a district that is not helpful. Similarly, a district cannot sustain successfully the reform if it works in a society that is not aligning or co-coordinating policies (Fullan, 2001b).

Strengthening infrastructure means that the improvement strategies will not be instituted in only a small proportion of schools. On the contrary it can help the initiated reforms to be replicated on a large scale. The main elements that make an infrastructure to be interactive and capable of building in "lateral accountability" (Fullan, 2001a, p.152) include the following:

- The development of collaborative school culture where teachers are motivated to work in teams, teachers and principals are encouraged to work together, focusing on the constant improvement of students' performance.
- The introduction of new alliances between communities and schools.
- The redesign of initial teacher education, first- rate induction support, standards of practice and corresponding compensation, to foster and reward teachers throughout their career. Teaching profession is gaining the status and the attraction required to sustain reform.
- Reculturing, developing, nurturing and supporting school leaders.
- Coordinating policies at the district and national level, achieving synergy, connectedness and coherence.
- Investment in co-coordinated assistance to support schools while establishing a system of accountability.

Such an infrastructure will bring improved support for teachers and school leaders, making their profession more attractive. If they suffer from overload and low moral, teachers and leaders are not motivated to foster sustainable reforms.

The infrastructure cannot be improved automatically. Complex systems are characterized by overload, fragmentation and centrifugal forces of any kind. In any case, schools usually require external intervention to get better, and they should become skilled at seeking and exploiting assistance and guidance where it is available. Above all, school-level development should be in harmony with aligned forces in local, national and international infrastructures (Fullan, 2001a).

The Reform Initiatives and the Educational Procedures

Although two decades ago, education systems in most industrialized countries functioned in the belief that teachers were competent and needed to be left alone to teach, today, rising national expectations about schools have been accompanied by reduced teachers' autonomy and increasing demands for higher performance, on the basis of the general assumption that the improvement of the micro-efficiency of the school is a vehicle for addressing some of the macro-problems of society. In many countries and contexts, the material, means, conditions and outcomes of teaching have become issues for politicians to decide about, and teachers to act on. In most cases, the professional voice tends to be muted, the pupil voice silent and the parental voice limited. Typically, reform initiatives give insufficient weight to perceptions and experiences of people caught out in the reform process – administrators, teachers, parents and pupils – who usually feel pressurized and confused by reform (Riley, 2000).

Around the world, governments are now engaged in the education reform procedures. However, the debate about the reform business is characterized by deep controversy. There are claims and counterclaims, as those of Boyd (1999) about the impact of change, about the success of generic solutions, which are being introduced, and about the growing need to empower public confidence in education. There are even more claims and counterclaims about the financing of education: a belief that there has been soaring spending in education; assertions that there has been little real increase in spending, except in specific areas; a belief of some economists that money is thrown away in education, a counter argument on how money matters; and a focus on value for funds but few evaluations of reform initiatives.

There is a general belief that investment in education should always be encouraged. Investment can help reduce poverty, contribute to the accumulation of human capital, strengthen the national capacity and good governance and add to the well - being and development of individuals. However, the gap between investing in education and achieving all or some of these goals is wide. According to Fuhrman (1993) there are no certainties in the education reform procedures, and despite the arguments that have been made about the need to provide coherence to the reform process reform initiatives are more likely to be characterized by disconnection than connection, and to be divided into two mental sectors: one called structured reform and the other called cognition and learning (Riley, 2000).

The crucial point is that educational reform is as much about leadership and learning within the local context, as it is about national policy. The change imperative is strong and emanates from a range of sources. In any case, the focus of reform inevitably reflects national concerns. A range of strategies encompasses the current phase of reform efforts, which is the enhancement of student learning. According to Murphy and Adams (1998), each strategy reflects a different conceptualisation of the nature of the need for change. Intensification reforms target the problem of low expectation. Restructuring reforms address the problem of outmoded school organization. Systemic reforms attack the problem of fragmentation and uncoordinated state policies. Standard setting reforms confront the problem of unspecified or inadequate student learning goals and measures of success. Privatisation focuses on the problems of entrenched bureaucracy and weak incentives (Murphy & Adams, 1998).

The external context is shaped by changes in social and public policy, which have taken place over recent years in many countries and by shifting cultural and political influences. For industrialized counties, the effort to maintain a competitive edge in the global economy has been the strong reform driver. The emergence of the knowledge - based society coupled with the technological revolution, create strong imperative for change. For developing countries and countries in tradition, the provision of basic education as a primary goal to social transformation has been the pressing concern. These societies are usually focusing on specific aspects of reform, seeking to address the relatively low levels of literacy and develop packages of reforms aimed at enhancing the skills and competence of teachers (Riley, 2000).

Educational change, policies and practice are shaped by political, structural, individual and social dynamics (Murphy & Adams, 1998). The legislative framework and the cultural context create expectations and boundaries about what can and should be achieved – and how. Approaches and priorities to reform differ significantly, depending on the political possibilities policy options, national circumstances and historical arrangements. Some governments follow the path of decentralization, giving greater autonomy to schools, although often retaining significant degrees of central control. Others tend to privatisation, deregulation and choice. Others have placed greater emphasis on quality control evaluation and testing, as part of a general accountability thrust. Whatever the rationale for change is, the question of how to introduce successful reform is one which policy makers share (Riley, 2000).

While national policies are important, the local context and the schools themselves influence the way in which reforms are interpreted and implemented. Schools' history, leadership and community effect how a national reform initiative is perceived. School principals, teachers, parents, local authority, usually have their own views about the needs for change, educational principles and how the local and national priorities can be taken into consideration.

Managing change at school level means balancing competing sets of realities, which are the policy context set at the national level, the community context and the local needs, and the internal workings of the school itself. Too often, rational and planned models of change fail to capture the realities and complexities of the school environment. It has been recently recognized that school development is a complex process that occurs as a result of the interacting influences of three sources of change: that which is deliberately planned, that which is naturally occurring in the life cycle of organizations and that which is unforeseen or unknowable in advance (Riley, 2000).

Change depends on the will, capacity and actions of many players at different levels in an education system. The degree of alignment between any reform initiative and the personal goals and aspirations of individuals and organizations engaged in the change process is a powerful factor in school reform (Murphy & Adams 1998). Successful implementation of change procedure requires incentives for reform, capacity building and opportunities for professional learning. In any case, change is not linear. Reform initiatives, are not received by schools in a uniform way. Key actors in the local context construct their own meanings about the nature of change and their perceptions may resemble or differ from those of policy-makers. Change is unpredictable, stuttering and drawn out, requiring the identification of existing constraints and obstacles, as well as capacity to design new strategies and embed these within existing policies and strategies. However, despite the fact that reform and school change is a never- ending process, its route and final destination will need to be thoroughly planned as Riley (2000) suggests.

School Policies Towards a Renewed Emphasis on Teaching and Learning

Notions of what constitute a good school depend on culture and context. According to Silver (1994, p.6), "good" has been a word used of schools of many kinds by interested parties of many kinds. It is difficult to reach a consensus on issues deeply associated with values, beliefs and principles in a multicultural democratic society. However, in the framework of a typical pluralistic educational community, if decisions have been reached

after genuine and wide consultation process and if there is clarity about what is to be achieved and how, it is believed that even controversial policies can come to be respected (Riley, Docking & Rowles, 1998).

Teachers are key players in change implementation. Reform will be limited in its impact if teachers are designated and disengaged from the whole process. Teachers can foster successfully the change effort if they see it as a central activity, which will improve their professional practice. They are motivated to change their strategies if they can see benefits. Investing in the sustained development of teachers and providing them with a wide span of opportunities, as work-shadowing, shared classroom observation, access to relevant web – sites and teachers' networks, which cross schools and localities, are key elements in the change process. Research evidence suggests that teachers who are part of professional development networks have higher standards, a strong service ethic in their relations with students, and a greater commitment to their profession than other colleagues (Talbert & McLaughlin, 1994).

Parents should always be recognized as co-educators being able to play an active part in their children's learning. Within the framework of a genuine partnership between schools and parents, the school provides for the special cultural and linguistic background of pupils while parents are confident that problems will be dealt with and feedback given. Parent – teacher meetings are useful and productive and pupil progress is shaped with parents on a regular basis (MacBeath, 1999).

Pupils are often the most crucial key partner in a change process aimed at the improvement of learning, Students' perspectives give fresh insights into what schools are and into what they might be. Young people may describe what in their view makes a good teacher, what kind of school policies help maintain a climate of mutual respect and trust, and what needs to be changed (Riley, 2000).

The ways in which teachers, parents and pupils think about school leadership usually differ between countries, societies and groups of people. Some groups ask for assertive or strong leadership, others prefer cooperative and collaborative leadership. Usually, old students value an inclusive leadership style with demonstrated care and respect for pupils contributing to a school environment that can be conductive to effective learning. Younger students emphasize safety, security and relationships (Riley, 1998).

According to current views of all the civil rights for which the world has struggled and fought, the right to learn is undoubtedly the most fundamental. Children need to get familiar:

"with such an array of facts and such an attitude toward truth that they can have a real chance to judge what the world is and what greater minds have thought it might be" (Darling – Hammond 1997, p.1).

If classrooms are to become intellectually rigorous and exciting places, learning should be put at the centre of the school life and radical change needs to be made in the organization and delivery of education services. Moreover, if young people are to become "autonomous and self regulating learners, able to cope with uncertainty and change", rather than "diligent workers who have a sense of duty and discipline" (Posch, 1996, pp 6-8), a transformation from teaching to learning will be needed. In the framework of the open knowledge-based societies, all pupils are expected to see themselves as independent learners who can gain success. Avenues to learning need to be accessible to a wide community, creating a stronger focus on distance and self directed learning with a wider definition of the essence of what effective learning is. According to Macbeath (1999) learning in and out of school is seen as a coherent totality and students should be involved in the renewing progress, by recording achievement and target – setting.

Despite the growing research focus on learning, the evidence across many countries is that structural reforms have had insufficient impact on the substantive core of teaching and learning. Classroom activities, knowledge, competencies and values are still predefined and stored in curricula, tests and accredited textbooks (Posch, 1996). Besides, the pace and speed of change has often meant that head teachers or school principals have had to focus much of their time and energy on administration, rather than on pedagogical effectiveness, classroom innovation and improvement. Similarly, teachers have had limited time and opportunity to review the effectiveness of their practices or to think about new modes of learning. The problem of change implementation has been further compounded by the pressures of testing, which overemphasizes examinations and the ability of students to recall bodies of knowledge rather than the students' capability of solving problems (Riley, 2000).

In refocusing on teaching and learning, assessment has to be addressed. According to Gipps (1999), there are many demands on today's assessment systems. Assessment is now required to support teaching and learning, provide information about pupils, teachers and schools, act as a selection and certification device, as an accountability procedure and drive curriculum and classroom strategies. There is a need to move away to an assessment model in which all candidates will have real opportunities to show what they know, understand and accomplish (Gipps, 1999).

Professional and Political Aspects of Educational Management

School leadership is accepted as a key constituent in the effective school. Only principals who are equipped to handle a complex, rapidly changing environment can implement the reforms that lead to sustained improvement (Fullan, 2002). In the process of change implementation, leadership should not be narrowly equated with principalship, but it should rather be conceived in a broader sense. Leadership must be seen as a network of relationships among people, structures and cultures, both within and across organizational boundaries. It is not a role-based function assigned to, or acquired by, a person in an organization, who can use his or her power to influence the actions of others. The notion of distributed leadership extends beyond the immediate school community, embracing other actors on the leadership stage. Leadership should be seen as an organic activity dependent on interrelations and connections (Riley, Docking & Rowles, 1998).

Riley and MacBeath (1998) argue that literature does not provide the current way of thinking about education with a general theory of leadership. However, there are a number of conceptual understandings about leadership, which offer some relevant insights into the management of change. Research projects have identified some important issues referred to school leadership, such as the following:

- Despite the fact that there is no single model to be learned and applied, regardless of culture and context, leadership can be developed and nurtured.
- The school leadership is beyond the undertakings of an individual.
- The school leadership is not static. School leaders do not learn how to do leadership, polishing their style to perfection. Effective school leaders are often rule breakers and are willing to change to response to new sets of circumstances, and the differing needs of children, young people and teachers (Riley & MacBeath 1998).

According to the model of school leadership that is based on the notions of mobility and fragility, which rests on the assumption that schools are constantly changing, the challenge for the school leader is to respond to the school's inner life, as well as to the demanding and constantly changing external context. This paradigm recognizes that construction of school leadership is profoundly value-laden and bound in national and local context. It acknowledges that schools have to serve internal and external contradictory constituencies. It also recognises that school leaders have to manage

contested notions about achievement, as well as multiple interests and demands, and complex ethical dilemmas. School principals of today are expected to act in separate and at the same time interlocking social spheres: government bodies; parents, teachers and students. This involves managing conflicts and competing expectations (Riley, 2000).

Effective school leaders exercise both professional and political leadership. Political leadership is about being able to recognize patterns, draw on past experience and note the unique elements of a situation (Riley, 1998). Leaders always have to seek alliances, decide on courses of action about individuals involved, draw on their own beliefs and judgments to make decisions about resource uses. Research evidence suggests that school principals exercise a considerable, although indirect influence on the effectiveness and achievements of schools. According to Hallinger and Heck (1999) there are four areas in which leaders influence the school: a) the establishing and conveying the purposes and goals of school, which is achieved mainly through the selection and motivation of teachers, b) the interplay between the school organization and the social networks, c) the fostering of group goals and the modelling of their desired behaviour for others by providing intellectual stimulation and support for staff, and d) the relation to the organizational culture. Overall, school leaders operate within an environment but also influence how others perceive that environment and interpret events.

Leadership is about learning, therefore, successful leaders are learners themselves. They should empower teachers' learning through supporting educators in meeting professional challenges and in managing the change process, showing evidence of learning by growing and changing themselves. In any case, "teachers appear more willing to participate in all areas of decision-making if they perceive their relationship with their principals as being more open, collaborative, facilitative and supportive". On the contrary, they are less willing to participate if they characterize their relationship as "being closed, exclusionary and controlling" (Smylie, 1992 p. 23).

The role of leadership in the change process is closely associated with the discussion on decentralization. From the policy-makers' perspectives school leaders can perhaps be seen as holding the key to resolving many of the problems, which appear to be facing schools. There are cases where decentralization offers the potential to improve the quality of educational services and maximize resources. Some countries have pursued decentralization as a way of dispersing power and widening decision – making. Moreover, community financing has been an attraction, either because it offers the prospect of sharing the financial burden of education by getting alternative funds from local

communities, emphasizing at the same time the importance of partnership and joint responsibility in the education enterprise (Riley, 2000).

Decentralization should be seen as a tool, which if properly used can aid reform. There is no empirical or statistical evidence to suggest that school – based management has increased student achievement if it is not associated with substantial changes in the culture of schools themselves. Sometimes, decentralization can create fragmentation, loss of expertise and reduction in professional development opportunities and networks. School autonomy, when linked to choice is as likely to exacerbate differences, as lead to school improvement. There are cases where a climate of isolation and insularity reduce professional reflection and challenge and contribute to failure (Riley & Rowles, 1997).

The degree and success of change implementation depends mainly on the ways in which school – based actors have interpreted the school autonomy. Where perceptions and expectations differ radically among teachers, principals and community, and are not reconciled in some way, and where schools lack cohesion and a shared vision, the impact of reform will be limited. If decentralization is to be linked to learning, teachers have to be prepared for a decentralized context and schools have to be able to think about the long-term as well as the short-term teachers' development. In other words, in thinking about decentralization, school management has to consider what checks and balances are needed to ensure the achievement of educational goals (Riley, 2000).

Most of all, Riley (2000) states that the decentralization process needs to be regulated by policy – makers in such a way as to reduce inequalities as well as to create opportunities for teachers and pupils. The roles and responsibilities of all members of a learning community should be redefined. Teachers and teachers' associations need to be actively involved in decision making and programming. The overall goal should be learning improvement. Otherwise, any effort for change implementation whether is based on decentralization or not, is meaningless.

According to Sergiovanni (1998), the implementation of educational reform needs to be an open and inclusive process. There are two discredited theories about how schools should be run: the pyramid theory, which assumes that the way to ensure that schools achieve their goals is to put one person in charge to control the others, and the railroad theory, which assumes that teachers can be controlled by standardizing their work. Such approaches are outmoded. Cassidy (1999) believes that as societies become more complex, education systems will need to move away from maintenance and control,

towards quality and development, which in turn will require new ways of monitoring and evaluating performance.

Successful change requires strong connections between structural reform and cognition and learning as well as the involvement of all interested members pf the educational environment. Educational leaders, policy – makers, local systems, schools' principals, should develop their own thinking and capacity, recognizing that pupils are co-learners, parents are co-educators and teachers are co-agents of change in the reform procedure. Reform depends on three interlocking elements: the skills, capacity and commitment of educators within school and at the local system level, the enthusiasm and commitment of pupils and parents, and the ability of politicians to create the right legislative framework. At last, the success of the implementation of reform will be judged by the ways in which real changes affect the level of student learning (Riley, 2000).

The Cultural Change Principal

Leading Sustainable Change in a Knowledge Society

For some time, educators have believed that principals must be instructional leaders if they are to be the effective leaders needed for sustained innovation. School capacity has been considered to be the crucial variable affecting instructional quality and corresponding student achievement. At the heart of school capacity are principals focused on the development of teachers, knowledge and skills, professional community, program coherence and technical resources (Newmann, King, & Youngs. 2000). Empirical evidence has suggested strategies for developing the role of principals as instructional leaders, including sets of strategic activities such as nested learning communities, principal institutes, leadership for instruction, peer learning and individual coasting (Fink & Resnick, 2001).

However, instructional leadership as the principal's central role in increasing student learning does not go far enough to ensure deeper learning requires leaders who can create a fundamental transformation in the learning cultures of schools and of the teaching profession itself. Leaders have a more profound and more lasting influence on organizations, and their focus should extend beyond maintaining high standards, building "enduring greatness" (Collins, 2001 p. 20). In the knowledge-based society of the future, the cultural change principal should be characterized by moral purpose, an understanding

of the change process, the ability to improve relationships, knowledge creation and sharing, and coherence making (Fullan, 2002).

School leaders with moral purpose act with the intention of making a positive difference in their own schools as well as improving the environment in other district schools. They are concerned about closing the gap between high-performing and lower-performing students and schools. In fact they seek to make a difference in the school life ensuring that the whole system is moving forward. The cultural change principal involves teachers in explicitly monitoring student learning. But the principal is also concerned with other issues concerning the general role of education in a democratic society, the relationships that exist in the frameworks of educational communities, and the professional development of educators at all levels of the system (Fullan, 2002).

Being a change agent involves understanding the goal and the nature of educational change in particular situations. The goal of school reform is not to innovate the most but to innovate selectively with coherence. Leaders should help others assess and find collective meaning and commitment to new methods. They should keep in mind that there are some difficult steps in the change process, therefore, resistance must be redefined and concerns must be addressed. Deep and lasting change requires the transformation of any structural and superficial culture of the educational organization. Changing the culture of the organization, which means changing what people value and how they work together, is a complex activity that requires hard and day-to day work, providing at the same time opportunities for people to get acquainted with new ideas or inviting questions and productive comments.

The single factor common to successful change is the improvement of relationships, which undoubtedly leads to better school. Building relationships with diverse people who think differently and groups is the most difficult skill for education leaders. In complex environments, emotional intelligence is a must. Emotionally intelligent leaders are able to build relationships because they are aware of their own emotional profile and are sensitive and inspiring to others. Besides, they are able to manage their emotions and empathy towards others (Goleman, Boyatzis & McKee, 2002).

Knowledge creation and sharing is central to effective leaders. Organizations must foster knowledge giving as well as knowledge seeking. Knowledge creation is a social process in which, relationships and professional learning communities are essential. The cultural change principal appreciates that teaching is both an intellectual and a normal profession. This principal constantly reminds that teachers are engaged in practicing

studying and refining the strategies of teaching. Thus, the principal is the head learner in the school engaging in and encouraging action research, and implementing inquiry groups among the staff. Knowledge creation and sharing fuels moral purpose in schools led by the cultural change principals (Fullan. 2002).

All of the above characteristics of the change leader help forge coherence through checks and balances embedded in their interaction. In the context of complex societies, which inherently generate overload and fragmentation, effective leaders must be coherence makers (Fullan, 2002). Leaders with deep moral purpose provide guidance, and at the same time are challenged through the dynamic of change and the interactive relationships, as well as by the ideas generated by new knowledge. They should concentrate on student learning as the central focus of reform, keeping an eye out for external ideas that further the thinking and vision of the school, and having into consideration that the creative potential of diverse ideas must always be appreciated.

The Key Components of Sustainability

To develop and support cultural change principals, the overall system must be capable to regenerate itself towards improvement. School improvement depends on principals who can foster the conditions necessary for sustained education reform in a complex rapidly changing social and intellectual environment. Fullan (2002) argues that the key components of sustainability are: developing the social environment, learning in context, cultivating leaders at many levels, and enhancing the teaching profession.

In the social and moral environment educational leaders can use the resources to close the achievement gap between high and low performers and to develop all schools in the system. Leaders should always be concerned about the depletion of environmental resources, if their schools are to be connected to the strength of democracy and to the production of valuable knowledge. Learning in context is usually designed to improve the organization and its social and moral context, establishing at the same time, conditions conductive to continual development, including opportunities to learn from others and to develop shared and collective knowledge and commitments (Fullan, 2002).

To a certain extent a school leader's effectiveness in creating a culture of sustained change will be determined by the leaders left behind. Fullan (2002) states that for leaders to deal with complex problems they need many years of experience and professional development on the job. Schools and districts usually need many leaders at many levels. Learning in context helps produce such leaders.

Effective succession of leaders is crucial to sustained school improvement. Organizations need to set their sights on continual improvement at all levels by nurturing, cultivating and appointing successive leaders, moving constantly in a sustained direction.

Principals need to work to transform teachers' working conditions. Conductive conditions in teachers' environment are likely to lead to continual development and high accomplishments. Teacher workload must be reduced, teacher ownership must be increased and teachers must be provided with the capacity to manage change in a sustainable way that can lay the foundation for improved school life and pupil performance in the future (Price Waterhouse Coopers, 2001).

Social Environment and Sustainable Educational Change

The Implications of Sustainability

Sustainability of educational change should impact positively on the surrounding environment and promote ecological diversity and capacity more widely (Hargreaves, 2002). Sustainability does not simply mean whether something can last. It addresses how particular initiatives can be developed without compromising the development of others in the surrounding environment, now and in the future (Hargreaves & Fink, 2000 p 32). Educational change theorists and agents have been concerned for many years with the problem of how to move beyond the implementation phase of change when new ideas and practices are tried for the first time, to the institutionalisation phase when new practices are integrated into school life affecting many members of the educational community (Hargreaves, 2002).

These traditional preoccupations with how to keep improvement over time imply several things. First, sustainable change is enduring, not evanescent. Initiatives are not to be withdrawn when initial interest has gone. Sustainable improvement involves committed relationships, not fleeting infatuations. It contributes to the good of everyone, instead of fostering the benefits of the few at the expense of the rest. Similarly, it does not promote model schools or magnet schools or school with special emphases that raid scarce resources from the rest. Second, sustainable improvement develops and draws on resources and supports a rate that can match the pace of change. It requires investment in building long term capacity for improvement such as the development of teachers' skills that will stay with them forever, long after the project funds have gone (Stoll, 1999).

Lastly, sustainability means cultivating and recreating an educational environment or ecosystem that possesses the capacity to stimulate ongoing improvement on a broad front. As Capra (1997) states, like the natural ecosystems, which need biodiversity to thrive and progress in evolutionary terms, schools need professional diversity, to create learning, adaptation and cross-fertilization in increasingly complex evolving systems. Rational, standardized scientific efficiency, as well as excessive specialization, do not strengthen or support the healthy or creative diversity. Standardized reform usually destroys diversity and seriously endangers the lives and futures of the weakest members of the school system, the poor, the marginalized the students who are learning through a new language and those with special educational needs. Similarly, high pressure improvement in test results in the short run are bought at the expense of long-term recruitment and retention crisis in teaching, since teaching driven by short-term results is not wanted by teachers (Hargreaves, 2002).

Another idea related to sustainability is that not anything or everything is worth keeping. In education, sustaining means keeping alive in every sense. What is sustained is what, in terms of teaching and learning is itself sustaining. The core of sustainable education refers to supporting and maintaining those aspects of teaching that are deep, endure and that foster sophisticated understanding and lifelong learning for all. This includes knowing not only what is to be sustained but includes also deep understanding of the application process as well as the building of social networks and social capital (OECD, 2001).

To sum up, sustainability in education comprises:

- Improvement that sustains learning, is not merely change that alters schooling
- Improvement that endures over time.
- Improvement that can be supported by available or achievable resources.
- Improvement that does not impact negatively on the surrounding environment of other schools and systems.
- Improvement that promotes ecological diversity and capacity throughout the educational and community environment.

This means that sustainability raises questions not only about the endurance of educational and organizational change over time, but also about its arrangement and articulation through space. In other words, sustainable improvement is a matter of social geography as well as social history.

Social Space and Geography Influencing the Change Procedures

Social geographies of educational change encompass the ways that changes or failures to change are located distributed and redefined or reconstituted as they move from one place to another. In fact, instead of speaking about educational phenomena in terms of "regimes of succession" over time, social geographies address "regimes of articulation" across space (Shields, 1991, pp.274-275).

Social geographies of educational change examine: how classrooms or departments are influenced by the surrounding environment of the community or the nation; how innovations spreads from one school to another; how policies are borrowed by different nations and how the interrelationships among schools are affected by technology, principles of market competition and choice, public beliefs and understandings. Underpinning all these trends and possibilities, are a set of basic theoretical principles of social geographies involving the study of physical space and human constructions, perceptions and representations of spatiality as contexts for and consequences of human interaction (Hargreaves, 2002). In relation to this basic definition, there are more specific principles of a social geographical perspective.

Firstly space is a central, not a contingent feature of social organizations and social being. Although much classical social theory has tended to give priority to time and history over space and geography, this does not mean that geography merely modifies or adds contingency to generalized time-based trajectories of history, or evolutionary development. Indeed claims for social explanations have often been advanced from the presumed and unquestioned superiority of one single space, such as the European or the American one. Spatial configurations of social life are just a matter of basic importance to social theory as are the dimensions of temporality (Harvey, 1989).

Secondly, space is a social as well as a physical phenomenon. The study of space and its relationships to educational change does not include only the buildings, places and the materially designed environments that condition and constrain the actions of educators. It includes the study of the organization of social space, which is a social activity. Educational change agents can create and recreate their own spaces, without being totally constrained by and dependent on the environments created for them by others (Hargreaves, 2002).

Thirdly, space is both a medium and outcome of human interaction. Space structures and is structured by human actions and relationships. Thus the status and social

significance of educational change initiatives are in part defined by spaces that have been created for them over time. Attempts to change the status and social significance of particular change initiatives should include deliberate and collaborated efforts to relocate and rearrange the spaces they occupy, by making them less peripheral and subject to marginalisation (Hargreaves, 2002).

Fourthly, spaces are often imbued with imaginary properties as well as physical and social ones. In human interaction, spaces are often related to images and myths or metaphors. The imaginary and mythical properties of social spaces leave their historical traces of meaning long after the practices, which gave rise to them have passed away. Successful reform involves redefining the mythical spaces of imaginary geographies of schools and districts as well as the redesigning the distanced and isolated spaces of their physical ones. Making improvements often means inventing new myths (Shields, 1991).

Fifthly, space, time and being define the core of human existence. The ways that people design their spaces have fundamental implications for the ways they define themselves. Spatiality, temporality and social being can be seen as the abstract dimensions that comprise all facets of human existence human selves construct and occupy social spaces. They define their spaces' social and physical boundaries, which in turn define them. The ideas of reconfiguring spaces pose deep challenges to people (Soja, 1989). Attempts to redefine the borders of particular spaces through alterations often threaten the boundaries of identity among the occupants of those spaces, because it is not just physical boundaries that change but social, psychological boundaries and identity as well (Hargreaves, 2002).

Sixthly, distributions of social space reflect and reinforce distribution of social status. Relations of social power and discipline are inscribed into the apparent innocent spatiality of social life (Soja, 1989). Cultural categories of high and low, central and peripheral are closely related to the geographical distinctions of the same kind. Emotional perceptions of success and failure, distinction and disgust are reinforced by policies of market competitiveness. Parents and community members make decisions on this basis. As a result the people who have the power to choose and to move in seeking out the best opportunities, are separated from those who do not (Bauman, 1998).

Finally, experiences, perceptions and representations of social spatiality are undergoing profound changes in the age of information. Space and spatiality take on particular importance in the current age of instant information and computer communication. Mechanical, print-based technologies created differentiated specialized

patterns of living and organizations. Electronic technologies, mobile phones and computer systems are now undoing previous developments. Through the economy turnover and ways of living that technology has accelerated, the annihilation of space through time has been achieved (Harvey, 1989). As Foucault (1976), argues the present epoch will perhaps be above all the epoch of space, and human experience of the world is a network that connects points and intersects with its own skein.

The knowledge society recreates the traditional understandings of social geography. Transformations in human experiences of space influence the procedures of designing, planning, decision-making and operating in the context of a social technological environment. Successful organizations and especially corporations stay ahead by knowing how to access information and how to process knowledge in order to out-invent and outwit their competitors (OECD, 2001). Workplaces become more flexible and structures undergo continuous change. Kanter, Stein and Jick (1992) state that organizational life in this new context needs to be viewed in terms of clusters of activity sets whose membership, composition, organization and goals are constantly changing and in which projects rather than positions are central.

From today's educational point of view, changes in social geography are not conceived any more just as a set of nested or embedded layers or levels or concentric nodes of influence, extending from nations to districts, schools and department and affecting the nature of teaching at the centre. In the current knowledge society, the system-theory conception of distinct layers in an embedded system cannot give an image of the highly complex, penetrating and shifting patterns of interaction. Neither does the nested system explanation address the characteristics of contextual changes, the emergence of new forms of organizations or the impact of information technologies (Hargreaves, 2002).

Recent theorists and researchers have begun to develop more sensitive and sophisticated approaches to understanding the in-school interactions and the social context of educational communities. These views do not draw conceptual boundaries between the classroom environment and the world of the community beyond school (Hargreaves & Fullan, 1998). Today's schools are demanded to be politicised and transparent. There is a constant interchange of people, who go in and out of the school. The relationships between parents and professionals are becoming more evident and visible. The corporate world is involving in the definition of the curriculum, in the sponsoring of new technologies and in setting the basic agendas and terms of educational programs through

which, improvement is debated and designed. Commercial and market forces intrude in school life weakening the boundaries around educational organizations. Schools have their own culture that is formed in contact with the wider society in particular local contexts. Hargreaves (2002) believes that educational research needs to address all these forces that affect schools and communities, education and enterprise, technology and cultural tradition, to explore their influences and interconnections in specific sites.

The links of communication are constantly expanded providing teachers, students, leaders and parents with opportunities to be enmeshed in complex networks rather than embedded in distinct contexts of influence. In the framework of the new network society, all people can access information, ideas, advice and support from any source (Castells, 1996). There are, however, markers of inequality in the age of information. While globalisation seems to have brought about the end of geography, where instant communication means that space no longer matters, where classrooms can be borderless and schools seem doomed, there are people who cannot be networked, cannot access social capital, and most of all, have not the capacity to be mobile or the option to choose (Bauman, 1998).

In the challenging network society, there are people who behave as conquerors of space travelling through life and choosing their destination by their inner desires and the offered opportunities. On the contrary, there are other people who are imprisoned by space, being condemned to enforced isolation and exclusion. Thus, to a certain extent, globalisation and network communication divide as much as they unite, as they signal new forms of freedom and interaction that cannot be experienced and enjoyed by all people in the world (Bauman, 1998). The new social geographies of the knowledge society, shape identities, articulate opportunities, and release or trap diverse groups of people. They also disguise hierarchies with networks and segregate the mobile that have the flexibility to create the knowledge economy, from the immobile, which are denied choice and opportunities to act creatively at highest levels (Heargreaves, 2002).

Prominent Strategies of Educational Change

According to Hargreaves (2002), the current views about the changes that need to occur have generated new strategic geographies of educational reforms: market geographies; network geographies; virtual geographies; geographies of scaling up; standardized geographies; differential geographies and geographies of social movements.

Market geographies refer to the competitive relationships that may exist among schools. They address performance criteria, norms and procedures that open up parental choice of schools and schools' evaluation. They are, therefore, political geographies that define and distribute differences of status and opportunity between schools through complex processes of consumer choice. They indicate to those who have the power to choose, which school is best suited to them and their children.

Network geographies can use networks as a basis for initiating and sustaining educational change efforts. Through social or professional networks people are connected and build relationships in ways that develop shared knowledge as well as links of communication and support over time. Network geographies operate through and aside from existing institutions, forming independent structures of learning, influence and power in educational change. Educational networks can be virtual, electronic and face-to-face. Usually, they are not maintained by market principles, but by the investment of individuals in education who want to pursue common goals.

Virtual geographies, through the power of computers and other technologies are becoming the dominants of space. They give to parents and student independent access to prescribed curriculum. They also open up access to knowledge beyond the set curriculum and its recommended texts. They encourage distance learning and have fuelled rapid increases in home schooling.

Geographies of scaling up have received mixed reviews in education, as a result of the intensity of interest in educational reform, affecting many schools. Reform movements often use the incentive of allocating funds to school districts, which adopt the proposed models of reform aimed at improving student achievements and the organizational structures of educational communities. The combination of financial incentive, district pressure and voluntary school commitments create a new educational environment for professionals, teachers, leaders and parents. In this environment time is often too short and not everyone is knowledgeable about the options (Datnow, Hubbard & Mehan, 2002).

Standardized geographies refer to the creation of a policy space in which all aspects of educational practice are prescribed in details. In this context, the effort to generalize school reform is pursued through legislative insistence, scrupulous attention to detail, all-encompassing coverage, and relentless surveillance to ensure compliance. These tendencies for large-scale reforms with prescribed programs, intensive coaching and heavy leadership investment can often achieve striking short-term results in relatively

basic skills, but have difficulty securing longer-term sustainable improvements in more sophisticated levels of learning. Research evidence indicates that standardized educational programming has yielded disappointing literacy results in many countries (Hargreaves, 2002).

Differential geographies refer to the increasing understanding in the social geography of school improvement, according to which levels of government intervention in schools should be inversely related to their success. Schools, which persistently perform well, should be allowed to break free of any central prescription as they follow their own creative procedures to continuing success. The differential approach to school improvement is beyond unenforceable voluntarism of networks and scaling on the one hand, and beyond the inflexibilities of enforced standardization on the other. Thus it underpins social division with educational differentiation. It provides the schools with opportunities to act as autonomous organizations. However, there is a danger that these differential geographies of improvement and change will degenerate into educationally and socially divisive ones (Hargreaves, 2002).

The geographies of social movements refer to the social and political geographies in the wider society that separate people by status and enmesh them in relations of power. Social movements are empowering for their adherents. They acknowledge that those who stand aside from social change are those who consume society rather than producing and transforming it and are subordinate to those who are in charge of the economy, politics and information (Touraine, 1995). Social movements are purposive collective actions whose outcome in victory as in defeat, transforms the values and institutions of society (Castells, 1996). These social movements are the potential subjects of the Information Age and they are perhaps the people's best hopes for a democratic and socially just future as well as for a sustainable and successful educational change (Hargreaves, 2002).

The Life-World of Schools as a Key Element of Substantive innovation

Consideration of the Essential Structures and Values of the Organization

According to Sergiovanni (2000a), most theories, research studies and policies about educational change are based on the assumption that change is good and resistance to change is bad. Many policy scientists take for granted that the potential change impact, once understood, can lead to educational improvement. Accordingly, leaders are thought

to be successful if change succeeds and unsuccessful if it does not. Finding the right change strategy means unquestionable victory in the national and even international level. This attitude reflects a common tendency to emphasize and focus upon the process rather than the substance of change. Instead of worrying about substantive issues, authors and policy scientists are engaged in struggling to figure out the best methods to get teachers and school to change. They are arguing about the best incentives, the restructuring models, the test scores, the standards, the school or class size, the approach and style of leadership and the commitment to teacher learning. What seems to be important is not what the change is but how schools change and what are the best ways to implement these policies so that educational communities will do what they are supposed to do (Sergiovanni, 2000a).

There are cases in which schools are declared to be successful just because they have been restructured by requiring all teachers to adopt a particular school design, even though some teachers oppose the change and parents and students have not had any participation in decision-making. In other cases, teachers have been motivated with cash incentives or other similar stimuli that make them involved in their work for calculated rather than professional or moral reasons. Often, the change strategies used to reach a particular goal can be those used to reach a totally different one, providing further evidence of the overemphasis given to the process rather than to the profound substance of educational change (Sergiovanni, 2000a).

There are also leaders who have been praised for being successful in bringing about change, even if change has been turned out not to be a good idea. Equating effective leadership with change is an idea that has been supported by the literature referred to the educational policy and administration.

Early researchers in educational administration describe a distinction between management and leadership in that management is about running things as they are, while leadership is about changing situations.

> "leadership is the initiation of a new structure or procedure for accomplishing an organization's goals and objectives or for changing the organization's goals and objectives" (Lipham, 1964, p.122).

Management, as the force that "does the things right", implies stability, while leadership, as a force that "does right things", implies change (Bennis & Namus, 1985, p 21). Thus, management focuses on maintaining organizational systems and leadership focuses on changing them.

However, leadership must not be regarded only as a change agency. Effective leaders not only change, but also protect and intensify a school's present structure in a way that enhances meaning and significance for students, parents, teachers, and other members of the educational community. This enhancement provides a sense of a shared vision, builds a culture and empowers the relationships among members of educational and local communities. Coleman (1988) suggests that leadership forces should be regarded as means available to not only bring about needed changes needed but to protect and preserve values, such as the life-world of schools, culture, beliefs, meanings and understandings that are shared by community members.

Balancing Between the Inner Life-World and the External Systems-World

According to Habermas (1987), society's enterprises possess a life-world and a systems-world. School culture –leaders and their purposes, members of the educational community and their needs, traditions and norms– comprise life-world.

Management decisions and protocols, all strategic and tactical actions, policies and procedures and accountability assurances comprise systems-world. At school's individual life-world, there are ideas and commitments, which function as a source of authority for people's behaviour and ways of thinking about educational goals, principles and values. Sergiovanni (2000a) suggests that school character flourishes when life-world becomes generating force for determining the systems-world.

Moreover, school character erodes when systems-world becomes generating force to determine life-world. In that case, as Habermas (1987) claims, all purposes, values, beliefs of educators, parents and pupils are decided by distant policy-making procedures. As a result, the school loses its character at the individual level, leadership loses its authenticity and schooling becomes less effective. Schools cannot be improved when their life-world is ignored and when meanings and understandings of educational communities are not taken into consideration by the distant, central policy-makers. School life and experience provides ideas and commitments that function as source of authority for what people do, influencing thoughts, behaviours and providing the basis for decision-making (Sergiovanni, 2000b).

Sergiovanni (2000b) argues that any school is, simultaneously, a democratic institution driven by the needs and desires of students, parents and teachers at local level, and a technocratic institution in the form of a governmental-corporate complex driven by technocrats at state level. Change goals and processes are driven by policy-makers,

legislators, governors, and corporate executives, or by research establishments that provide information to support certain kind of proposed changes not sensitive to local contexts, interests and needs. Technical experts decide about desired schools' standards, students' outcomes, classroom assessments and curriculum nature. Even when local authorities decide about the means for goal achievement, they are not real paradigms of democratic participation, as the ends determine the means. They reflect an ideological trend according to which, scientific research must replace local preferences, values and beliefs (Sergiovanni, 2000b).

Concentrating upon the Essence of Change

In today's world of educational change, systems-world often determines life-world. Change strategies as schooling models, standards lists, accountability plans and organizational structures, are often experienced in schools in the form of management systems that take no account of unique cultural characteristics of local communities. In these cases, change does not embrace experiences of community members and, consequently does not support school's life-world (Sergiovanni, 2000a).

Restoring local authority as key change factor ensures that procedures do not dominate substance. Change strategies should emerge from local goals, values and beliefs rather than determine them. The schools' life-world and the systems' world have to be met in a way that takes into consideration two basic principles. The first principle is subsidiarity, according to which every member or institution should be free from excessive intervention or regulation. The second principle is mutuality according to which all interdependent associations should be characterized by dignity and respect among people and integral parts of a larger community where interests from all levels come together on an equal footing. These two principles can be achieved in schools if the demands of life-world determine systems' world and when the community's values and beliefs influence instrumental decisions. Intellectual and other forms of integrative capital can help the development of cultural capital, which then further enriches life-world (Hill & Celio, 1998). That cycle of cultural reproduction supports effectively deep and sustainable learning (Habermas, 1987).

Mutuality is an important concept in a democratic society. It implies the authentic sharing of power with, by and among people in a way that recognizes fundamental dignity and obligation to attain and maintain what is necessary to sustain that dignity (Nothwehr, 1998). This way, it can provide basis for setting standards for what students need to know

and schools need to do. Standards and assessments can contribute to the building of school communities that most citizens ask. They can form a system that serves the educational life-world rather than dominate it. This system can be created through the adoption of a layered approach to establishing standards and a shared approach to accountability, with strong local component.

Central policy-makers and the members of the local educational communities can participate in setting standards, within the structure of layered systems, but their role and responsibilities have to be clearly figured out. When only the state sets standards, the schools become more and more similar. When local communities set standards school become diverse in broad areas. The procedure that combines some common understandings with many diverse understandings is consistent with the democratic ideal and provides the basis for real choice. Real choice requires new programs and new images of schools, as well as participation of schools' boards in setting standards. The state is usually responsible for developing standards for all schools in the skill areas of learning, while the local school board is demanded to participate in developing standards in advanced and diverse areas learning, which might be influenced by characteristics of the school districts (Sergiovanni, 2000b).

Members of the local communities could provide technical and financial assistance to authorities for schools' development. Sergiovanni, (2000b) claims that the state should provide a centralized standards bank from which local authority might draw as needed. Students are expected to participate by setting standards and by assessing their own performance. No single set of standards and no single assessment should dominate. Moreover, in cases where schools must be rated, no single rating source should determine a "school's score or a school's category designation" (Sergiovanni, 2000b. pp. 89-91).

5. MANAGING CHANGE IN PRIMARY SCIENCE EDUCATION IN THE FRAMEWORK OF SYSTEMIC REFORM

The Nature of Primary Science Education

School science is not considered any more to be merely a body of knowledge. Current tendencies lead to a broader and more democratic basis for understanding science that narrows the divide between science learning and cultural context.

A major purpose of science education is to make students able to respond to socio-scientific issues. This requires understanding of the nature of scientific knowledge, which can be developed through investigative work, providing insight into the problems of data collection and the relationship between data and explanation or between evidence and theory. Besides, other learning contexts can contribute to the acquisition of scientific literacy, including case studies, historical and contemporary sources, and everyday practical life (Levinson & Thomas, 1997). Referring to science learning, some basic principles should be taken into consideration.

Firstly, science is both content and process. As content, science is essentially analytic, describing and explaining the main concepts and ideas related to the natural phenomena and the scientific world, using methods of deduction. As process, science is characterized by interplay of observation and experimentation, deduction and intuition, which results in speculation, productive explanation and prediction (Levinson & Thomas, 1997).

Secondly, science teaching should take into consideration the perceptions of the young learners about science. There has been a shift of the focus of science education from the teacher and teaching to the learner and learning. Apprehension of the needs and characteristics of students and how they conceived of learning science is required for effective teaching. Children's conceptions or understandings of natural phenomena and science concepts- some of which are widely and strongly held - should be explored at the initiative phases of science teaching.

Thirdly, science is a human product built up through social processes. Knowledge of science is not merely the acquisition of conventional wisdom. Individuals are not passive recipients of raw science, neither is science seen as a superior form of natural understanding. Knowledge of science becomes situated within a broad web of complex social and emotional factors. A scientifically literate person is not only knowledgeable

about science, but is also able to respond to messages about science (Levinson & Thomas, 1997).

Fourthly, science teaching must take account of cultural diversity and difference if it is to provide adequately for all children. According to Meek (1996), science teachers need often to develop special pedagogical strategies, when they teach in a multicultural classroom. Teachers should provide each child who comes from a culturally diverse background with the assurance of success. Recent learning approaches recognize that the development of successful practice stems fundamentally from accepting the diversity as a constructive base for improving the classroom activities (Meek, 1996).

Guidelines for Change in Primary Science Education

In the knowledge society, which is characterized by cultural diversity and multidimensional perspectives, students will spend much time determining ways to interpret information provided to them and perspectives represented by different data collection, methods and interpretations. They will develop understanding of the historical, social, cultural and environmental contexts, which influence human interpretation and application of scientific data, and they will have many opportunities to apply scientific and technological knowledge to solve current and real problems. They will see many different types of people using scientific thinking in a variety of ways to satisfy a wide variety of needs.

Pupils should develop an understanding about science as a human activity, that scientific ideas change through time and that the nature of scientific ideas and the uses to which they are put are affected by the social and cultural contexts in which they are developed. This statement encompasses the notions that science is what people do, that scientific knowledge is not static and that both the content and methods of science are dependent on the world-views of people (Peacock, 1997).

The major content changes in science imply that all students are capable of learning complex concepts if provided with developmentally appropriate experiences. All students will study all of the disciplines of science in an integrated approach. Greater emphasis will be given on the inquiry skills-science process skills and reasoning- rather than memorizing science facts. Students are expected to use their skills of inquiry to construct deeper explanations for physical phenomena and to find and verifying facts.

The major shifts in the vision of science education lead towards schools that will provide greater emphasis on concepts and process skills and less emphasis on specific facts assuming that only the in-depth study enhances learning. The development of process skills of science deepens children's understanding of systems and phenomena. In a community of diverse learners people learn more rapidly, perceiving experiences differently. This variety strengthens students' understanding of scientific phenomena. As far as applications and technology are concerned, learning is considered to be more meaningful into the world outside school and mastering technology will help students' function in the recent world (Peacock, 1997; Driver *et al.*, 2000).

Current state of science education is similar to that of other disciplines. While research shows a clear need for new instructional strategies based on a constructivist model of learning, practice remains rooted in behaviourist theory and rote methods of learning. Regardless of which science standards are implemented, a new vision of science teaching and learning must be based on instruction that emphasises engaged learning in which students create meaning from their own experiences.

As Peacock (1997) believes, implication of change in primary science education requires, primarily, a wider view of science learning. Moreover, change needs clear vision, commitment to continuous improvement, and willingness to challenge past practice. Consequently, the goals of educational change concerning primary science can be summarized as following:

- Primary education should help children develop the skills and knowledge needed for the construction of their own understanding of science, technology, and the world in which they live.

- Approaches to science teaching and learning will emphasise learner-centred classrooms, problem-based learning, and the construction of understanding and meaning by students.

- The organisation of science content will promote a more holistic view of science, rather than the traditional division of science subject matter.

- Assessment will be a normal part of instruction and will help students evaluate their own learning.

- Teachers will rethink their beliefs about the nature of science and science learning, resulting in a new commitment to help all students become scientific literate.

- Policymakers and administrators will break down barriers to reforms that affect the whole system, such as limited time, resources and facilities.

- Teachers as well as administrators will engage in strategic planning to implement the new vision for science education.

Peacock (1997) also concludes that reform of science education goes beyond shuffling and re-labelling old content. It begins with the careful examination of the fundamental principles driving the organisation, that means looking first at the organisation's beliefs about learning and the way students learn. Next, steps are taken to align pedagogy with practice by using practices designed around the organisation's fundamental beliefs. All learning needs to be verified through assessment procedures that are consistent with both learning theory and pedagogical practice. Organisational processes must support continual improvement if successful reform is the goal.

Management Actions bringing about Systemic Reform in Primary Science

Change requires clear vision, commitment to continuous improvement and willingness to challenge past practice. The following actions that may bring about systemic reform can be part of a strategic plan leading to improvements in teaching and learning science.

As far as time allocation is concerned, Solomon (1997) states that for systemic reform requires change in the allocation of student and teachers' time. Curricula reform will result in redistribution of the content of science education. Currently, the underlying theme of much of the content reform has been that less is more.

As emphasis shifts from specific factual detail to underlying concept formation, science education will need to rethink the way science is packaged for instruction. The subjects into which science knowledge is traditionally divided will be replaced by an integrated approach to science learning that emphasises the holistic nature of scientific inquiry. Meanwhile, as laboratory experience replaces textbook study as the primary

vehicle of instruction, teachers and students will need more flexibility in how they spend their time.

Solomon (1997) also claims that teachers need to be granted both the time and the opportunity for professional development if they are to break away from traditional practice, embrace a new way of teaching and learning, and use modern assessment methods that are embedded in instructions. They need new kinds of knowledge and skills to make good decisions.

Demands for educational reform are expected to affect accountability models and practices. So far, tests and examinations have traditionally served as major means of setting and maintaining educational standards. They have also been used to revise standards and influence curricula. In spite of widespread use, they have not generally been shown to improve significantly the quality of learning. To some extent, they have resulted in teaching in the traditional way and focus on skills and knowledge that are easily described and measured. They do not provide teachers with adequate information to focus on individual students and help them to construct knowledge and understand science concepts in a personal and unique way (Solomon, 1997).

The new standards in science education demand alternative assessment models that will support the constructivist procedures of learning, being at the same time fair, valid and meaningful. New curriculum frameworks are needed to develop learners capable of creating their own knowledge and for the incorporation of new assessment process. Besides, the curriculum frameworks at the state or local level should focus on a holistic approach to science content and provide all children with opportunities for meaningful learning. They should also emphasise the process of science and the meaning of the new conceptions about scientific literacy (Solomon, 1997; Millar, 1997).

In what concerns availability of facilities and equipment, Millar (1997) suggests that both inside and outside school the facilities used in science process learning need to be up-to-date and available to students. School management should be concern about the improvement of the equipment the accessibility of children to technology by making the whole system more user-friendly and providing easy access to data for learners of all ages.

There is also the issue of explanation and demonstration of desired reforms to parents and policymakers. Bryk *et al.* (1998) emphasise that communicating the needs for

change and the proposed plans for improvement and reform may lead to the change of traditional beliefs and attitudes that cause resistance and opposition to new strategies.

Managing Science Education and Promoting the Scientific Culture

Issues About the Nature and The Scope of Science

According to Wolpert (1992) science needs to act with profound certainty. It is the best way to understand the world. It is difficult to identify its real meaning, although the boundaries of modern science are strongly defined. To a certain extent, science is as complex as human life. Nevertheless, some characteristics about its features and aims can be given. Science attempts to explain natural phenomena in terms of the underlying causes in as economical way as possible. It deals with self-consistent ideas that correspond with reality. It permits predictions and requires testing and experimenting theories and statements.

Science too often explains the familiar in terms of the unfamiliar. Sometimes neither the scientific ideas, nor the procedures of science fit with common sense and they go against everyday experience. Common sense refers to individuals' expectations derived from everyday experience. It is complex but has its naturalness it is the matter-of-fact apprehension of reality (Wolpert, 1992).

Common sense thinking on its own does not lead to science. Acquisition of a scientific understanding of the world as well as doing science requires a special self-awareness. It is often necessary to actually resist common sense since an unfamiliar quantitative rigour is required. However, there is generally no prescriptive scientific method for doing science. According to Peter Medawar (1974), understanding consistency and correspondence with the real world is all that matters.

Bauer (1997) recognises the complexity of science. The different intellectual disciplines within science are of deep, tribal significance and are culturally determined. Every scientific topic carries with it idiosyncratic beliefs about how much or little objectivity is possible, about how certain the knowledge that can be obtained is and how truth can be approached. Every discipline develops a distinct culture specifically suited to its particular tasks. It also has its own language, practices, traditions and is associated with specific patterns of behaviour and meaning sharing.

Many stereotypes and taken-for-granted views evolve around the nature of science. Scientists accept that most scientific knowledge is enormously reliable

corresponding in some valid manner to the realities of Nature. Scientists who look into meta-science tend to accept Thomas Kuhn's (1963) views about the scientific revolutions that alter scientific theories when some peculiar facts occur that the existing theories cannot explain. Philosophers of science concentrate on epistemology and theorising and they focus upon the scientific method. Historians believe that no particular interpretive framework can be considered to be universally valid, while sociologists take realistic views and examine the detailed interactions in the scientific community that consider science to be the means of generating reliable knowledge (Bauer, 1997).

Midgey (1997, p.35), explains.

> "Too often confusion arises between the local internal issues that can be seen from inside a particular profession and the wider ones, which are usually hard to grasp at all. During the last century, that large abstraction, which in science has acquired tremendous symbolic importance by being linked with a great range of practical movements which have profoundly altered people's everyday live. These movements have been hailed as essentially and typically scientific".

Rhetoric and symbolism play a crucial role in current conceptions and understandings regarding science. Science should not be linked with imaginative factors that lead to misunderstandings neither should be conceived as a single entity directly related to a certain environment. It is, however, part of human culture and has profound social responsibilities (Midgey, 1997).

Rose (1997) states that science is above all a human activity and as such is socially shaped. In the context of contemporary societies, new ideas emerge about the changing production system of knowledge (Gibbons *et al.*, 1994) moving towards a new type of science, which is not necessarily related to the academic way of thinking (Ziman, 1995). Both the boundaries and the nature of science are continuously subject to change over time and place. This change opens "the possibility of many new actors entering the production system of science" (Rose, 1997, p. 63).

Science in the Context of Formal Education

School science is expected to promote scientific literacy and to enable all children to participate fully in public policy decisions in science (Dalyell, 1997). Scientific literacy according to Jon Miller (1983), may be defined as the development of the ability to be knowledgeable and to respond to messages about science.

Despite the agreement about this statement, evidence shows that current educational systems are far short of this ideal.

According to Claxton (1997), school science is both a process and content. As content, it consists of maps and languages, whose value inheres only in their ability to facilitate the human purposes, mainly of articulation and technical control. Conventional, content science is analytic and based on the logic of deduction, as a way of thinking. It addresses issues that are embodied in school curriculum but it cannot give satisfactory studies about more subtle physical phenomena, as the behaviour of the microorganism systems, global ecology or aspects about conditions of living bodies (Prigogine & Stengers, 1984).

As process, science

> "is loosely characterised by an interplay of observation and experimentation, deduction and intuition, governed by criteria of coherence, elegance, and parsimony, which result in interesting speculation, productive explanation and successful prediction" (Claxton, 1997, p. 74).

Process science evolves within a context of personal, social, political, and financial pressures influencing the scientific procedures. Non-scientific priorities can influence decisively the behaviour of the scientific community (Collins & Shapin, 1986).

Millar and Wynne (1988) argue about the need for a development of the public understanding of science. In a democratic society, the public accountability of science depends on peoples' understanding of science, which enables them to recognise the issue in a socio-scientific dispute, reach informed views and participate in discussion, debate and decision-making.

A major purpose of science education is to equip students to respond to socio-scientific issues. Investigative practical work can contribute significantly by providing insight into data collection and explanation. This is not enough as other learning contexts are necessary such as case studies, of both the production of knowledge and scientific dispute. These highlight the ways consensus creation is created and the identification of dispute features, which can result in consensus absence (Millar, 1997). For more adults, the major source of their scientific knowledge and understanding comes from school science, which affects significantly their attitudes toward the scope of science education as well.

According to most current intellectuals' way of thinking, science education has to reflect on the values inherent in science, question them and look at alternatives to

dominant sciences and technologies, if students are supposed to be empowered and if science education is due to play crucial role in the cultural, social, political and economic development (Levidow, 1997).

The Public Understanding of Science

The new approaches to science education call for a shift from a focus on supporting the acquisition of formal science content to promoting a culture of scientific literacy by engaging students in the languages and the way of scientific inquiry (Millar & Osborn, 1998; Liang & Gabel, 2005). This shift is driven by a sense of growing disparity between the kind of science provided in schools and the needs and interests of future citizens. School science should not only be preparation of future scientists. It should be a part of the human question and wonder for understanding the world (Barab & Luehman, 2003; Roth & Lee, 2004).

According to pedagogical perspectives, this shift involves curriculum and teaching strategies that tend to abandon lecture-based modes of instruction, in favour of models in which students are collaboratively engaged in the process of scientific inquiry (Barab & Luehman, 2003). In most cases, implementation of innovative curricula is suggested to be integrated within existing classroom cultures, providing at the same time students and teachers with meaningful learning opportunities.

Modern curricula along with associated tools and resources for supporting sustainable learning can create a technology–rich and inquiry–formed science environment. This environment would support natural complexity of content, avoid oversimplifications, engage students in inquiry process, encourage collaboration and present instruction in the context of authentic scientific investigations. Within that environment, students will have the opportunity to use advanced cognitive tools, as the Internet and a lot of diverse set of resources as video, books and journals. Moreover, the new contexts can require students to work with others and negotiate goals, tasks, practices and meanings (Barab & Luehman, 2003).

The latest efforts of science education reforms focus on scientific literacy, for all students. It is argued that all students, regardless of differences in cultural and economic backgrounds or individual needs, should become scientifically literate, so that they can lead a personally fulfilling and socially responsible life. Science education reformers later recognised that they need to have details relating to reform–based teaching and learning

specified so that the goal of science for all would be achievable. These details have been articulated in the form of benchmarks or standards (Bianchini & Kelly, 2003).

Standards may be conceptualised both as a vision and a set of criteria for judging progress towards attaining that vision (National Science Education Standards, 1996; Liang & Gabel, 2005). Standards are usually established by government sectors that exercise primarily responsibility for organising and overseeing public education. Implementation of a standards based reform, involves formulation of policies for the funding of schools, decisions about appropriate instructional materials, establishment of criteria for professional development and division of accountability schemes for assessment (Bianchini & Kelly, 2003).

In the framework of a standard-based reform, there is a renewed effort to include teachers in the translation of standards into local, situated practice. It is frequently argued that standards, implicitly conceive of teachers as means to enforce the decisions of the central policy–makers, rather than intellectuals offering expertise in a democratic society (Strike, 1993). Moreover, standards often promote an increase in volume in already overstuffed instructional materials or they limit democratic decision making among participants in the reform process. However, despite these concerns, standards are suggested to promote the ultimate goal of any science education reform, which is the improvement of teachers' practices and students' learning (Bianchini & Kelly, 2003).

Effective change implementation also includes change of attitudes to the public understanding of science. The public view of science and, consequently, the significance and scope of science education is shaped substantially by controversial current events. In many cases, lack of democratic involvement in setting research priorities, together with positivist views of science, have contributed to a public fear of science and technology. Complex science topics, which are incapable of providing clear answers to crucial questions asked by public and politicians alike, create uncertainty and confusion (Thomas, 1997; Roth & Lee, 2004).

Science understanding is often revealed to be transitory and incomplete. However, it is questionable whether informing the public about the benefits and the limits and uncertainties of science will result in greater respect for science and science education. Thomas (1997) recognises a need for educators to re-assess and re-affirm the reasons for teaching and learning science in the context of general education and to develop robust justifications for implementation of sustainable change. Educational managers are increasingly encouraged to shift attitudes and enhance the public appreciation of the

realistic character of science and create sustainable links between scientist, researchers, educators and the members of the community.

The emerging alternatives in science teaching emphasise on a holistic approach to learning, influenced by movements from psychology such as situated learning and constructivism. Such perspectives maintain that learning is not a discrete package that can be delivered by a teacher. It is constructed by pupils through connecting new experience, facts and emotions to previous experience and knowledge (Foskett & Lumby, 2003).

The shift of the paradigm of learning suggests that though the current ranking assessment and teacher-centred system dominates, there is a growing intention to change this situation by introducing an interdisciplinary, criterion–referenced, learner–centred approach that implies a more equal relationship between teachers and pupils and potentially more equity in life chances for all.

According to the constructivist model, every individual is an active constructor of understanding. Learning outcomes depend not only on the learning environment but on the prior knowledge, attitudes and goals of the learner as well. Constructing links with prior knowledge is an active process involving the generation, checking and restructuring of ideas and hypotheses. Learning involves radical re–organisation of existing conceptual knowledge. Therefore, all knowledge should remain provisional because new experience could require restructuring of existing understanding (Driver *et al*, 2000; Roth & Lee, 2004).

There are some arguments that question the constructivist thinking and conceive scientific concepts as social and historical constructions that must be taught to children and not discovered or constructed in the classroom. However, despite these arguments, participation in education expands focusing on the learning needs, not the knowledge transmission wishes of teachers. The management of learning tends to move from the intentions of the lecturer to the experience of the students and the active management of the student and the active management of learner outcomes tend to move to the centre of the educational stage (Foskett & Lumby, 2003).

Research scientists and science teachers are increasingly encouraged to play a role in the public understanding of science and the scopes of scientific literacy. The new demand of instant and global communication urges the educational community to engage with new patterns of instructing and informing the public about the underlying meanings and functions of the practices associated with science education.

Fullan (2001a) supports the idea that leaders and educators who are interested in making substantial changes in practice need to get involved in the development of an intellectual apprehension of the new shifts of teaching and learning paradigm. Getting people intellectually ready for the change is an important task to be considered in the process of change implementation.

Intellectual understanding is a situation that presupposes a) the empowerment of public appreciation, understanding and support of science, engineering and technology, b) the elimination of common fears about the possible negative impact of scientific and technological developments on human life, and c) the setting of rational goals for science education. School leaders and science educators are often forced to defend the desired reforms from anti-scientific criticisms. Society should be open to rational change and be able to appraise educational programs, assess policies and judge suitable means of achieving improvement. In other words, effective change implementation presupposes a population with a predisposition to think critically, a belief in rational problem–solving and a healthy respect for evidence (Longbottom & Buttler, 1998).

Science has a very powerful and all pervasive influence on contemporary society. The relationship between humans and their world is influenced by scientific thinking and by peoples' understanding of the material world. Scientific knowledge fosters the rapid advance of technology, which in reality alerts the ways of life. However, the affect of technological change on peoples' lives, influences the ways in which science is viewed and the esteem, in which science education is held. As no change is ever an unqualified influence for the better, some people tend to often downgrade the status of science.

A common starting point for the criticism of science and for the advancement of an anti-scientific philosophy is a fear of a technocratic control. This fear has two components. The first is a feeling that technology controls people rather than the reverse, since technological inventions have had a dramatic and irresistible effect on demography and cultural diversity. The second component is a belief that there is always a totally determined technical solution to every problem, or that scientific logic removes from people any choice about the solutions (Longbottom & Buttler, 1998).

A challenge faced by educational management is to inform people that it is not the scientific ideas and technological capabilities by themselves that alter social life, but the political and economic decisions that are made about the use of technology. Moreover, research orientations and allocation of available funds are often open to prejudice, bias and misunderstanding. Thus, sharing meanings of change priorities and participating in

the process of change implementation always strengthens and empowers the progress of science education.

A second fear arises from a belief in the narrow positivist new of science. In this mistaken view science is a strictly logical procedure for pursuing truth by objectively observing the facts of nature. This is an oversimplified and empirical picture of a scientific method that leads to claims of certainty of knowledge. Such view is damaging to science education, because it reduces the complex set of knowledge to the mindless following of a specific problem–solving process. Although at a professional level the positivist view of science has been thoroughly discredited, such views linger at the public level as unfortunate and unintended outcomes of traditional science education.

Current public views of science and science education range from naïve inductivism where scientists uncover objective truth by careful and unbiased observation, to the post–modern sociological interpretations of science at producing an inevitably culture–bound, relativist picture of the world. It is a fundamental challenge for educational management to inform the public about the realistic character of science, as a robust and rational practice that tends to produce trustworthy knowledge. Scientific theories are neither direct constructions of the world from objective observations, nor are they simply social constructions unrelated to reality. Scientific knowledge is usually generated by individuals, communicated to the scientific community and turned into public knowledge (Longbottom & Buttler, 1998).

To sum up, the public image of science, and especially that, which informs the vast majority of science education, is often wrong or misleading at almost every point. With only few exceptions –such as the dispute between Galileo and the Church– the social and historical context are ignored in favour of a routine transmission of a body of knowledge. Likewise, new scientific approaches, such as chaos theory or qualitative biology, are often rejected as unproven or non–familiar knowledge (Claxton, 1997; Roth & Lee, 2004).

A General Argument about Innovation in Science Education

New Ideas Challenging the Roles of Subjects in Education

Terms and circumstances of human existences are expected to change radically during the next human life span. Science, mathematics and technology, will be at the centre of that change – causing it, responding to it. It is generally believed that scientific literacy is

essential to the education of today's children for future world. A set of purposes that influence many innovations focus on the securing of inclusiveness and equity through education. Differences of social class, gender, ethnic origin, family background, home language, performance ability, motivations and learning styles amongst students can all create obstacles for particular groups of children. Educational organizations must be constantly vigilant to remove these obstacles. The means can be direct, such as using examples from a minority groups' culture, in a technology lesson, or indirect, for instance by deferring choice and specialization until students are sufficient mature to fully understand the consequences of their choices (Black & Atkin, 1996).

Systemic Reform requires the involvement of wide range of persons and agencies, sharing responsibility for promoting and supporting educational innovations. In addition to national and local governments and their schools, parents, community groups, those working in media, museums, administrators, researchers, teacher educators, publishers and professional and voluntary organizations involving many of these groups, can have a role to play. Sometimes, motivations begin in the classroom. In other cases, the drive for a reform is associated with the change in the social status and roles which teachers and students are charged with (Black & Atkin, 1996).

Current studies show that changes in the nature of school sciences can shift the subject from science presentation as disembodied truth to describing of science as the products of human work. They may also move the emphasis away from pure research towards the more complex fields of application, concerning the practical and everyday context as the framework in which science should be taught. The traditional approach, based on teaching deep concepts and then showing how they lead to applications, is challenged. Now, applications tend to come first, on the assumption that they are closely related to the interests of young people, their daily lives and their future as citizens. Curriculum design is expected to be more complex, including such topics as pollution, conservation, global warming or genetic engineering. The focus of the whole effort is to lead to the acquisition of profound concepts and stringent methodologies of science as well as the authentic and useful basis for the students' future interest (Black, 1996).

A common consequence of these tendencies is a move away from the teaching of the separate sciences – especially in secondary schools – towards having a single unified course in which many relevant topics are taught in a coordinated way. Besides, a more profound cross-curricular work is being developed in the innovations in a few countries, linking sciences to mathematics, technology and even to humanities. The introduction of

issues of social choice and moral values in the teaching processes as well as the emphasis on the practical application of sciences, are increasingly seen to be necessary parts of dealing more realistically with human problems in the fields of education (Black & Atkin, 1996).

Changes in sciences, which are reflected by equally profound changes in school mathematics tend to decrease the emphasis on the teaching of rules and procedures. They enhance the tackling of problems and give high priority to social need for better informed citizens. Students should see science and mathematics as ways of dealing with problems by constructing models of reality and manipulating them. Along with technological advances and the increasing use of computers this trend expresses the commitment to a new, or newly re-defined, school subject that takes into consideration the importance of meeting human needs by designing and putting into practice optimum solutions (Black, 1996).

Transforming Didactic Attitudes by Emphasis on Constructive Approaches

The ideas about student learning have already been challenged and many of them abandoned. The traditional delivery model of learning was underpinned by assumptions about learning suggesting that:

- knowing that must come before knowing how,
- students should firstly receive and memorize the new knowledge at the abstract level and then get familiar to it through routine exercises, before attempting to apply it to different contexts,
- motivation can be achieved by external pressure on the student rather than by change in the mode of learning or alterations in the teaching strategies, and
- difficulties or failure in learning arises from an innate lack of ability or inadequate effort.

The new trends based on the constructivist ideas imply that students must clarify and express their own beliefs and then be challenged to develop or change them in ways that make it possible for them to give personal meaning to the new knowledge. Thus, true innovations involve transforming didactic attitudes than changing teaching methodologies. They also imply that the roles of both teachers and students and the relationships between them have to change. Teachers should take on the new role and be

able to break away from their role as mere lecturers whose purpose is knowledge transmission (Black, 1996).

Students should be provided with choice and flexibility to shape the way they approach scientific topics, by working in contexts familiar to them. They should use a variety of procedures in order to gather, synthesize and present effectively the new information. Of course, these approaches can cause confusion and anxieties in cases where students were successful in traditional-type programs. It usually takes time to adapt to new learning processes and there is always a need for empowerment of support and collaboration.

The new approaches put emphasis on hands-on and appropriate practical work, on real-world problems, on opportunities for taking responsibilities, on working in groups in the school community and on the importance of enhancing the confidence and maturity of young people. New learning resources as computers and the possibilities opened up by collaboration with local communities and institutions should be used. Technology is going to play a very important role being the most radically cross-curricular item that may provide all members of the learning community with the necessary information, assess to resources of materials, knowledge and skills. In such a learning context, science should become a subject that can provide initiatives for a broad, deep and multi-dimensional student development (Black, 1996).

Teachers' Professional Work Inside and Outside Classrooms

The incorporation of ideas or initiatives about assessment in the change process is a threatening or, at least, a problematic theme. There is always a difficulty in ensuring the student activities that provide assessment data are valid, correspond to the learning aims of learning and give indicative results. Besides, there is always a tension between the different aims of assessment. The formative purpose is served by information collection for immediate use by teachers to improve students' progress. This is embedded in classroom activity and must be under teachers' control. The summative purpose is concerned with providing information about students, to guide their transfer between different stages of schooling and their move out of schools to employment or further education. This purpose is closely related to the demands for school accountability. These purposes are often served the same data and by the use of external tests, which sometimes dominate the routine classroom work (Black, 1996).

As the essence of teaching and learning changes, improvements in assessment require difficult changes in the roles of both teachers and their students. The new forms of assessment, which are being currently proposed, such as students' self-assessment or peer assessment require the development of new learning activities. Students are demanded to set their own problems report their work to peers collect their best work into portfolios ask their own tests and provide the teachers with valuable flow of information about progress. They are expected to behave as honest and clever young people, capable of taking the responsibility for constructing actively their own learning. There are cases where students' portfolios could replace parts of the general formal school examinations (Black, 1993).

It has been increasingly recognized that if new aims and methods are to be translated into effective classroom practices, teachers have to be provided with flexibility to implement change. Teachers should act as partners in decision-making, planning and programming, collaborating with peers and refining new strategies through shared experience and reflection. This is the essential element of any attempt for systemic reform. Changes in initial teacher training are usually not enough to re-culture the roles of teachers according to the new paradigm of the school organization as a learning community. Teachers are asked to take risks in establishing new practices and new relationships. They often have to act in ways that threaten their authority and pedagogic expertise in the classroom, demanding new working approaches and deeper knowledge of the subjects to be taught (Black, 1996).

According to Black, (1993; 1996) in order to cope successfully with change, teachers should take into consideration that the whole process involves the following behavioural conditions:

- Disequilibrium: teachers realize that there is a need for improvement in the present programs.
- Exposure to alternatives: teachers get convinced that there are better approaches.
- Existence proof: the proposed changes are demonstrated.
- Modelling: teachers get in touch with peers who are operating the innovation to model initially their own efforts.
- Support: teachers are empowered to implement change by their own district and school community.

- Experimentation: teachers' trying out new ideas with students from outside the particular school.
- Reflection: providing teachers with opportunities to sit back and reflect alone and with colleagues, thinking about the effects of change.

6. CASES OF EDUCATIONAL RESEARCH REFLECTING CURRENT APPROACHES TO CHANGE SITUATIONS

Research shows that over the last decades significant efforts have been made to bring change to science classrooms. Anderson and Helms (2001), have pointed out the need to examine reform efforts systematically in order to understand the pathways and impediments to successful reform.

The Davis (2002) study provides a critical analysis of the implementation of an innovative science curriculum at a school site. The author explores the issues that surround teachers learning of new practices. Parallels are drawn between students and teacher learning and the importance of autonomy and decision–making structures for both groups. The new instructional approaches have been used both for the student and teachers' learning. Findings presented showed that a) staff development with constructivist underpinnings facilitated teacher learning, b) regular and frequent opportunities for interactions with colleagues and personnel of external support contributed to teacher learning, c) the decline of interactive forms and the continuation of old decision–making structures restricted the development of teacher science program, and d) the process of field testing at this site limited the incorporation of teachers' prior knowledge and impacted teacher acquisition of new knowledge and skills (Davis, 2002).

Palus and Drath (1995) propose a model of leadership development based on the process of meaning–making, which contains the essential element of the re-organisation of individuals' thinking[5]. The model has been applied to the study of leadership development in communities of educational practice. Such a case is the 'sci-link project'

[5] According to this model this is accomplished by providing opportunities for persons to participate in and be changed by five interwoven processes: experience; disequilibrium; equilibrium; construction and potential. The person who enters a developmental program can initially be at a state of confusion and anxiety that causes disequilibrium and recognition of the need to make change. At the next stage, the person is encouraged to explore new avenues of understanding and eventually to re-establish equilibrium, within a flexible and supportive environment. Through this process new meaning structures are built and new ideas or events are accepted. Finally, this person becomes sensitised to the possibility that new perspectives and new ways of knowing can be found. The goal for all participants is to develop the ability to foster and effectively participate in processes of leadership in their communities as well as in broader areas, beyond their immediate community. Additionally, there will emerge and evolve from the leadership developmental program a holding environment, in which leadership processes are embedded and enacted (Palus and Drath, 1995).

(Howe & Stubbs, 2003, p.281). Within this project, the Palus and Drath (1995) model was used as a framework for analysing and understanding the experience and forces that have led three science teachers to become active, effective leaders in their schools. The purpose of the project was to bring science teachers and environmental scientists together so that teachers would learn about current scientific research and advances and translate this knowledge into interesting and effective lesson plans and activities for their students. Teachers listened to and discussed with scientists particular scientific topics and then planned a lesson that included classroom activities for all students, co-operative learning and open–ended experience. They were supposed to bring to this task their previous knowledge, along with their knowledge of teaching and curricula and they were encouraged to use Information and Communication Technologies in classroom.

A multiple-case study showed that three participating science teachers, who had been chosen from different backgrounds and with different teaching experience, have emerged as teacher–leaders able to analyse situations, understand environmental issues, enter into discussions with engineers and other professionals and contribute to community decisions. This new view of leadership calls for science teachers to become leaders in their schools without leaving the classroom (Howe & Stubbs, 2003).

Bianchini and Kellys' study (2003), which examines the adoption process of a standard–based science education reform in California, offers substantive critique of the ways content standards narrowly frame science education and raises questions about uses or misuses of standards to shape curriculum and instructional practices. Research evidence does not advocate elimination of standards. It calls for greater recognition of challenges in using them to promote science education reform and for renewed effort to include teachers in the translation of standards into local, situated practice. California standards, which are not explicitly grounded in educational, psychological, historical, philosophical or scientific research, have been developed in the absence of standards for teaching, professional development for teachers, assessment and educational programs and systems. As a result, they serve as an inadequate resource for textbook publishers and science teachers interested in working towards reform (Bianchini & Kelly, 2003).

Science standards are presented as long lists of scientific facts that students are expected to know. These lists are neither situated by an introduction nor framed by a rational. They focus on specific contents, laws and theories and they describe the scientific process skills but they do not examine the nature of science and the ways

science is situated in society. Moreover, they implicitly consider teachers as means to enforce political decisions rather than intellectuals offering expertise in a democratic society. Findings proved that California's science content standards that have been employed as instruments of accountability, had led to the overstuffing of educational programs and prevented teachers from formulating their own instructional goals and devising the most appropriate means of responding to their diverse students' needs (Bianchini & Kelly, 2003).

A major challenge that science educators have to face is the development and implementation of project-based, technology-rich science curriculum that is consistent with current calls for a new approach to science education while at the same time meeting the everyday needs of classroom teachers. Researchers from multiple institutions have focused on this topic, particularly with regard to the use of the Internet. Specifically, they discuss the interplay among the affordances and requirements of technology, curricular interventions local and district–wide cultures and environments, widespread curricular implementations and sustainable use over time (Barab & Luehmann, 2003).

Squire *et al* (2003), examined the implementation of a project–based curriculum by describing a series of four abbreviated case studies of teachers, implementing that project. Their discussion highlighted the major importance of school and classroom culture in determining the implemented experience. Their findings suggest that teachers cannot be viewed as inheritors of university –developed curriculum but as users or makers, drawing on and adapting pre-developed materials in ways that they consider as useful for their students and consistent with their personal pedagogical beliefs, classroom climate and past experiences.

Barab and Luehmann, (2003, p. 545) applied the 'Kids as Global Scientists', or simply 'KGS' program, which is a 9 year study that examines the implementation of a technology-wealthy inquiry focused program. The program is a suite of tools that include relevant curriculum, software and a systemic structure of teacher professional development. The study presents data from science classrooms that successfully implemented the KGS curriculum, environment comparing the experiences of different groups of teachers.

A research study by Linn, Douglas and Slotta (2003, p.517) examines the implication and local adaptation of the 'Web-based Inquiry Science Environment (WISE) project'. This WISE inquiry curriculum and learning environment technology together with supports for teachers aims at the improvement of instructional practices, the advancement of scaffolded knowledge integration framework and the support of local customisation as one means to help teachers build sustainable science institution. The research paper analyses 25 cases, highlighting design strategies underpinning WISE and dissemination, specifically the challenges of allowing local adaptation yet maintaining curricular integrity (Linn & Hsi, 2000).

A small study conducted recently by Luehmann (2002) identifies component processes involved in the professional task of customisation required of each teacher. These processes refer to the consideration of local needs, critical examination of the innovation in light of these needs, prediction of possible outcomes of reform, and finally, procedures of making plans or decisions regarding change implementation. Luehmann, (2002) suggests that educational managers need to understand the teachers' work through these processes in order to support the development of the desired innovation and to improve its fit into the local culture. In addition, understanding these customisation processes will allow the managers to support teachers to address the local needs and redefine the classroom culture with respect to new challenging goals.

Another study by Leuhmann (2001) presents the answers of 30 teachers who were asked to identify the factors most important to them when appraising and considering an innovation for potential implementation. Analysis resulted in the grouping of the teachers into five groups defined by shared concerns: accountability focused; subject-matter focused; scaffolding focused; logistically focused, and pedagogically savvy. A subject-matter focused teacher is usually very concerned about students' understanding of the content while a logistically focused teacher is most concerned about the smooth running of activities and the appropriateness of time frame. In practice teachers are not only receivers of the pre-designed change. They are continually remaking and conceptualising the innovation in terms of their own perceptions.

Research on cases of teacher-controlled change reveals that biography, experience, personality and context play a main role in the change choices that individuals make (Richardson, 2001). Observation of educational situations led Randi and Corno (1997) to

conclude that classroom innovations are socially derived and always affected by teachers' goals, local constraints and pedagogical values. Relevant studies by Rogers (1995), support the argument that, change implementation is after all an optional innovatory decision in which teachers usually have the autonomy to decide on an individual basis. These studies also pointed out that any innovation, it involves, by definition, newness and therefore a degree of uncertainty, even if it offers potential benefits that the current practices do not. Furthermore, what might appear beneficial to the designer might not be perceived as beneficial by a teacher, especially when considered in light of personal values or costs.

Bell and Lederman (2003) investigated the role of the nature of science in decision-making on science and technology based issues and the factors or reasoning patterns associated with this kind of decisions. They found that the individuals' understandings of the nature of science do not influence considerably the process of decision-making. Other factors, not associated with the nature of science, including social and political issues, ethical considerations, and personal values, appeared to dominate the participants' decisions on complex controversial science and technology- based issues.

In this study, participants selected from the faculty of diverse universities were divided into two groups, on the basis of their divergent views of the nature of science as assessed by open-ended questionnaires and following-up interviews. Profiles of each group's decision-making were constructed. The two groups' influencing factors and decision-making strategies were compared. No differences were found between the two groups decisions of the two groups. These findings contrast with basic assumptions of current science education reform efforts, which aim at the developing of better decision-making skills and call for a re-examination of the goals of nature of science instruction (Bell & Lederman, 2003).

An empirical study focusing on large-scale initiatives to reorganize local provision of state schools in England (Wallace & Pocklington, 2002) led to conclusion that it is beyond human capacity to achieve fully predicable, directive control over the change process. The researchers conceived a dispute over the allocation of available computers among schools, arose during the reorganization process, as an instance of the wider phenomenon of complex educational change, to show that change, intrinsically, is

relatively unmanageable because it challenges habitual practices and beliefs of people in and around the organization affected.

Furthermore, studying the dispute over computers during the reorganization process has shown that change usually increases the endemic organizational ambiguity experienced by those who have to manage it. Individuals cannot exert absolute control over the other members of the educational community. Sometimes they are not even fully aware of what is happening during the re-organization procedures. Besides, the change process can generate conflicts by bringing together, in the same situation, contradictory and incompatible beliefs and values, which often coexist harmoniously by being kept separate (Wallace, 2003).

The Research group at Caltech's Precollege Science Initiative (CAPSI) is a team of researchers studies together important issues in science teaching and learning to improve educational policy and practice. They aim at investigating the different ways children learn about science, how science may be taught most effectively, the connections among science, literacy and technology, and how to implement useful research findings in the classroom. They have been engaged with educational reform for two decades utilizing both qualitative and quantitative research methods to understand the deep complexities of science teaching and learning (CAPSI, 2004)

The CAPSI Research and Evaluation Group have developed several projects aimed at studying the extent and effectiveness of science education reforms, assessing and improving elementary science teaching, developing and evaluating innovative educational technologies[6]. These projects suggest that teachers and learners can benefit from high quality science instruction when given the opportunity (CAPSI, 2004).

James Bower (1994), after eleven years of involvement in science education reform efforts identifies some common myths of science education reform referred to teachers' knowledge and motivation, to scientists' involvement, to the significance of curriculum and to allocation of resources. Bower (1994) argues that the role of professional scientists is very important in validating the reform program, supporting teachers, contributing to the acquisition of resources and modelling the scientific process.

[6] The IS IT project examines the value of hands-on inquiry science education in elementary school asking some basic questions about science education reform. The RESEARCHING THE SUSTAINABILITY OF REFORM project is an historical analysis of nine school districts that have sustained a hands-on elementary science program for many years. The SCIENCE NOTEBOOK STUDY is designed to draw on the expertise of experienced teachers to study aspects of the relationship between literacy and science.

Most important, involvement in reform efforts through research projects, means growing awareness of the quality of science education offered in colleges and universities.

Bower (1996, p.55) describes the Nebraska Earth Science Education Network (NESEN), an organization engaged in multiple strategies aiming at the improvement of science education. It was created to serve as an interface between science educators, on the one hand, and resources available from university or other scientific organizations, on the other. NESEN has developed an interesting educational project that focused on the process-oriented environmental change education and provided a model for connecting research to the classroom. A primary objective of the project was to use inquiry-based professional development workshops for science educators. In these workshops, teacher teams developed interdisciplinary units, consistent with their local curriculum objectives that aimed to help connect students to their environment through the use of relevant environmental change information.

The whole effort was based on the assumptions of Gosselin and Meyer (1999) that students need to actively experience the methods and processes of scientific inquiry and that global environmental change data and information need to be more accessible to educators and students. Successful educational projects were suggested to help teachers to improve their abilities as learning facilitators and actively engage their students in doing science. The most significant products from this project was the development of portfolios of hands-on and minds-on units that encourage students to examine and evaluate the issues of environmental change from various perspectives as well as the implementation of some flexible, user-friendly educational programs that are accessible and effectively importable into the curriculum (Gosselin & Meyer, 1999).

CHAPTER III:
INVESTIGATING CHANGE MANAGEMENT IN THE CONTEXT OF GREEK EDUCATION

"And I saw Sisyphus at his endless task raising his prodigious stone with both his hands. With hands and feet he' tried to roll it up to the top of the hill, but always, just before he could roll it over on to the other side, its weight would be too much for him, and the pitiless stone would come thundering down again on to the plain. Then he would begin trying to push it up hill again, and the sweat ran off him and the steam rose after him"

[Homer, Odyssey, Λ, 599-606]

Every effort for educational change in Greece reminds of the myth of Sisyphus

(Kazamias & Zambeta, 2000)

INVESTIGATING CHANGE MANAGEMENT IN THE CONTEXT OF GREEK EDUCATION

INTRODUCTION

Having described the main theories and literature relating to the topic of managing Educational change in science subjects and reform it is now necessary to examine them in the context of the Greek educational system. This chapter begins with a description of the Greek educational system and analyses the current social economic and cultural trends affecting the Greek educational policies and the underlying factors that characterize its functioning and development. Finally, it defines the directions of the study which are: the needs and reasons for change; the attitudes of the agents of change; the parameters and dimensions of change; and the management of systemic change and its impact on public understanding of science.

1. MANAGING CHANGE IN THE FRAMEWORK OF GREEK EDUCATIONAL REALITY

Description of the Greek Educational System

General Insights of Greek Education

In Greece, education is a basic principle and mission of the state. Its ultimate objective is to equip the Greeks with the necessary qualification that will help them obtain moral, intellectual, vocational and physical instruction, to promote national and religious awareness and to develop free, responsible citizens. Every Greek citizen has the right to free education, at all levels, in state or public institutions, irrespective of family background, origin and sex. Education is regulated by state laws and by executive acts (decrees, ministerial decisions). The Ministry of National Education and Religious Affairs is overall responsible of educational issues (EURYDICE/CEDEFOP, 1995; YPEPTH, 1985).

There are 108 Directorates of Primary and Secondary Education in the 54 regions, concerned with management of primary and secondary education. Those Directorates report directly to the Ministry. In regions with a large school population, there are

Education Offices, as well. As far as higher education is concerned, institutions of such level (AEIs/universities and TEIs/institutions of technological education) are autonomous, even though they are funded and supervised by the Ministry of National Education and Religious Affairs[7].

Levels of School Administration

National Education Policy in Greece is primarily a responsibility of the Ministry of Education and Religious Affairs. Its main tasks and responsibilities are definition, evaluation and creation of the necessary conditions for healthy education. More specifically, its work is: to propose educational legislation; to implement the laws and the associated administrative decisions; to coordinate and evaluate the regional services and schools; to provide financial support for educational activities (EURYDICE/CEDEFOP, 1995; YPEPTH, 1985).

However, all these issues might not be completely under the charge of the Ministry. There are other bodies, foundations and organisations, which function in assistance to the ministry, to which they report directly. These are:

- The Pedagogical Institute, an autonomous public body, operating under the intendance of the Ministry of Education, mainly responsible for a) formulating guidelines, b) the preparing timetables and curricula, c) commissioning and approving of textbooks, d) applying vocational guidance, e) introducing new subjects and new teaching methods, f) the providing in-service training for teachers.

- School *Consultants or Advisers* of Primary and Secondary Education who have a minimum of fifteen years' experience in education and significant number of them

[7] Vocational education and training for young people are issues shared by the Ministry of National Education and Religious Affairs and the Ministry of Labour. The former provides vocational education in post-compulsory secondary education. The Organization for Vocational Education and Training *(OEE*K), which has complete responsibility for the vocational training institutes *(IEK*s) is also under the supervision of this Ministry. The later, through the Manpower Employment Organization *(OAE*D), runs technical-vocational schools as Apprenticeship Schools *(Scholes Mathiteias*). It also operates parallel programmes of vocational training for adults in Centres for Vocational Training *(KE*K) under the responsibility of various bodies. Moreover, other ministries, as the Ministry of Agriculture, supervise vocational schools, the education offered by which, emphasises in the sectors of agriculture and animal husbandry (EURYDICE/CEDEFOP, 1995).

hold postgraduate qualifications. In secondary education, each consultant is responsible for a category of teachers who teach the same subject or discipline. Their mission includes provision of in-service training and pedagogical support for educators.

- The School Buildings Organization (*OSK*), a self-governed organization, responsible for the construction of school buildings and for their equipment.

- The Textbook Publishing Organization (*OEDV*), also a self-governing organization, responsible for the publication of school textbooks, other educational material and their free distribution to schools.

- The Organization for Vocational Education and Training (*OEEK*), another self-governing body, established by Law 2009/14.2.1992, to organize and administrate state or private Institutes of Vocational Education and Training (*IEKs*), which work under the supervision and responsibility of the Ministry of National Education and Religious Affairs.

- The State Grants Foundation (*IKY*), the main purposes of which are: a) to provide funds, loans and awards to Greek expatriates and foreign nationals b) to provide financial support within the framework of European cooperation programmes, c) to gather and distribute information on all opportunities for financial support offered to Greek citizens and d) to carry out and disseminate, the research, studies and publishing, which are linked with its objectives.

- The Interuniversity Centre for the Recognition of Foreign Qualifications (*DIKATSA*), which's main function, is to recognize foreign universities and the qualifications they award as equivalent to Greek ones.

- The National Youth Foundation (*EIN*), which is a self-governed legal entity of private law and supervised by the Ministry of National Education and Religious Affairs. Its primary mission is to assist young people by founding university and

other students' halls of residence, pupils' halls of residence and pupils' centres, by promoting cultural events, as excursions and camping programmes, and by implementing special programmes of the General Secretariat of Youth (EURYDICE/CEDEFOP, 1995; YPEPTH, 1985).

At regional level, administration is managed through the various basic duties and responsibilities of Directors of primary and secondary education. Firstly, they are responsible for the coordination of Education Offices in their region. Secondly, they have the duty to supervise head teachers. Thirdly, the supervision and coordination of the maintenance of school buildings. This includes the improvement of school equipment, as well as allocation of teaching staff to schools and the supervision of private schools. Fourthly, they are charged with submission of proposals both to the local government and to the Ministry of National Education and Religious Affairs for the improvement of educational activities in their prefecture. The administrative tasks and responsibilities of the Heads of Education Offices are similar to those of the Directors of education in the region.

Moreover there is *Regional Council* that deals with issues concerning teachers' status, at a regional level. The same issues are dealt by *Central Council* in the Ministry of National Education and Religious Affairs at national level (YPEPTH, 1985). The former is composed of five members. The President of the Regional Council is the head of the Directorate of Education in the prefecture, two members are heads of Education Offices or, if there are none, teachers with the highest grade in the career structure (A grade), and two further members are elected representatives of teachers. The Central Council comprises three heads of Directorates of Education with corresponding alternates and two elected representatives of teachers (EURYDICE/CEDEFOP, 1995).

At the level of the school and individual institution, the administration is mainly the responsibility of the head-teacher who is accompanied in this work by the deputy head-teacher and the Teachers Council. In Greece, during the last twenty years, there is no official inspection of teachers. Assessment and inspection is within the purview of the School Consultant and various supervisory tasks can be carried out by the Directorates and Offices in Education in the Prefectures (YPEPTH, 1985).

Pre–School Education

Pre-school education is optional. It lasts for two years and is intended from children at the ages of 3 or 4 to 5 or 6. It is provided in nursery schools (nipiagogeia) that can be either independent or part of a primary school. There are state nursery schools, where attendance is free of charge and private ones, which are fee-paying. In the former priority for admission is given to the children that reside close to the area of the school (EURYDICE, 2000; YPEPTH, 1985).

The purpose of it is to promote in an environment of freedom, security and mental stimulation the complete "harmonious and balanced development of the children, their psychomotor, social, emotional, moral and religious development, the cultivation of skills, and mental and aesthetic development" (EURYDICE/CEDEFOP, 1995, p. 9).

Nursery schools operate for 172 days a year. The timetable is 3½ hours daily, either in the morning (8.30 a.m. to 12.30 p.m.) or in the afternoon (2.00 p.m. to 5.00 p.m.)[8] (EURYDICE/CEDEFOP, 1995).

Compulsory Education

Education is compulsory between the ages of 6 and 15. Compulsory full-time education is completed in two phases. The first phase is Primary school (*Dimotiko Scholeio*). It is a 6 year circle lasting from the age of 6 until the age of 12. The second phase is Junior High School (*Gumnasio*), which lasts for three years, from the age of 12 until the age of 15 (EURYDICE/CEDEFOP, 1995; YPEPTH, 1985).

As far as the primary school is concerned, its main objectives are to help the pupils:

- Expand and adjust the relationship between their creative activities and the situations, programmes, subjects and phenomena, which they are studying.
- Establish the techniques and mechanisms that help the approach and construction of new knowledge, the promotion of motor skills and the development of physical and mental balance.

[8] A curriculum monitoring the program of nursery schools was introduced in 1989. This curriculum recommends activities, including periods of group games in various parts of the room known as corners, specially designed for these games. It also recommends activities planned, along with their objectives by the teacher. When organising an activity, the teacher needs to take into deep consideration the curriculum and integrate more than one aim and various areas of development from those mentioned above (EURYDICE/CEDEFOP, 1995).

- Seize the essence of fundamental concepts and steadily conquer the ability to construct them, by using information and data coming from their senses to the field of abstract thought.
- Understand, appreciate and organise a system of moral, religious, humanitarian and national values.
- Improve aesthetic judgement in order to be able to respect works of art and express themselves through their own aesthetic creations.

As it happens with nursery schools, in order to enter state primary or secondary school, students must be living near the area where they are built. Admission to primary school is permitted to children, who are at the age of 6 by the end of the year of registration. Admission to high school is automatic as soon as primary school circle is accomplished[9]. Study in state primary and secondary schools as well as text-books are provided free by the state (EURYDICE, 2000).

The academic year includes 175 days, from 10 September until 15 June. Schools normally operate five days per week and the hours of lesson are between 23 and 35 increasing with the age. The duration of a lesson may be from 40 to 50 minutes[10].

The curriculum is designed by the Pedagogical Institute and approved or applied by the Ministry. At the level of the primary school, compulsory subjects are Greek, mathematics, science history, religion, environmental studies, geography, social education, aesthetic education, music, foreign language and physical education. Those subjects, with the exception of the last four are taught by the same teacher. Foreign language, music, aesthetic education and physical education are taught by teachers of relevant specialisation (EURYDICE, 2000). The curricula and timetables, for each subject, are planned in detail by the Pedagogical Institute, which is also responsible for

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[9] At the end of every school year, the students of grades 1, 2, 3, 4, and 5 are awarded the Progress Certificate (*Τίτλος Προόδου*), where the word *promoted* is written. The students who accomplish grade 6 are awarded the Study Certificate (*Τίτλος Σπουδών*), where the word *Released* is written. The certificates of the last two grades also include a descriptive mark and its numeric equivalent, which represents the average mark of the student. Promotion to the next grade or level of education is automatic and is assured by the Certificate given at the end of the year. The only case where a students has to repeat the year is because of insufficient attendance, which is defined as attendance of less that half the school year (EURYDICE/CEDEFOP, 1995; Greek Education Act Law 1566, 1985).

[10] In 1996, the minimum number of hours taught per year were 525, for children at the age of 7, 761 for children at the age of 10 and 919 for students at lower secondary level (EURYDICE, 2000).

the school textbooks. There is no choice of textbooks, except if this is provided by the Pedagogical Institute[11].

In primary school assessment is resultant of different dimensions. The first is based on daily oral tests and the overall participation of the students in the learning process. The second includes the evaluation of the work written and prepared by students as homework. The third is the performance of students in written tests[12].

The type of descriptive assessment, from the 3rd grade and onwards, is accompanied by a marking scale. More specifically, during the third and the fourth grade, there is the scale for grades A, that stands for Excellent, B that stands for Very Good, C that stands for Good and D that stands for Quite Good. In the fifth and the sixth grade the scale is numerical. Marks 10 and 9 mean Excellent, 8 and 7 mean Very Good, 6 and 5 mean Good and everything below five is Quite Good.

Until 1982, nursery and primary school teachers were being educated in Colleges for Nursery or Primary School Teachers respectively (Παιδαγωγικές Ακαδημίες). In these foundations, studies lasted for two years.In 1982, however, in accordance to a law, University Departments of Nursery and Primary School Education started being established. These departments, where the duration of study is four years, started working during the academic year 1984 and their first graduates are seen in the year 1988 (EURYDICE/CEDEFOP, 1995)[13].

The Primary School is then followed by attendance at Junior High School (Gymnasio), which is obligatory for children between the ages of 12 and 15. Entrance and

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[11] In addition to the ordinary curriculum, there are supporting teaching programmes established for less able pupils, mainly in language and mathematics. There are also induction classes for children of returning nationals and foreigners (EURYDICE, 2000).

[12] During the first term, in the fifth and the sixth grade, students are usually asked to carry out a big project under the supervision of the teacher. This project, which is presented at some stage in the whole classroom, might influence the students' assessment as well. The form of assessment in every class of the primary school is mainly descriptive. This allows the parents to have a more detailed and broader view of their children' s performance in each subject, abilities, talents and possible weaknesses. The teacher is also required to keep a register of his class, in order to be able to keep detailed data, about the assessment and the record of each student. This register is only for school use and might only be open to the head-teacher or maybe the teacher of the same class during following years (EURYDICE, 2000; Greek Education Act Law 1566, 1985).

[13] Teachers, in the beginning of their work, have to attend three month introductory training course at Regional Training Centres (ΠΕΚ, Περιφερεακά Κέντρα Επιμόρφωσης).Teachers who have teaching experience between five and twenty five years are invited every five or six years to attend in-service training courses. The nursery and primary school teachers who are appointed at state schools work under the civil servant code. Before becoming permanent, a two-year, probationary period is required (EURYDICE/CEDEFOP, 1995).

admission to the Junior High School is automatic, with no examination. There are State Junior High Schools, where attendance is free and there are Private ones where there are tuition fees. Their main aim is their complete development in accordance with their abilities and the corresponding demands of life. In Junior High Schools, there are three grades, 1st, 2nd and 3rd, organised according to student's age (YPEPTH, 1985). They operate for five days during a week and each group has to attend 33 to 35 lessons, which may last from 40 to 45 minutes each. The total number of teaching days per school year is 175, from 10 September until 30 June.

The subjects taught in junior high schools, which are the same for all students are, modern Greek language and literature, ancient Greek, mathematics, physics-chemistry, biology, geography, religion, music, physical education, art education, household economy, Informatics and computer technology, foreign languages (English and French or German), career guidance and orientation and social education.There are also remedial classrooms, which operate after school and aim to assist students who are considered to perform weak by their teachers (YPEPTH, 1985).

Assessment is based on the student's performance on oral, written test, which form a term grade, as well as written exams at the end of the year. Pupils are promoted to the following class if their final marks, which are calculated through their term and exam grades, can give an average greater than 10 out of possible 20. If a student has final mark lower than 10 in four different subjects or if the sum of absences, (the number of lessons the student has missed), exceeds the limit addressed by the law, (50 unjustified and 150 justified), the student fails and has to repeat the year. Of course, the decision whether the student is promoted or not is also subject to the Teachers' council and his or her performances in the other subjects (YPEPTH, 1985).

The teachers are specialised in the field that they are teaching. They have attended four-year University courses where they have majored in studies that are relevant to the subjects they are teaching[14]. Parallel to those Junior High Schools, there are Music Junior High Schools and Sports high schools, which mainly follow the same subjects and the Curricula, but specialise in Music knowledge or Sports equivalently. They refer to primary school leavers who wish to specialise further and pursue careers in these fields (EURYDICE/CEDEFOP, 1995; YPEPTH, 1985).

[14] Usually, as primary and nursery school teachers, they work under the civil servant's code and are required to attend in-service training during their career (Greek Education Act Law 1566, 1985).

Upper Secondary Education

Upper secondary education can be offered either in Senior High School (Lykeio) or in Technical Vocational Schools (TEE). It refers to students between the age of 15 and 18. Entrance to those schools is permitted, automatically to graduates of Junior High School without any examinations involved (EURYDICE, 2000).The Senior High School known as *Lykeio* can be both, state or private. As in high school, they include 3 different grades. At state schools attendance is free and the books are provided with no charge to students.

There are different types of Senior High Schools. The most usual is the General Senior High School (Γενικό Λύκειο). Its main aim is to help students cultivate such character and personality so that they will be able to contribute actively to the economic and cultural development of the country. Another aim is to help the students gain the necessary abilities to apprehend the society where they live, so that they can take the necessary decision for their future. Pupils attend daily for three years. There are approximately 30 to 35 lessons per week.

The subjects that are taught in Senior High School are Modern Greek, Ancient Greek, mathematics which might include separate subjects of algebra and geometry, physics, chemistry, biology, foreign language (English, French or German), religion, physical education, Information Communication Technologies, School Vocational Guidance (EURYDICE/CEDEFOP, 1995)[15]. In what concerns the assessment methods used, as well as the qualification of the Senior High School teachers are no different at all with those at Junior High Schools (EURYDICE, 2000; YPEPTH, 1985).

Apart from the General Senior High Schools, there are other types of Senior High Schools for students of the same ages. Those serve the same aims as the General Senior High School, but emphasise in other more specialised subjects or skills. These are:

- *Technical Senior High School*, which provide the necessary technical and vocational education and training so that the students will be able to pursue a career in a technical or vocational field of work.
- *The Comprehensive Senior High School* which emerged as a combination of both General and Technical, in order to provide students the opportunity to combine programs.

[15] Even though at the first grade of High schools the students are taught the same subjects, during the second and the third grade, different students might attend different subjects depending on the option stream they choose, during their preparation in Higher Education (EURYDICE, 2000).

- *The Classical Senior High School* emphasises arts, theoretical and classical studies and not that much in subjects of mathematical and scientific nature.
- *The Ecclesiastical Senior High School*, which emphasises religious studies and is permitted only to boys.
- *The Music Senior High School*, designed for students who want to specialise in music and work in this field.
- *The Sport Department Senior High Schools*, established for students, selected after having shown excellence in their performance as athletes in various sports (YPEPTH, 1985).

Apart from Senior High Schools there are the Technical Vocational Training Schools. Their students are provided general education through core units and specialised technical education. Training is sufficient to offer them the opportunity to work in technical field, as mechanics, technicians and other relevant specialisations. The qualifications of the teachers and the assessment systems are approximately the same with those of the Senior High School (EURYDICE, 2000; YPEPTH, 1985).

Initial Vocational Training

The National System of Vocational Training was established in 1991, aiming: a) to organise, develop and provide vocational training, b) to award formal certification or professional training, c) to provide of opportunities for training. The main foundations offering courses vocational training are Institutes of Professional Training (IEK) and the Organisation of Manpower Employment (EURYDICE, 2000).

Higher Education

Higher education is provided in Universities (Higher Educational Foundations, AEI), which offer general academic education or in institutes of technological education (TEI). Entrance in the Universities or Technological Foundations is achieved by graduates of senior high schools, after succeeding in written general examination, carried out every year at the end of June. The number of entrants in higher education courses is restricted throughout the range of higher education (numerus clausus). Attendance at state

universities is free of charge. Textbooks are, also issued free of charge to all students[16] (EURYDICE, 2000; YPEPTH, 2001).The academic year lasts between 1 September and 31 August the following year. Each academic year is divided into two semesters. Each student, at the end of the study is awarded the Degree (Πτυχίο) of the Department he or she has attended (YPEPTH, 1985).

Educational Reforms in Greece

Reflections of the International Calls for Change on the Greek Educational System

The universal forces that reflect the current social, economic and philosophical trends, calling for educational change, seem to have influenced the tendencies and orientations in Greece. The attempt to respond to the challenges that call for reform can be described as the rise of a new culture, evident in various fields of educational policy. Specifically, the emergence of the new culture is visible:

- In the redefinition of educational objectives.
- In the changing links between education and economy, between training and the labour market.
- In the introduction of new ethos in educational management.
- In the introduction of market mechanisms in educational assessment and accountability (Zambeta, 2000a).

The Shift in the Political Culture

During the past decade the Greek society has been undergoing dramatic socio-economic, political and cultural change[17].

The shift in the political culture of the Socialist party as well as of the major part of social, economic and academic institutions was already visible in the policies followed

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[16] Meals are also provided free of charge to some students depending on their personal or his/her family's finances (YPEPTH, 2001).

[17] This period was marked by two major political events, which had drastic impacts in Greek society. In 1981 the country joined the European Community as a full member state while at the same time the Socialist Party (PASOK) came to power. Although the Socialist Party came to power by using a radical anti-European political discourse, in the followed years, this same party took over the project of full adaptation of Greek economy to the European unification process (Zambeta, 2000a).

at the second part of the decade. Gradually but steadily, Europe started being a key determinant at every field of national policy. New interests have been developed at the national and local level and new opportunities have been created for governmental manipulation regarding the distribution of the considerable influx of sources coming from European funds. The task of inclusion of Greece to the European Monetary Union has met the wider social and political consensus and became a motivating factor for Greek society (Zambeta, 2000a).

In this context Greek economy is undergoing drastic restructuring. There is a considerable capital accumulation in certain sectors of the economy, banking, mass media, ICT and services in particular. Privatisation processes have been put forward in various sectors, which were traditionally under public ownership and control, such as the banking sector, transportation, telecommunication and energy. The view that the Greek economy should be restructured and adapted to the general European trends in order to meet the criteria of Maastricht, has been adopted by the big political parties, trade unions and most of the major social actors (Zambeta, 2000a).

The Presence of Economic Immigrants

The collapse of the Eastern European economies had serious impacts on the Greek society. The massive wave of economic immigrants has dramatically influenced the socio-economic structures and cultural landscapes of the country. In the past, Greece had been one of the emigrant countries that have exported labour force in USA, Australia and Germany. However, since the 1980s, when a large number of economic immigrants came mainly from Asia, this situation has been reversed. The profile of population has changed and Greek society has been criticized for not being prepared to deal with this new phenomenon.

In most cases, Eastern Europeans, repatriated Greeks and Asian economic immigrants are groups of unregistered labour force, living at the margins of the society and becoming subjects of discrimination. Government has made recently serious attempts to develop the institutional framework that enables the immigrant workers, together with the rest of their families, to be registered and educated, protecting them from phenomena of prejudice and social exclusion. It seems that the import of labour force reflects a real need of Greek economy for unskilled or semiskilled and low paid labour. Besides, the wave of immigrants seems to compensate for the Greek demographic deficit. According to some estimation more than 0,5% of the growth in the gross national product (GDP) is

attributed to the presence of economic immigrants, and more that 10% of the student population at elementary level consists of immigrants' children. In this respect regulation of immigration has been a strategy of the state for exercising identity politics and control over space (EURYDICE, 2000; Zambeta, 2000a).

The Concept of Modernization (Eksynchronismos)

In terms of the political culture it seems that during the period of rapid socio-economic restructuring the most sweeping change has taken place within the Greek policy-making institutions at all levels of the social system. The traditional Greek views of democracy as well as of social and human development and of the nation's prosperity have been overwhelmed in a process of change. The new ideological term of Modernization has been introduced that indicates the emerging tendencies and targets of political, intellectual and economic sectors.

Modernization is perceived as a change of the conditions and contexts of social and political power, associated to a situation of economic development and social prosperity. It is manifested as a desired endeavour to overcome the traditional deficiencies of Greek political culture, and an indicator of the new place of Greece in the international labour division. Moreover, Modernization is associated to the acknowledgement of multiculturalism as an essential characteristic of current society.

The Modernization movement takes for granted that Greece is rapidly transformed from a country of high cultural homogeneity to an increasingly multicultural society. Multiculturalism is understood as a new challenge related to the presence of economic immigrants and to globalisation of media. It is assumed that the whole society, especially the most dynamic parts of it, at all levels and classes, should achieve a cultural transition towards the new realities caused by breaking with the past. In this respect it is expected that the processes of Modernization will be based on the most progressive and dynamic parts of the society that are able to a have a prompt response to the imperatives of globalisation and other universal tendencies (Semetis, 1999)[18].

[18] Declarations of the Greek modernization movement seem to reflect the key points of European political tendencies, especially those of the UK and Germany. Similar to the manifestations of European leaders, Greek policy-makers acknowledge the need to apply politics within a new modernized economic framework and develop a robust and competitive market. They also recognize the need for reduction of public expenditure and the rejection of the state-wide intervention. Moreover they intend to fight unemployment through developing employability and investment in human capital as well as to promote a go-ahead mentality and a new entrepreneurial spirit at all levels of society (Blair and Schroeder, 1999).

However, whilst modernization understands the impacts of globalisation as being positive in the main links between Greece and the western political and economic culture, some ideologies of tradition, still focus on the importance of preserving Greek identity. Globalisation, Europeanisation and other cultural tendencies that call for change, are often considered as threatening the traditional national culture and ways of thinking. Traditional elements exist also among the modernization context since the links with tradition have not been broken yet. In fact, any attempt for change implementation is a contradictory and pending process with inherent phenomena of resistance to change at all levels of social interaction (Charalambis, 1996).

The Entrepreneurial Culture in Education

Discussions on the links between education and the economy, or emphasis on the skills that develop employability can indicate the introduction of an entrepreneurial culture in education. This is a new element in the Greek education. It seems that during the last decade some aspects of enterpreneurialism have been introduced in Greek education, but not in the same way with other European countries (Zambeta, 2000b).

Privatisation perspectives or the introduction of market mechanisms in education meets considerable opposition from students, teachers and Greek society in general. The concept of education as a public good, realized through public provision, has strong advocates and deep roots in the country's political culture. The Greek Constitution provides free education for all citizens at all levels of the educational system. However it is constantly argued that public expenditures in education are not enough to ensure quality. This in turn leads to high private expenditures spent on education as a compensation for the inadequacies of the public sectors. Most of these expenditures refer to the private supplementary courses, the so-called "phrontistiria" (Zambeta, 2002, p.637), or to the cost of university students studying abroad. Public education expenditures were used as an argument to support the need for an overall educational reform, the reform introduced in 1997 (Kazamias & Zambeta, 2000).

According to Zambeta (2002) the aim of the 1997s reform was to preserve and strengthen the public character of education. The reform mainly changed the system of access into universities and increasing the subjects that are examined in upper secondary education. Additionally, the reform has been presented as having egalitarian objectives and as a response to the needs of students and families. Within that reform the regulations that referred to access of students into universities have been presented as a policy that

aimed at bringing relief to families that used to spend considerable amounts of money on phrontistiria to prepare children to participate in formal exams.

However, the reform did not achieve that goal. On the contrary, Greek families responded to the changes by spending more money on supplementary private courses. As a result private tuition enterprises were expanded, and the citizens' lack of confidence in public education was reinforced (Zambeta, 2000a).

Paradoxically, although the Greek educational system is supposed to be based on public educational provision, it is evident that parallel to this system another strong system has grown aiming at covering the inadequacies of the formal sector. Greek people spend tremendous amounts of money on education, either from public or private resources, without having the desirable education outcome. Researchers as Stangos (1998) and Zambeta (2000b) claim that this system needs to be changed.

Redefinition of the Essence of Valuable Knowledge

The recent political discourse on Greek education emphasizes the link between general education and the capacities and skills needed within a context of knowledge society. A goal of the reform of 1997 was the restoration of general education in the upper secondary level that had been devalued because of the emphasis on the examinations that regulate access to universities. This goal seems to reflect European and international tendencies and can be understood in connection with the realistic perspective of raising employability. Students should be perceived as future enterpreneurs, able to function in a competitive global economy (Zambeta, 2000b).

The construction of the enterpreneureal individual presupposes a modernized educational state that provides and fosters abstract and useful knowledge. This knowledge involves many more skills of gaining access to information. It also involves the capability of using knowledge in changing contexts and environments of uncertainty. The need for education to respond to the new needs of the economy for the development of highly qualified staff on information and communication technologies, has been acknowledged by the Greek political and economic leaders as well as by policy-makers at all sectors of society (Zambeta, 2000a).

Summarizing, the enterpreneureal culture associated with the attempt to modernize Greek education, is evident in various fields of educational policy despite the alleged public character of the formal educational system. In fact, this culture exists underneath the institutional framework of recent reforms. The educational objectives have been

redefined within wider contexts of criticizing the quality of public education, acknowledging imperatives of globalisation and modernization, and seeking for efficiency, operational and useful knowledge and competitiveness.

The redefinition of the educational objectives meets with resistance in many cases and cannot be perceived as a linear process. Within a context of uncertainty, cosmopolitanism and global interaction, considerable traditional forms of political and educational culture still persist making more difficult and more unpredictable the implementation of change and innovation (Zambeta, 2000b).

Greek Society in the Context of a Broader Changing Environment

In an era of globalisation and accelerating worldwide technological advances, the Greek society seems to be oriented towards compelling change, challenging not only existing structures and functions of social and political institutions but also traditional beliefs, understandings and expectations of individuals and communities.

The current Greek political and educational discourse is dominated by specific sets of arguments that reflect the cultural transition, which Greek society is undergoing during the last decade. The communications revolution, driven by processes of globalisation, the spread of western values and symbols and the growth of international interactions have impacted upon the ways of thinking and have penetrated all parts of social, economic and intellectual life (Zambeta, 2000a).

Greek society has been influenced by political, economic and cultural dimensions of globalisation. According to Waters (1995), political globalisation is the emergence of groupings and organizations that operate at a wider scale than single nation state, as the European Union, the OECD and the UNESCO, that shape policies and practices within many individual countries. Economic globalisation is the growth of international trade and exchange, and the operation of markets and businesses at a scale above that of individual countries. Cultural globalisation involves international exchange of values and beliefs. These processes are interwoven to multi-dimensional global forces that directly or indirectly exert various pressures on local societies, and to supranational policy paradigms on which national policy-making is often based (Foskett & Lumby, 2003). The combination of all of those elements derived from values underpinning globalisation, which has been described by Beare, Caldwell and Millikan (1989, p. 224) as the

'enterpreneurialism of culture', is the driving force that informs the attempts of current Greek society at change and innovation.

The links between Greece and Europe entail cultural intimacy and political realism. Cultural intimacy draws upon the primacy of Ancient Greek civilization in the formation of the European identity, the European romanticism as this has been expressed in philosophy, historiography and literature, and the cohesive elements that exist between people who are identified as Europeans. Political realism has to do with the geopolitical order, the role of the European Union, and the place of Greece in the wider area beyond the boundaries of the individual state (Zambeta, 2000b)[19].

In what concerns education, change forces seem to drive the Greek society towards policies on outcomes and practices that emerged in western political settings, and the adoption of western approaches to management. This phenomenon, which is identified as "managerial globalisation" (Foskett & Lumby, 2003 p.7), is another dimension of globalisation illustrated well in the fields of educational management.

There is evidence that the dominant themes in the literature of educational management in the developed world in the last two decades have been: a) a consideration of the public, private or voluntary sector divide, with an emphasis on adopting and adapting approaches from business world to the world of educational management, and b) a consideration of educational management practice in other countries. The emergence in the literature of business management terminology and the rising emphasis on business-based forms of accountability "infiltrate educational language and begin to spin their conceptual webs" (Bottery, 1999, p. 303). As a result, as policy-makers seek to adopt the most appropriate suggestions from international literature on education a common perspective that can "define what looks increasingly like a global picture of management practice" emerges (Bottery, 1999, p.303).

Until recently, the debate concerning such issues in Greece was limited. In Greece education services are provided free of charge by the state at all levels. The role of private

[19] According to current trends within Greek society, Europe is perceived as a construct of modernity and as a place where the ideas of democracy, tolerance, social contract and welfare have been initiated and developed. European Union is considered to be the political realization of the European ideal. Greece is understood as an integral part of European culture and as the borderline, which marks the southeastern ending of Europe. In this respect the conceptualisation of the cultural relationship between Greece and Europe has important political and educational implications. In general, both tradition and modernity in the Greek political culture are ideologically mediated through the historical linkage between Greece and Europe. European Union is expected to contribute in the country's prosperity and to strengthen the place of Greece in the global community (Zambeta, 2000a).

education is limited and so it has been widely assumed that education subsidies have a progressively re-distributive impact. Besides, the functioning of the economy is not based on formal education and training, and the links between vocational education institutions and enterprises are considered weak. However, a number of studies have shown that issues related to the efficiency of the Greek education system have been raised. Tsakloglou and Antoninis (1999) agree that major improvements are needed in order for the system to respond to the global challenges that call for change.

Recent research evidence indicates that the need for educational change and reform is widely acknowledged by the Greek political, intellectual and economic world. Discussions are developed about re-examination of the role of education in Greek economic development; analysis of relationships between human capital and economic growth; pedagogical restructure of technology-based educational activities; aspects of professional development; consequences of household's expenditures on education; distributional impact of public education, and convergence between educational and economic field (Tsakloglou & Antoninis, 1999).

The processes of sustainable educational change motivated by the commitment to the creation of a knowledge-based, technologically informed, multicultural, democratic and inclusive society, is generally a focus for debate on a wide range of matters relating to the nature and purpose of education in the social context of the specific country's own culture and heritage. In the case of Greece the outcome is expected to be a compromise between the extremes of tradition and the adoption of externally generated initiatives. There is no doubt that forces of globalisation often generate instability, contradiction and ambiguity in environments within which policy-makers must operate. However, cultural change is inherent in Greek society, and the need for educational improvement is already a dominant argument in the Greek political and educational discourse (Zambeta, 2000a).

The Main Areas Covered by the Current Educational Reform in Primary Science Education

The last reform in science education is consistent with the idea that the main aim of primary education is to contribute to complete, harmonious, balanced development of intellectual and physical capabilities of pupils in order to enable them to evolve into well-rounded personalities able to lead creative lives. It focuses on a) the implementation of

new teaching methods with emphasis on developing the student's critical abilities, reinforcing self-reliance and promoting skills for independent study b) the introduction of new textbooks that help children develop their scientific way of thinking, their skills of analysis and synthesis and their ability to conduct and observe outcomes of laboratory tests and scientific experiments, together with their ability to critically examine information sources, and c) the establishment of a flexible zone in the context of school time-table during which teachers may develop programs or suggest projects that can promote cross-curricular competencies (YPEPTH, 2000; EURIDICE, 2002).

Bearing in mind the reforms' aspects along with the general tendencies, which seem to guide it, it is implied that its general aims are at learning outcomes level:

- The movement towards the vision of science for all, according to which, with all students engaged in science experiences that teach the nature and process of science as well as the subject matter.
- The establishment of an environment where pupils learn by acting as scientists, in the sense that the activities of the lesson emphasise the process and nature of science as well as the subject of the matter.
- The introduction of constructivist learning approach, in which the knowledge is being approached and constructed on the foundations of the already existent beliefs, experiences and misconceptions (Driver *et al*, 2000).

As far as the level of organisational management and capacity is concerned:

- The autonomy of teacher, classroom and schools is being reinforced, as teachers now have to plan lesson and cross-curricular activities by themselves.
- There is the issue of school equipment, with laboratories, where science lesson activities should be carried out and computer rooms.
- Teacher and educational evaluation is being introduced,
- There is the establishment for opportunities for further training and professional development (YPEPTH, 2000; EURYDICE, 2002).

Fullan, (2001a; 2002) considers such decisions as foundations for the achievement of systemic reform.

Research Conducted in Greece around the New Approaches to Primary Science Learning

Many research programs have been developed recently worldwide addressing the principles and conceptions of scientific and technological literacy for all students. In Greece, after the implementation of the reform in primary science education, a research context has been established to examine and analyze projects, which are relevant to new approaches, indicating their characteristics and linking their philosophy to current educational trends at international level. Within this context, a program named as ICMAS (Intentions, Content, Modification, Assessment, Support) was designed and presented in 2001, based on the theoretical statements about the curricula structures, the new learning paradigms and evidence derived from teaching experience. This program investigates strategies, communicational patterns, roles and structures, resource allocation and any issue related to reorganization of science education in Greek primary schools (Karydas & Koumaras, 2003).

An investigation of teachers' attitudes towards the new constructivist approaches, conducted within the context of a professional development program, showed that most teachers are willing to reject traditional strategies, change teaching habits and rethink about their roles of science educators, provided that they are properly guided and supported (Koliopoulos, 2003).

Action research projects developed in four primary schools of Attica, concerning an interdisciplinary constructivist approach in teaching the subject of time in primary physics, revealed that learning outcomes have been impressively enhanced by redesigning teaching strategies in accordance to the reform instructions (Plakitsi & Kokkotas, 2003). Similarly, an investigation based on a comparison of the use of the old textbooks with the use of the new ones, proved that the images and illustrations of the new books can lead to a deeper and broader understanding of scientific concepts, linking classroom learning to daily experience (Sklaveniti, 2003).

Recent research studying the impact of Information Technology tools upon learning outcomes in primary science indicated that computers can enhance pupils' understanding of basic concepts of physics, chemistry and biology. Research on the introduction of constructivist approaches assisted by the appropriate use of technological tools showed that students' attitudes and conceptions were influenced in a positive way by the new teaching methods and their interest in science has increased noticeably (Alimisis,

2003; Arvanitakis & Tsoupakis, 2003; Giogia, 2003; Ganetsos & Kelaidi, 2003; Malamitsa *et al*, 2003; Michas, 2003; Polizois, 2003).

Research on the potential use of computers and interactive curriculum materials in science classrooms, showed that teachers and students responded positively towards the use of technology in designing experiments and practical investigations, provided that there is adequate equipment, teacher training and encouragement of procedural skills development (Papaeuripidou & Konstantinou, 2003; Stylianidou, 2003; Tsitouridou & Vryzas, 2003; Vegiannis, 2003).

Studies undertaken from the perspective according to which learning involves socio-cultural processes (Newton *et al* 1999), investigated argumentation levels in science classrooms. Findings indicated that although teachers were willing to promote argument and controversy, the opportunities offered to students for interactive discussion are limited. The main constraints are time, size of classroom and teachers' difficulties in managing discussion effectively (Piliouras *et al*, 2003a). However, the structure of new books can help teachers support discussion (Rizaki *et al*, 2003).

Investigations of teachers' views on these recent developments made clear that they do not feel confident and experienced enough to organize and lead effective group activities or to engage in constructivist teaching strategies (Piliouras *et al*, 2003b). Moreover, they commented having problems with changing traditional practices of testing into new types of pupils' assessment that requires more interactions and development of distinctive skills (Fisfi & Chalkia, 2003).

2. DEFINING THE DIRECTIONS OF THE STUDY

The Focus of the Study

This thesis aims to approach and investigate some fundamental aspects of the process of implementation of change in primary science education. It is a study of the meaning of educational change for individuals at all levels of the educational system, who are involved in change, as they experience it.

The study attempts to provide information about individuals' perceptions of needs, dimensions, consequences in classroom life, inner controversies and impact of change on the improvement of teaching, learning and understanding of science. It is believed that a research–based study of the views and understandings of people, whose role is essential for the accomplishments of the change objectives, can enhance the knowledge-based management of educational reform. It can also contribute to the establishment of effective patterns of planning and co-ordinating a process of change implementation in primary science education.

According to Fullan (2001a, p.69), implementation of educational change "consists of the process of putting into practice an idea, program, or set of activities and structures, new to the people attempting or expected to change".

Any innovation or reform, in order to become fully implemented in practice, is expected to alter several aspects of school life. Success in educational change highly depends on the ways individuals at all levels of educational system act and react towards change. People's ways of thinking about change is a critical factor that commonly influences change and determines the implementation process.

Usually, educational change is likely to occur in: a) curriculum materials, b) teaching practices and c) beliefs and understandings of people involved in education. Thus, effective implementation is associated with the extent that teachers, students, administrators and parents change their practices, beliefs, the use of raw materials and learning standards in the direction of desired, preset educational goals. Changes in beliefs and understandings are considered to be the foundations of achieving lasting and sustainable reforms (Fullan, 2001a).

Educational change is a highly complex and subtle social process. Research shows that "multiple phenomenology of the different roles, engaged in the educational enterprises" (Fullan, 2001a, p.32) is a key factor in the implementation and continuation

of change. Neglecting the phenomenology of change, the way people actually experience it, causes lack of success of many educational reforms. Peoples' perception of change reflects its inner workings and reveals inherent controversies and its impact on learning outcomes and teaching standards.

According to Fullan, (2001a) over the past decades, many reforms and innovations around the world did not get implemented even in cases where change was really desired. It is estimated that many attempts at policy and program change have concentrated on product development that is legislation and other on–paper changes ignoring the fact that what people did and did not was the crucial variable for a sustainable change.

Besides, many attempts at change have failed because no distinction is made between "theories of change" (Fullan, 2001a, p.95) that is what causes change and "theories of changing" (Fullan, 2001a, p.95) that is how to influence those causes. In education, rhetoric often differs from reality. Many decisions about the kinds of educational innovations, introduced in school districts, are poorly thought and unconnected to particular values, goals and requirements of people who belong to a learning community and share concerns of education. Managing change means, in fact, managing people within a particular educational context (Fullan, 2001a).

Another reason for failure is the fact that policy-makers act often as if they have only to explain the need for a kind of change that makes sense to them. When their explanations are not accepted, they consider any opposition to be a result of ignorance or prejudice. Denying others the chance to think about the proposed change, or to work out a process that makes sense to them, means ignoring important aspects of change and misinterpreting individuals or institutions. Within the framework of the complex current social systems any innovation cannot be assimilated unless its meaning is shared (Marris, 1975).

Of course, personal meaning of change is not the only element that should be taken into consideration in managing the implementation of educational change. It is a factor within a broader system of variables that interact to determine success or failure. A holistic view of the change process should examine the subjective reality of a desired change along with the specific characteristics of the proposed change, as well as the external political social and economic factors that may influence the implementation and continuation of change. Above all, educational change is a dynamic process involving interacting variables.

Effective approaches to managing change call for combined and balancing factors that are unpredictable and difficult to deal with. In any case, it is a process of managing multiple realities of the main participants in implementing change. The main assumption of this study is that any attempt for change, which presupposes what change should be and leads to actions that preclude subjective realities of people with common concerns about education, is bound to fail.

Managing affectively change means, on the one hand keeping in mind values, goals and consequences associated with specific educational changes and, on the other hand, comprehending the dynamics of educational change as a socio-political process involving all kinds of individual, classroom, school, local, regional and national factors at work in interactive ways (Fullan, 2001a).

Specific Aims and Directions of the Work

Within the general purpose, the study has specific aims. Specifically, it is concentrated on:

- The identification of the actual forces that call for change in the specific context.
- The obtainment of insights into the role of teachers and other members of the educational system as agents of change in the community life.
- The examination of the considerations regarding the management of external and internal relationships in a learning community that may lead to the implementation of a sustainable change. Acknowledgement of these topics is a fundamental prerequisite for the effective management of human capital and material resources in education as well as for the establishment of parental and community links affected by or involved in change situation.
- The examination of the parameters of change, such as the reform of the curriculum, the use of materials, procedures of assessment and other functions related to the new paradigm of learning and the new conception of science, as well as the investigation of the dimensions of change, namely the current public views and expectations about the values and status of science education (Foskett & Lumby, 2003).

It is believed that a study of personal views of people involved in change implementation, and of the issues referred to the social, human or external facts that affect change implementation can give a satisfactory image of the current meaning of managing educational change in primary science education.

Examining a particular reform introduced in a specific educational context, the study is expected to approach the basic perspectives of a design and decision–making process leading to the effective managing of systemic educational change in the context of a democratic complex society (Fullan, 2001a; 2002).

Topics of Discussion concerning the Management of a Systemic and Sustainable Change in Primary Science

First Topic: Needs and Reasons that Call for Change

Changing economic, social and technical factors lead to educational change. Changes in the global context for education exert profound forces that translate into pressure to change the way children and adults learn. The rapid growth of international interactions in trade, travel, communications and culture happening the last decades tends to shape patterns of management of educational and training system, generating or requiring the change of attitudes of people involved (Foskett & Lumby, 2003).

Education is a global scale enterprise. Policy makers promoting the development of educational management in many countries are expecting that an international perspective will be incorporated in learning programs. Additionally, there is a commitment and an increasing stress felt by teachers, world-wide to respond to the growing pressures of globalisation. Consequently, it is assumed that some accepted norms and paradigms in educational management are challenged and a range of new perspectives of approaches and practices are introduced.

However, there are huge contrasts that can be seen in an examination of the different patterns of provision and experience among various educational settings. The daily school–life of children, teachers and principals around the world differs fundamentally because of extremely diverse expectations from government, community and family. Beyond schooling process, there is a multiplicity of aims, ideologies, practices and outcomes that generate instability contradiction and ambiguity at regional, local and individual levels, in case of educational change implementation (Foskett & Lumby, 2003).

Education is culture–bound. Changes in the ideological or technological context call for educational reforms. Foskett and Lumby (2003) state that policy–makers and school leaders need to be mindful of social and organisational, cultural characteristics when formulating, adopting and implementing policies. The prospect of successful

implementation is enhanced when policies consonant with the characteristics of the prevailing social culture are adopted.

Culture is that set of values and beliefs, both explicit and implicit, which underpins the educational organisation and provides the basis for action and decision–making, especially in cases of direct instruction. Culture is expressed at a range of operational scales within an educational system that is at the level of individual classrooms, at the level of groups within schools at the whole school level and at the level of the communities –local, regional and national– within which the school exists (Foskett & Lumby, 2003).

Culture is usually expressed conceptually through the valuing of particular ideas, which will be expressed in every explicit aim that the organisation has. It can also be expressed verbally, through the adoption of specific discourses and usages of terminology. Moreover, it can be expressed behaviourally, through rituals, ceremonies and social interactions or visually, through designs and styles adopted by the organisation.

In examining patterns of change within national settings, the implicit influence of culture can provide strong boundaries and constraints to reform implementation. It is not advisable to impute a deterministic relationship between culture and organisational outcomes. Nevertheless, the fact, that change is the result of the interaction of indigenous and exogenous forces that promote and restrain it, must be taken into consideration (Foskett & Lumby, 2003).

Culture pluralism is an increasing phenomenon in current societies. Educational administration must recognise the cultural dimensions of certain social interactions that reflect the impact of values and beliefs of groups on the implementation of change. Such dimensions can be associated with the patterns of the distribution of political power, with the degree of emphasis given on individuals rather on the community, on the stereotypical conceptions of gender differences, on the society's tolerance of risk and ambiguity and on the extend to which long–term perspectives are counter-balanced by values associated with short-term orientations (Hofstede, 1991).

Cultural change is inherent in all societies. It is expected that the spread of Western culture and values will inevitably interact with the existing groups' culture. Understanding possible outcomes of that interaction requires knowledge of both the inherent character of existing culture and the areas, in which implementation of change will generate tension (Foskett & Lumby, 2003).

Educational change is inevitably related with technological advancements. The new information and communication technologies have enormous potential as tools for enhancing teaching and learning in schools and consequently for implementing reform and innovation. In particular, the role that the Internet can play in the dissemination of learning support material for both teachers and pupils has already been widely promoted (Davis, 2002). Policy makers have recognised this fact and signalled attention that, within the next few years, all schools would be connected to the Internet. Besides, educational communities have recognised the need for teachers' training in the use of Information and Communication Technologies. This means that educational activities will have to change. All newly qualified teachers are expected to have the knowledge, understanding and skills needed to use ICT effectively (Skinner & Preece, 2003).

Introducing ICT technology in primary science education can improve teaching practices, through encouraging innovative investigative approaches to science teaching and learning, enhance the understanding of science concepts and promote critical reflection and interactive lesson–planning. It can also provide useful framework for developing the professional knowledge of teachers both as educators and leaders in school life.

However, the introduction of ICT in schools should not be conceived solely as a tool or mean of facilitating teaching procedures or improving enjoyment and motivation. It is also a challenge for the educational system to be totally re-organised practically and philosophically if its role is to develop the ability of learners to participate actively in the functions of knowledge–based society. Technological advances imply new experiences, new learning, new ways to access information and new demands for funds allocation. They can challenge habitual practices and beliefs of people in and around the organisations affected. Overall, implementation of ICT in school-life, is a force that, tentatively, calls for change and simultaneously makes the planning and managing of change to be a highly complex task of school leaders (Skinner & Preece, 2003).

It is necessary to examine which of these are the actual reasons for the reform in primary science education in Greece, in order to understand in greater depth the actual meaning and the aims of the reform. Moreover, since it is the agents of the reform that will give answers it will be possible to see if they actually share the meaning of the reform, which is required for a systemic and sustainable reform (Fullan, 2001a; Everard *et al*, 2004).

Second Topic: Attitudes of the Agents of Change – The Importance of the Beliefs of the Primary Science Teachers

According to Fullan (2001a) during change implementation, teachers' role needs to be re-cultured. Actually, the teachers are often forced to become change leaders, having to manage reform and innovation in science teaching, which is a kind of leadership that is not hierarchical but it is shared enterprise. Thus, they have to change their classroom activities, attitudes and beliefs about science education (Howe & Stubbs, 2003; Morge, 2005). Teacher learning as the process of acquiring new ideas, changing or deleting old ones, and gleaning new knowledge and skills is called, is a key ingredient to educational reform (Davis, 2002).

As Fullan (2001a) claims professional development of science teachers according to current views, needs to incorporate socio-cultural or social constructivist perspective, focusing on social and personal development and more traditional areas of content and pedagogy.

Social development involves learning ways to interact with others and to renegotiate the role of teacher. Personal development involves constructing, evaluating, accepting or rejecting the new socially constructed knowledge of what it means to be a teacher and to manage feelings associated with changes in activities and beliefs. Professional development occurs in phases as teachers change their practice and accept beliefs underlying new activities and methods (Davis, 2002; Morge 2005).

Davis (2002) suggests that teachers learning, just like student learning should be framed in constructivist learning theory. Teachers' beliefs, reasoning and knowledge are necessarily connected with changes in their instruction. Certain conditions need to be met for teachers to change the theories that guide their teaching. In order to participate actively in a change process, teachers must firstly become dissatisfied with the existing teaching methods. They have to become disconnected with a practical theory because they start considering it as ineffective and unsuccessful, or because it leads to dissonance or dilemmas in practice. A new practical theory or method should appear reasonable for it to become accommodated by teachers. It should be clear, understandable, sensible and beneficial in particular situations and compatible to the teachers' goals.

There is a series of mentioned in the literature problems that are expected to emerge whenever a change is introduced and implemented, as teacher training, school structure, time and financial matters (Fullan, 2001; Everard *et al*, 2004; Bush &

Middlewood, 2005). All these usually refer to hiderances that teachers and the moral agents of change have to face and overpass if they have to implement the reform successfully to ensure its systematicity and sustainability. According to Fullan (2001a) these problems can help teachers if they are dealt as motives for teachers to plan and act in order to solve them. When dealt appropriately, they can serve as opportunities for further teachers' learning, development and school improvement. The opinions and attitudes of teachers, head-teachers, pupils, parents and policy makers can provide important information about the level that these problems come up in the case of the reform in primary science in the Greek schools.

Especially in cases of change in primary science education and the new paradigm of constructivism, it is the teachers that will explain whether there is concern about the appriate school organisation that will allow healty implementation. The negotiation of pupils' ideas, the establishment of the necessary conditions for the construction of new knowledge and development of abilities as observation, critical thought and other post-cognitive skills are required if the constructivist learning approach has to be followed (Driver *et al*, 2000; Osborne *et al,* 2003). Despite the reforms' necessity, unless attention is paid to these issues it is doubtfull whether the implementation of reform in primary science will be successful (Davis, 2002). The opinion and the attitudes of teachers and all people involved in education can provide evidence concerning the level of preparation and readiness of the school and its intellectual capital to welcome, implement and institutionalise reform in primary science curriculum.

Consequently, teachers and all the people involved in teaching and school functions should address pre-existing knowledge and beliefs about teaching, learning and subject matter. They should also express their opinions about the particular reform and change generally. They should make their belief explicit and provide them with contexts to examine, critique and weave new ideas into their existing constructs (Davis, 2002). Such evidence can show the possibility of a reform in primary science to be systemic and sustainable (Fullan, 2001a).

Third Topic: Investigating the Dimensions of the Reform

Fullan and Miles, (1992) appreciate that managing school change and improvement, is a fundamental task of school leadership. School leaders need to understand the change

process, in order to lead and manage it efficiently. They must learn to overcome barriers and cope with the chaos that naturally exists during the complex process of change.

Managing change, specifically in science education is s subtle and complex aspect of educational reform. Current literature provides significant evidence of new trends and thoughts about the topic.

Firstly, science education is directly linked with the crucial forces that call for change in the social economic and cultural environment, as the influence of globalisation, the vision of sustainability, the advancements in information and communication technologies and the current non–positivist views of approaching the natural and social reality. These views take into consideration the elements of uncertainty, unpredictability and cultural context dependency, which are inherent to scientific thought. So, as Davis (2002) claims even tough planned change in science education –including organised assessment and problem solving– can be useful, managers need to cope with more informal, turbulent and spontaneous change.

Secondly, the implementation of innovative science programs in primary education depends, to a large extent, on teachers' attitudes towards the new instructional approaches that they are asked to put into practice. Teacher's knowledge, attitudes and beliefs greatly impact the classroom activities. Educational leaders who engage in discussion about science education reforms, need to investigate the teachers' learning style, their prior knowledge, the way that this knowledge has been acquired and changed over time and the specific processes that can bring about change in individual change practices as well as deep and long lasting change in science classroom (Davis, 2002; Pinto, 2005).

Under the recent science education standards (National Research Council, 1996), teachers should encourage students to interact and voice their ideas, express and choose their individual approaches. Student's ideas must be acknowledged and incorporated into the problem–solving process. Teachers are asked to revise their beliefs and practices and to develop new understandings about the nature of science and the principles underlying the new processes of learning and scientific inquiry. Their response to educational change is affected by their practical personal experience, which is consisted by their integrated set of knowledge, conceptions, beliefs and values. Teacher learning, as a process of acquiring new ideas, changing or deleting old ones, and gleaning new knowledge and skills (Anderson & Helms, 2001), just like student learning that is constantly constructed in the classroom context, is a key ingredient to educational reform (Davis, 2001; Pinto, 2005).

Thirdly, implementation of change in science education usually focuses on changing the curriculum, changing teaching practices and changing the beliefs and understandings of people involved in education. These dimensions of reform aim at the development of young peoples' ability to understand the scientific way of thinking (Fullan, 2001a).

As Claxton (1997) concludes, systemic change in science education refers to the function and goals of education as a whole. Regardless of the specific innovative reforms in curriculum materials and practices, it is expected that the processes of teaching and learning science need to be moving towards a system that will adequately address the real world demands of future citizens. Managers' attention needs to be shifted from the content of learning that is based on concepts and competencies, to the development of young peoples' "learning prowess" (Claxton, 1997, p.86).

There are also dimensions of breadth, depth and length that Hargreaves and Fink (2000) state that a reform should have. All these aspects of the reform need to be examined within the context of the Greek educational context and the reform in primary science curriculum.

Forth Topic: Managing Change Implementation in Science Education. for a change in the Public Understanding of Science

According to Fullan (2001a) in implementing the new program there are several issues at stake such as the possible use of new or revised instructional resources, materials, equipment and technologies, the limitations and difficulties related to the possible use of the proposed teaching approaches. These are examined through different interrelated components or dimensions of the reform as a) the reconsidering of the management of time, b) the possible alterations of beliefs and the re-culturing of the roles of the people involved in the implementation of change, c) the opportunities for teachers' professional development, d) the level of the public understanding of science and e) the quality of the cooperative climate of school environment.

Fullan (2001a) also says that leaders and educators who are interested in making substantial changes in practice need to get involved in the development of an intellectual apprehension of the new shifts of teaching and learning paradigm. Getting people

intellectually ready for the change is an important task to be considered in the process of change implementation.

Modern pedagogies call for reform in science education which involves curriculum and teaching strategies that favour models in which pupils participate actively and collaboratively in scientific inquiry. Lecture-based teaching is not encouraged (Barab & Luehman, 2003).

Pupils should co-operate, negotiate their misconceptions and construct knowledge, in the context of authentic scientific investigations. They should have the opportunity to use advanced cognitive tools, as the Internet and a variety of resources as video, books and journals (Barab & Luehman, 2003).

Recent science education reforms focus on the vision of science for all children. All students, regardless of differences in cultural and economic backgrounds or individual needs, are expected to become scientifically literate. Science education reformers later recognised that they need to have details relating to reform–based teaching and learning specified so that the goal of science for all would be achievable. These details have been articulated in the form of benchmarks or standards (Bianchini & Kelly, 2003).

Systainable reform in science education should include change of attitudes to the public understanding of science (Thomas, 1997; Roth & Lee, 2004). According to the constructivist model, every individual is active constructor of understanding. Learning outcomes depends on prior knowledge attitudes and goals of the learner as well as the learning environment. Constructing knowledge based on pre-existing ideas is an active process involving generation, evaluation and restructuring of ideas. Consequently, knowledge should remain provisional as new experience could require restructuring of existing (Driver *et al*, 2000; Roth & Lee, 2004).

Science teachers are increasingly encouraged to play a role in the public understanding of science. The new demand of instant and global communication urges the educational community to engage with new patterns of instructing and informing the community about the meanings and functions of the practices associated with science and science education.

Intellectual understanding of science presupposes a) the empowerment of public appreciation, understanding and support of science, engineering and technology, b) the extinguish fears of common fears about the possible negative impact of scientific and technological developments on human life, and c) the setting of rational goals for science

education. In other words, effective change implementation presupposes a population with a predisposition to think critically, a belief in rational problem–solving and a healthy respect for evidence (Longbottom & Buttler, 1998).

Leaders and science teachers need to establish a school environment able to help pupils and learners confront the common fears about science, which are the technotractic control and the positivist view of science (Longbottom & Buttler, 1998).

Science teachers and schools must make citizents believe that it is people and not scientific ideas or technological capabilities that alter social life. It is political and economic decisions that affect the society. Moreover, research orientations and allocation of available funds are often open to prejudice, bias and misunderstanding. Thus, sharing meanings of change priorities and participating in the process of change implementation always strengthens and empowers the progress of science education.

Public understanding of science is considered to be the ultimate result of science education. Any reform in science teaching can be evaluated by its impact on the public understanding of science (Driver *et al*, 2000; Pinto, 2005). Simultaneously, institutionalization of reform and establishment of a school management system appropriate for future reforms is the ultimate aim of educational change (Fullan, 2001a). For that reason it is necessary for the study to include a relevant research question.

Assumptions Leading to the Empirical Work

In accordance with the current state of the art concerning the nature, the dimensions, and the philosophy of educational change (Fullan, 2001a) in the fields of primary science, as a management challenge in the contexts of current learning organizations, an empirical study has been conducted that investigates the subjective meaning of the motivating forces of change, the redefining and re-culturing of the roles of teachers, the dimensions of a systemic change and the re-shaping of the public understanding of science and science education. Being informed by the principles of the phenomenological approach, and using the interview as the main tool for qualitative data collection, the study examines in an interpretive way the subjective reality of an educational change situation, which took place in Greece. The change has been designed centrally by the Institute of Education of Greek government and was referred mainly to the changing of the primary science curriculum, textbooks and teaching instructions (EURYDICE, 2002).

Bearing in mind:

- The fact that educational change represents a serious personal and collective experience, which is one of the inherent characteristics of the current changing world,
- The role of science education in the emergence of a knowledge based society,
- The responsibilities of management as key-factor in the process of decision making associated with organisations and communities of people, which share common concerns about science education,
- The significance of the promotion of scientific literacy to all young people and the specific issues related to teaching and learning science in the context of a multicultural child–centred educational environment,
- The constructivist view of personal development, according to which new knowledge is produced on the basis of the acknowledgement and transformation of prior experience,
- The importance of analysing and investigating the meaning of the subjective reality of change, in the fields of primary science education,
- The structure and characteristics of the educational system in Greece, as far as it is high level of centralisation and the emphasis on the examination issues are concerned (Zambeta, 2002)

It seems useful to conduct a study that will examine the process and implications of dealing with change and reform in primary science as a prominent function of educational management.

The empirical study will be phenomenographic in character and will describe how people conceive change and how they are aware of its implications. The work will refer to a recent change in the formal primary science education in Greece. This change has been associated with curriculum reforms and relevant adaptations of the teaching procedures.

The Framework Questions

In consistence with the rationale of the study the specific goals of the investigation and the topics of discussion as stated in the previous paragraph, the following four questions were formulated for the empirical study, which is to be developed in the framework of the qualitative paradigm of educational research:

- What are the societal, educational, cultural and scientific changes that create the need for educational reform particularly in primary science? **(why)**
- What are the attitudes of the various factors of the educational community who are involved in the process of implementation and need to share the meaning of change? **(who)**
- In which way can school management design, organize, coordinate and control the implementation of a reform in a systemic and sustainable way? **(how)**
- To what extent do the procedures regarding primary science learning, curriculum, assessment, professional development investment in Information Technologies, enhance the public understanding of science and are they affected by the particular change? **(what)**

Through the negotiation of these questions, the research aims to justify that regardless of positive attitudes shown by members of educational community towards the particular change, the reform will not be sustainable unless designed and organized in the framework of the principles of systemic management (Fullan, 2001a).

CHAPTER IV:
METHODOLOGY

SOCRATES: And now, let me give a parable to show how far our nature is enlightened or unenlightened. Imagine human beings living in an underground cave with an opening upward towards the light, which filters into the depths of the cave.... At a distance above and behind them is a raised path. And if you look closely, you will see a low wall built along the path, like the screen used by marionette players to conceal themselves from the audience while they show their puppets....
....The prisonhouse or cave is the world of sight; the light of the fire within the cave is the sun. And you will not misapprehend me if you interpret the journey upwards to be the ascent of the soul into the intelligible world,

[Plato, The Republic, Book 7]

METHODOLOGY

THE PURPOSE OF THE CHAPTER

The purpose of this chapter is to criticise methodologies available for use in investigating the perceptions and dispositions of members of an educational community affected by the implementation of change in primary science education. It focuses on the patterns by which individual beliefs and estimations can influence the process of decision-making and the design and organisation of educational reform. Personal experience of people who share common concerns about the goals, scope and strategies of teaching and learning science, make up the subjective reality of educational change (Fullan, 2001a).

Assuming that the subjective reality of change exerts a profound influence on the causes and processes of change, this research attempts to examine in an interpretive way individuals' feelings at all levels of an educational system, from a phenomenological perspective. The first part (1-2) of the chapter is devoted to a critical consideration of the general debates on the available methodologies, in order to select a specific approach that suits the purposes of the work. The second part (3-5) of the chapter deals with the development of the work's empirical model as well as of the specific methodological instruments used, focusing on their appropriateness and their ability: to offer the people who experience change at a personal level the opportunity to present their views and attitudes, and to draw useful generalisations about the management of change in the context of a new knowledge-based, technology-informed and globally-oriented society.

1. GENERAL DEBATES ON THE AVAILABLE METHODOLOGIES

Positivism versus non-positivism

The dominant ways of thinking about social phenomena have been defined through various distinct theoretical positions, which form the cultural and philosophical background of this research. Carr (1995) has drawn a distinction between two quite different and varying philosophical traditions, which between them have dominated educational research. On the one hand there is a tradition, the normative paradigm that sees educational research as a subset of social science, seeking out the general laws and

conditions that enable teachers and policy-makers to operate. On the other hand there is the interpretive paradigm that aims at revealing the personal understandings and perceptions of the subjects of the research (Cohen & Manion, 1994). The normative paradigm has been influenced by the philosophical movement of positivism and is grounded in the 'intelligible ideal' (Pring, 2000, p.110) of a complete and scientific explanation of physical and social reality. Thus, it seeks the general laws or conditions which explain and govern the observed reality. These laws account for the happenings of the world and provide the scientists with a firm basis for prediction and control (Burrell & Morgan, 1979). The interpretive paradigm is inspired by an alternative view of social reality, which emphasises the relativistic nature of the social world and stresses the importance of the subjective experience of individuals in the creation of this world. The search for understanding here focuses on different issues and approaches them in different ways. The principal concern focus is on the way in which the individual creates, modifies and interprets the surrounding world (Cohen & Manion, 1994) and according to this tradition, the scientific model is not appropriate, since there is a "world of difference between the short of enquiry appropriate for understanding physical reality and the short of enquiry for understanding the mental life of the individual persons" (Pring, 2000, p.32).

Positivism derives from the acceptance of natural science as the best or only paradigm of human knowledge. It is characterised by its claim that science provides human beings with the ideal of knowledge. Therefore, the methodological procedures of the natural sciences can and should be directly applied to the social sciences. Investigations by social scientists should therefore be formulated in the same way as those conducted by natural scientists and their analyses must be expressed in laws or law-like generalisations of the same kind that have been established in relation to natural phenomena (Cohen & Manion, 1994). Most research methods which are influenced by the spirit of positivism, draw heavily on the scientific method either implicitly or explicitly. Scientific method necessarily involves standards and procedures that are consistent with certain principles and assumptions usually held by scientists as they go about their daily work, including the assumption of determinism, in that all events are assumed to have causes determined by other circumstances; the assumption of empiricism, in that reliable knowledge is assumed only to originate in evidence obtained by direct experience; the assumption of parsimony, in that phenomena should be explained in the most economical possible way; and the assumption of generality, in the sense that the study of a particular

situation should lead to a generalisation of findings and consequently to abstract knowledge (Cohen & Manion, 1994).

Scientists are primarily concerned with comprehension of the physical world. For them, the ultimate goal of science is theory. Theory provides the means of explanation and understanding, of prediction and control. As a set of interrelated constructs and definitions, it presents a systematic view of phenomena by specifying relations between variables and by growing together isolated pieces of empirical data to form a coherent conceptual framework (Kerlinger, 1970).

Concepts and hypotheses are the working tools of scientists, in their inquiries. Concepts express generalizations from particular situations. Each concept represents an idea. In fact, a concept is the actual relationship between the word (or symbol) and the idea. Concepts enable people to impose meaning on the world and they give sense, order and coherence to reality. Scientists have developed a set of concepts which enable them to shape their perception of the world in a particular way. Collectively these concepts form a wider meaning system on the basis of which scientists describe their direct experiences (Cohen & Manion, 1994).

Hypotheses are conjectural statements of the relationship between variables. The scientific method begins usually with the construction of a hypothesis, which is an imaginative preconception of what might be true. A hypothesis is an educated guess derived from study, reflective thinking and observation and it is. In the process of a research, it is exposed to criticism. Then on the basis of the evidence, the hypothesis is accepted or rejected. As research tools, hypotheses organise the efforts of researchers and provide them with a framework for collecting, analysing and interpreting data. Therefore there is the possibility that a hypothesis, once confirmed and established, will become a law (Kerlinger, 1970).

Opponents of positivism reject the belief that human behaviour is governed by generalisable laws and characterised by regularities, holding that the social world can only be understood from the standpoint of individuals, who are an important part of the ongoing action being investigated. Social science is therefore seen as a subjective, rather that an objective undertaking, as a means of dealing with the direct experience of people in specific contexts. Social sciences cannot penetrate to what lies behind social reality. They must work directly with a human definition of reality and although they do not reveal an ultimate truth, they help humans make sense of their world (Cohen & Manion, 1994).

Positivist schools of thought consider that human behaviour consists of responses to either external or internal stimuli that cause certain behaviours. Non-positivist approaches on the other hand focus on action; intentional behaviour that is future oriented. Positivistic researchers try to devise general theories of human behaviour and to validate them through the use of research methodologies; non-positivist researchers claim that theory is always emergent and that it must arise from particular situations and be grounded in data generalised by the research. For them theory should not precede research but follow it (Cohen & Manion, 1994).

Qualitative versus quantitative research

Understanding human behaviour demands a variety of methods each of which makes complex assumptions about what it means to explain personal and social activity (Pring, 2000). Researchers have long debated the relative value of qualitative and quantitative enquiry. Qualitative or phenomenological enquiry, which is influenced by the non-positivist movement, uses a naturalistic approach that tries to understand phenomena that are context-specific (Patton, 1990). Quantitative or logical enquiry is based on the positivist movement and uses experimental methods and quantitative measures to test hypothetical propositions (Kerlinger, 1970). Both qualitative and quantitative paradigms represent a fundamentally different enquiry approach and supplementary research actions are based on their underlying assumption (Patton, 1990).

Qualitative research has been defined by Strauss and Corbin (1997, p.17) as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification". Whereas quantitative research seeks causal determination, prediction and generalisation of findings, qualitative researchers seek illumination, understanding and extrapolation only to similar situations. Consequently, qualitative analysis results in a different type of knowledge.

According to Strauss and Corbin (1997), qualitative methods can be used to understand the foundations of any phenomenon about which little is known, to gain new perspectives on things about which much is already known or to gain more in-depth information that may be difficult to convey quantitatively. Research problems in the qualitative approach tend to be framed as open-ended questions so that they can support the discovery of new information. In qualitative research researchers tend to observe, describe and interpret settings as they are maintaining what Patton calls 'emphatic

neutrality' (Patton, 1990, p.55) while acting as the instrument of data collection. Qualitative researchers predominantly use inductive data analysis. Their reports are descriptive, incorporating expressive language and the 'presence voice in the text' (Eisner, 1991, p.36). Qualitative research has an interpretive character that aims to discover the meaning of events for the individuals who experience them, seeking the uniqueness of each case. It has an emergent design, as opposed to a predetermined design and researchers focus on this emerging process as well as the outcomes. Due to the emergent nature of qualitative research design researchers seek to observe and interpret meanings only in context and do not finalise research strategies before data collection has begun. Specify primary research questions are of course explored as are plans for data collection strategies and there are several "strategic ideals that provide a direction and a framework for developing specific designs and concrete data collection tactics" (Patton, 1990, p.40).

Schools of thought that reflect the essence of qualitative research

Ethnomethodology

Ethnomethodology starts out with the assumption that social order is constructed in the minds of humans trying to make sense of their surroundings. Educational activities are regarded to the outcomes of individual impressions and experiences that have been organized into a coherent pattern; an ethnomethodological investigation can give depth and unique insights into educational issues and produce worthwhile information about the social interactions that take place in the context of a society (Filmer *et al*, 1972). In the words of Garfinkel (1967), the founder of ethnomethodological research, ethnomethodogical studies seek to treat activities and sociological reasoning as topics of empirical study and as they focus on the commonplace activities of daily life with and the attention usually accorded extraordinary events, they seek to learn about them. Garfinkel (1967) views social reality as potentially chaotic. Social order is constructed in the minds of individuals, who usually try to organize their conceptions and experiences into a coherent pattern. Individuals select certain facts from social situations which appear to conform to a pattern and then they make sense of these facts in terms of the pattern. Once

a pattern has been established, it is used as a framework for interpreting new facts as and when they arise.

Ethnomethodology undertakes investigation of the everyday world, as it is encountered in mundane experience. It is preoccupied with making visible naturally occurring phenomena. It is concerned with discovering how people make sense of a situation at the most fundamental level of social action and interaction, studying in detail the methods by which people, through their actions and interactions propose, negotiate and come to shared understandings of what has happened or what is going on (Sharrock & Anderson, 1986).

Ethnomethodology, as a qualitative approach to observational research, describes and classifies various, racial and sociological groups by employing interpretive and naturalistic methodologies. It is both observational and narrative, relies more on apparency, verisimilitude, transferability (Connelly & Clandinin, 1990) and credibility (Lincoln & Guba, 1985), and less on the experimental elements normally associated with scientific research: validity, reliability and generisability.

Ethnomethodology, being concerned with how people make sense of their routine actions, focuses on the mechanisms by which participants achieve and sustain interaction in social encounters; the assumptions they make, the conventions they utilize, the practices they adopt, their decision making and their reasoning. Ethnomethodology seeks to understand social accomplishment in its own terms; from within (Cohen & Manion, 1994). Characteristically, ethnomethodologists see and hear things in a group that often participants do not (Coulon, 1995). They are aware of the tacit knowledge that all people involved in research have hitherto taken for granted (Carr & Kemmis, 1983).

Phenomenology

Phenomenology aims to uncover peoples' 'subjective meanings' (Pring, 2000, p. 12) that is, their personal connotations and associations. Phenomenology stresses the importance of the interpretation of events in the light of the subjective consciousness, claiming that social reality is but a construct of subjectivities and that there is no social or cultural reality existing independently of them (Cohen & Manion, 1994). It is based on the idea that humans can never perceive reality without filtering it through their consciousness. An object cannot be separated from the individual's awareness of it, since an individual cannot separate other persons from judgments about them (Hughes, 1999). According to Husserl (1965), human consciousness is not made up of anything substantial; it is simply

a set of interpretations about what is happening around. Human consciousness, therefore, consists of phenomena which have no substantial unity, no real properties or component parts, and know no real causality. What constitutes this consciousness is the world of human experience and phenomenology is the study of how things appear to individuals, in the light of that experience a subjectivist orientation opposed to the positivist tradition. For phenomenologists, there are many things that are taken as truths in people's everyday lives that can be open to doubt. Phenomenologists are, therefore sceptical about all methods of inquiry, accepting nothing as already given, and trying to unearth all presuppositions about social reality (Sharrock & Anderson, 1986).

With regard to theory building, phenomenology seeks to make enquiries in locations outside the frameworks of established theory. Such location is the world of pre-theoretical experience, which existed before people started to create theories. Phenomenology then devotes itself to the unprejudiced examination of the world as it is found in ordinary experience, in an effort to see more clearly the relationship between the surrounding world and existing theory (Sharrock & Anderson, 1986). At the heart of every phenomenological research endeavour there is a questioning of experience; an account of a lived experience or event in experiential terms. Phenomenological research does not seek causal explanations or interpretive generalisations. It is less concerned with factual accuracy and more with the person's living sense of the experience (Van Mannen, 1990). A phenomenologically oriented researcher believes that there is no such thing as tense objectivity. The researcher's role in shaping the research process and interpreting themes is recognised. The subjects of the research are active participants and the goal of is not just to examine their experience, but also to create a situation in which reciprocal learning can occur. Indeed, one aspect of the transformative nature of the phenomenology is learning about self (Perl, 1996).

Phenomenology seeks to describe basic lived experience, as a research method, it is the study of essences. Its ultimate aim is "the fulfilment of human nature: to become more fully who we are" (Van Mannen, 1990, p.12). Phenomenology is both "the description of the lived-through quality of lived experience and the description of the meaning of the expressions of lived experience" (Van Mannen, 1990, p.25).

The description of meaning is a mediated expression and is more interpretive. Interpretations of life experience are made through the use of some type of text or symbolic expression, which are descriptive in that they name things. In the naming, they

aim at letting these things show themselves the basic assumption being that the meaning of lived experience would be hidden. Phenomenological descriptions validate lived experience by which they are also 'validated' (Van Mannen, 1990, p.27).

In contrast to scientific approach, phenomenology is rooted in the idea that every day experience is worth examining. A common subject for phenomenological research is the experience of living in certain types of community. Its raw data are personal experiences, gathered through interviewing, reading, writing and living. It is from language that humans commence their understanding of phenomena, so phenomenologists place a considerable emphasis on understanding the etymological roots of words and on the writing process as a source of understanding (Perl, 1996).

Ethnography

Qualitative research emphasises the subjective reality of individuals and stresses the relativistic nature of the social world, which as claimed can only be understood by adopting the point of view of the individuals who are directly involved in the activities under scrutiny. Therefore, the major vantage point for understanding human activities lies in the frame of reference of the participant in action. This approach highlights the importance of knowledge as something, which is personally experienced and which can be best understood from the inside; from the subjective experience of individuals (Burrell & Morgan, 1979).

In terms of qualitative methodology, ethnographic research is that set of principles underpinning the kind of inquiry that takes seriously the perspectives and interaction of members of the social groups being studied. It aims to study the social world as it is and its influence on contexts. That inquiry requires insight into that world through participation. In this respect, it draws upon certain traditions from other social sciences, like anthropology (Pring, 2000).

While identifying the assumptions that characterise social and cultural situations and the ways in which the people involved make their activities rationally accountable, ethnographers use the notions of 'indexicality' and 'reflexivity' (Cohen & Manion, 1994, p.31). Indexicality refers to the ways in which actions and statements are related to the social contexts producing them and to the way their meanings are shared by participants but not necessarily stated explicitly. Indexial expressions are thus the designations imputed to a particular social occasion by the participants in order to locate that event in the sphere of reality. Reflexivity, on the other hand, refers to the way in which all

accounts of social settings – descriptions, analyses and criticisms – and the social settings occasioning them are mutually interdependent (Cohen & Manion, 1994).

Ethnography does not entail relativism as is so often assumed. The social worlds being studied are as real and objective as the physical world and they exist independently of the people involved in the particular research. Social facts can exist independently of individuals, and these determine, in some measure, the way people see and understand the world. Social reality both empowers and constrains. It is constituted and maintained by the agreements in interpretations of individual members of the society and of groups within it (Pring, 2000).

The methodological assumptions, distinctive to ethnography, can be summarised under the headings of naturalism, understanding and discovery.

Naturalism is the view that the aim of social research is to capture the character of human behaviour which can only be achieved by first-hand contact, so that research is planned to be carried out in natural settings, which exist independently of the research process. Findings can be generalised to similar settings that have not been researched, but all findings must be explained in terms of their relationship to the contexts in which they occur (Hammersley, 1998).

Understanding is the argument that human action differs from the behaviour of physical objects and even from that of animals. It does not consist of fixed or even learned responses to stimuli, but involves interpretations of stimuli and construction of responses. The concept of causality is usually not applicable in the social world, since human actions and institutions are freely constructed. Even if sometimes, causal relations are found or observed in social processes, they differ from mechanical causality that characterises the physical phenomena (Hammersley, 1998).

Discovery reflects the concept of the research process as having inductive or discovery-based, rather than limited to the testing of explicit hypotheses. Usually, the assumptions that are built into hypotheses prevent researchers from discovering the true nature of social phenomena. Researchers should begin work with minimal assumptions so as to maximise their capacity for learning. Theoretical ideas, descriptions and explanations should be developed over the course of the research and should be regarded as valuable outcomes rather, than preconditions for the study (Hammersley, 1998).

Ethnography, therefore, offers an orientation to understanding the process and structure of a social setting and employs techniques consistent with this orientation. It is

the study of both explicit and tacit cultural knowledge; the acquired knowledge people use to interpret experience and generate behaviour. Whereas explicit knowledge can be communicated at a conscious level and with relative ease, tacit cultural knowledge remains largely outside people's awareness (Spradley, 1980).

Case Study

Case study as a form of qualitative research, is grounded on the assumption that features of the social environment are constructed as interpretations by individuals and that these interpretations tend to be transitory and situational. In qualitative research, researchers develop knowledge by collecting primary verbal data through the intensive study of specific instances of a phenomenon, the case, and subjecting these data to analytic induction (Gall *et. al*, 1996).

A qualitative research is a multi-method in its focus, involving an interpretive, naturalistic approach. Researchers study cases in their natural settings and attempt to make sense of, or interpret, phenomena in terms of the meanings people bring to them, with as little disruption of the natural setting as possible (Denzin & Lincoln, 1994). It is important to gain the insider's perspective, which is the participants' perspective. This is not incompatible with inclusion of the outsider's perspective. The researchers' perspective contributes to the development of conceptual and theoretical sense of the phenomenon in terms of the researcher's personal and professional experience (Merriam, 1988).

In case study investigations, researchers are the primary instrument for data collection and analysis. Through their perceptions, they mediate the meaning of specific phenomena and build toward theory from observations and intuitive understandings gained. Consequently, case study researchers should be responsive to total context, sensitive to non-verbal communications, and able to adapt the method to specific circumstances, process data immediately, clarify and summarise findings and explore unusual responses (Denzin & Lincoln, 1994).

The American researcher Robert Yin (1993) writes that the case study is an enquiry in a real-life context, in contrast to the contrived contexts of experiments or surveys. More specifically, it is an empirical enquiry examining present phenomena in their real contexts especially when the boundaries between them and their context are unclear. The case study researchers are expected to come across many variables of

interest, have to rely on different data resources and benefit from theoretical ideas and propositions, so that data collection and analysis is accurate and successful.

Case study can be positivist, interpretive, or critical, depending upon the philosophical assumptions of the researcher and the research framework. The epistemological orientation of most case study researchers is interpretive, in which, understanding the meaning of a process of experience constitutes the knowledge to be gained from the inductive, hypothesis or theory generating mode of inquiry, rather than a deductive hypothesis or theory testing mode. Interpretive researchers start from the assumption that access to reality is through social constructions such as language, consciousness and shared meanings (Merriam, 1988).

In the positivist orientation of case study, knowledge is gained through scientific and experimental research and is objective and measurable. Positivists generally assume that reality is objectively given and can be described by measurable properties, which are independent of the observer. Positivist studies usually test theory, in an attempt to increase the predictive understanding of phenomena (Yin, 1993).

No matter the researcher's epistemology, case study can answer research questions, without requiring control over the events. Case studies can be descriptive, portraying an accurate profile of persons, events, or situations (Robson, 1993). They can be explanatory, identifying the patterns, in which a type of observed situation is systematically related to another. They focus on current events, seeking to find out new insights, ask questions and assess phenomena in a new light. Case studies can also be heuristic, enhancing the reader's understanding, bringing the discovery of new meaning, extending the reader's experience, or confirming what is already known (Merriam, 1988).

Regarding the case - study's strengths and limitations, Adelman *et al.* (1980) state that data gathered by case studies may be accurate but difficult to organise, and primarily, they pay attention to the particularity, uniqueness and complexity of the case, which is under investigation. Case studies are shaped by and they reveal discrepancies and conflicts between the principles and ideas that are followed and supported by participants. Case studies may provide opportunities for subsequent re - interpretations of beliefs, thoughts, social truths and realities by their descriptions. However, they may not be considered as the beginning of action. They start and take place in a social field full of action and contribute to it. Their findings may be directly interpreted and applied. Moreover, they present research data in a way that is more publicly accessible. Generally, case – studies offer the example of real people in actual situations. Children, classes,

schools or communities may be case study samples. It is not limited though, to a simple presentation of the case through abstract principles. They permit people to understand how relevant ideas and abstract theories and principles fit together, but the way situations are investigated and approached in a case study are not always suitable for quantitative analysis.

Generalising from case studies is a context-specific process that is expected to be in harmony with readers' experience. This means that case study findings often resonate experientially or phenomenologically with a broad-cross section of readers and thus facilitate greater understanding of the studied phenomena. Ability to generalize depends on the degree to which a case is representative of a large population (Williams, 1991).

By observing effects and phenomena in their contexts, case study researchers can appreciate the context as a determining factor of both causes and effects. The context cannot be considered simply as a sum of its parts. Contexts as societies and human features that are examined in case studies, need in-depth analysis as they include an entirely, which is more complicated than a loose trait connection. As contexts are usually dynamic and unique, case studies investigate and present complex dynamic interactions of events, relationships and other issues in unique situations (Cohen, Manion & Morrison, 2000).

In general, the approaches to the term case study seem to agree that it refers to the investigation of an individual group, effect, and phenomenon, in a particular situation.

Judging the quality of research

Qualitative research is judged using special criteria for trust-worthiness. Since there are no operationally defined truth tests to apply to qualitative research, researchers and readers share a joint responsibility for establishing the value of the research product (Glasser & Strauss, 1967). Eisner (1991) believes that the features of qualitative research which should be considered by reviewers are: coherence (the story must make sense); consensus (the conclusions have to be supported and the interpretations consistent with the evidence presented); and instrumental utility (the usefulness of the study). Lincoln and Guba (1985) suggest qualitative researchers must primarily persuade the audience that their findings are worth paying attention to.

With regards to the judging of the quality of conducted research, the conventional criteria for evaluating quantitative research are internal validity, reliability and objectivity,

while the corresponding criteria for the evaluation of qualitative research are credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985).

Internal validity refers to the extent to which findings accurately describe reality. The researcher postulates relationships and then tests them. The qualitative researcher assumes the presence of multiple realities and attempts to represent these realities adequately. Credibility, as internal validity, depends on the richness of information gathered and the quality of their analysis (Patton, 1990).

External validity refers to the generalisability of findings across different settings despite having examined only limited aspects of each local context. This allows a semblance of prediction and control over situations although sometimes the existence of local conditions makes generalisation impossible. In qualitative research, the transferability of findings to other situations depends on the degree of similarity between situations. The researcher provides sufficient information to decide whether the findings are applicable to new situations (Lincoln & Guba, 1985).

The reliability of qualitative research relates: to the degree to which a measurement, given repeatedly, remains the same; to the stability of the measurement over time; and to the similarity of measurements over a given time period. Qualitative researchers have been criticised for paying little attention to issues of reliability, focusing instead on achieving greater validity in their work (Kirk & Miller, 1986). The dependability of qualitative work, however, can be enhanced if the reviewers examine for consistency both the product and the process of the research (Lincoln & Guba, 1985).

Quantitative research relies on statistical measures to define a situation and is relatively value-free and objective. Qualitative research on the other hand, which relies on interpretations and is admittedly, is thought to be more subjective. There are many researchers who call into question the true objectivity of statistical measures (Eisner, 1991). They suggest that the qualitative researcher can demonstrate the neutrality or the confirmability of research by being non-judgmental, by reporting the findings in a balanced way (Patton, 1990) and by providing sufficient information about the whole procedure, so that explanation and control is transparent (Lincoln & Guba, 1985).

Thus, since there are no operationally defined truth tests to apply to qualitative research (Eisner, 1991), the researcher bears the burden of discovering and interpreting the importance of what is observed and of establishing a plausible connection between what is observed and the conclusions drawn. Besides, researchers and audience share a joint responsibility to establish the value of the qualitative research product (Glasser &

Strauss, 1967). Qualitative research, by its nature, can be emotionally taxing and time consuming, but it can be yield rich information not obtainable through statistical sampling (Cronbach, 1975).

Of course, it not necessary to pit these two paradigms against one another in competing positions nor is it necessary to draw sharp contrasts between the kinds of research. It is believed that theoretical underpinnings of quantitative research are not at odds with those of qualitative data and that integration of the two traditions can be mutually beneficial (Niaz, 1997). Quantitative and qualitative data can be effectively combined in the same research to give valuable insights where neither type on its own can provide any (Pring, 2000). Others support a paradigm of choices seeking 'methodological appropriateness' as the primary criterion for judging methodological quality, which 'situational responsiveness' can lead to the most appropriate methodology (Patton, 1990).

Triangulation

Since there is more than one data collection method that can be used in order to gather the required information for this study, there is an obvious need for some form of triangulation, which can be described as:

> *"cross-checking the existence of certain phenomena and the veracity of individual accounts by gathering data from a number of informants and a number of sources and subsequently comparing and contrasting one account with another in order to produce as full and balanced study as possible".*
>
> (Open University, 1988, p.54)

Though triangulation is widely accepted, it is not frequently used. Educational research has borrowed triangulation from sociological research, where multi-method data collection can provide a wealth of data about human behaviour by examining it through different 'prisms' (Cohen & Manion, 1994). Thus, it is easy for researchers to come up with information that might otherwise need long periods of time or assistance by other people to be collected (Bell, 2001).

The advantages of using triangulation are many. Thanks to it, various methods, gain more possibilities to be used. The most important advantage of it though is that the use of different methods of information gathering can increase accuracy and assurance

that the conclusions drawn are valid. As Lin (1976) states, the more the methods used in a study differ, the more accurate the conclusions are.

Triangulation, consequently, is a term that characterises the multi-method way of dealing with a research problem, in contrast to single method (Bell, 2001). Denzin (1970) however, has expanded the term by naming this type as methodological triangulation and by describing four more different types of triangulation, which are:

- data triangulation, which involves time, space, and persons
- investigator triangulation, which consists of the use of multiple observers, rather than single;
- theory triangulation, which entails the use of more than one theoretical scheme in the interpretation of the phenomenon;
- multiple triangulation, when the researcher combines in one investigation multiple observers, theoretical perspectives, sources of data, and methodologies.

Among those types, the methodological triangulation seems to be used more frequently in educational research. (Cohen & Manion, 1994)

However, triangulation use has risks, difficulties and points that call for attention. This applies especially to research studies that are restricted to qualitative techniques and focus on a specific event or fact, where there is mostly issue around validity. In order to deal with these, there is a group of three questions that need to be constantly asked and answered (Cohen & Manion, 1994).

The first has to do with the methods that need to be used and combined. This question can be answered by taking into consideration the type of information needed for the study and what source, human or not is in the position to provide it.

The second question has to do with the way these methods can actually be combined. The answer is given through careful examination of the research question and the actual aims of the study.

Finally, the third question refers to the way the data will be used. Apart from investigating the study aims, in order to answer this question it is necessary to evaluate the data and negotiate their meanings. In the case of quantitative data this may happen with the use of hypothesis or theory. In the case of qualitative data, attention should be paid as contradictory data might need further explanation (Cohen & Manion, 1994).

Addressing the ethical dimensions of educational research

The basic assumption in current research is that individual autonomy within the broader context of human relations; social and cultural environments should always be taken into consideration. People should be treated in the context of their social, political, economic and religious environment. Assessment of educational programmes should be made within the family and culture context. Research studies should treat people as part of a community while simultaneously respecting their individual autonomy (Simons, 1995).

Qualitative research is consistent with the belief that education refers to formally planned activities, which bring about learning. Education contributes to personal growth, provision of knowledge, understanding and values that enable people to think in a way that is considered worthwhile, and live more fully lives. This approach cannot avoid the ethical dimension to education, the different ways in which members of the learning community, within a particular cultural context, find value in some experiences rather than others. Consequently, research methods cannot ignore the fact that teaching and learning are personal endeavours shaped by influences beyond those that can be identified through rating scales, surveys, and narrowly focused observations (Pring, 2000).

Educational research can involve deeply personal and highly complex relationships, unlike other forms of research that rarely extend into the realm of personal life story. Education is concerned with the mental life of individuals and picks out activities and experiences because they meet certain evaluative standards (Pring, 2000). A challenge that researchers face throughout their studies, is to decide what information to include and what to leave out, as they attempt to transform a lot of diverse information into a coherent, meaningful story referred to an educational situation (Muchmore, 2002).

Although an in-depth study of a single educational case usually has little value for making generalizations about other situations, it can be useful as a vehicle for elaborating an understanding of beliefs and practices. Reading about single cases is a significant learning experience (Donmoyer, 1990) and narrative accounts of educational situations can serve as a tool of self-reflection, which has been shown to be essential part of personal growth and development. Additionally, case studies can be used to build theory and develop pedagogies within broader educational fields (Cole & Knowles, 2000).

While reflecting on these aspects and being concerned about the possible impact that findings of qualitative studies can have on educational life and thought, researchers,

tend to develop four criteria to apply to their work: relevance; accuracy; necessity; and ethics. Ethics take precedence over the other three (Muchmore, 2002).

Charmez (1995) suggests that, while deciding what information is relevant, researchers should have in mind the research objective and eliminate extraneous data. In deciding, what information is accurate, they need to develop a heightened sense of what is true. In other words, they need to see beyond initial impressions. In deciding what information is necessary, they should be selective, choosing representative passages exemplifying particular themes rather than trying to include everything or leaving out significant information simply for the sake of rhetorical integrity (Muchmore, 2002).

In deciding what is ethical or not to be included in research writing, researchers need to be guided by the suggestion of Kant (1959) that people should always be treated as ends in themselves, never as means to an end. People should place ethical considerations above necessity, relevance and accuracy. Usually, there is much worthwhile information to give, without delving into issues that violate the mutual trust and respect that the researchers and participants have to build and maintain (Muchmore, 2002). In general, investigators bear in mind that when they carry out case studies they enter into the world of real human beings who can be threatened or insure of what the study will bring.

Ethics in educational research refers to "the search for rules of conduct that enable people to operate defensibly in the political contexts in which they have to conduct educational research" (Simons, 1995 p 436). Ethics, in a broader sense, is a philosophical enquiry into the basis of morals or moral judgments that takes into consideration the distinctive features of human behaviour (Pring, 2000).

Moral judgment, which underlies research, requires a great deal of deliberation in the light of the many factors that have to be taken into account. There is rarely a context-free set of rules or principles that can be applied without judgment or deliberation. Usually, there is an on-going need to reflect on the values, which inform the research and the ways in which those values can be made more concrete in the research activity itself.

There are different kinds of moral considerations, which enter into a researcher's deliberation about the conduct of the research. There are considerations that relate to general principles of action and others that relate to the disposition and character of the researcher. A long tradition in ethics focuses on the significance of rules and principles.

Rules are specific guidelines referring to the actual conduct of the research; principles are statements, taken as universal truths to which people appeal in justifying an action. Principles have the logic of general rules and they embody the values, on the basis of which rules are established and questioned. The principles which seem particularly important to educational research are: the principle which requires respect for the dignity and confidentiality of participants or subjects and the principle which reflects the ultimate research aims, the pursuit of truth and the production of new knowledge (Pring, 2000).

The appropriate dispositions or attitudes of the researcher are related to the moral virtues that motivate people to act appropriately in a particular case. Moral virtues are deep-seated dispositions like courage, kindness, generosity of spirit, honesty, concern for justice, which determine human behaviour in complex social situations. Virtues embody the values that prevail in a cultural tradition and reflect the kind of human reactions and deliberations, which are required of subjects involved in a certain activity.

Case study requires very special sorts of virtue, both moral and intellectual. The intellectual virtues concern the disposition to search for the truth even if that is painful. They include openness to criticism and co-operation, considering that it is the truth that matters more than any other attainment. The moral virtues are concerned with resistance to the blandishments or attractions, which tempt someone from the research, even where the intellectual virtues press one to go on. These are courage to work out an unpopular project, honesty in producing uncomfortable results, modesty about achievements and readiness to take seriously any justified criticism (Pring, 2000).

Finally, the distinctive values and accompanying virtues of the educational researcher should be in harmony with the values and virtues of a democratic community, which ensures academic freedom, respect for all people and concern for the trust and confidentiality of the individuals or the organizations involved in the particular research.

It would be impossible, of course, to contemplate moral tests for potential researchers, but such qualities and dispositions seemed to be essential. Researchers should always set out the kinds of knowledge required in conducting case studies. They should try to keep anonymous the objects of the research. They should be open to cross-examination and take into account other interpretations of data, different perspectives, or alternative conclusions. In addition, researchers should be concerned of the possible use of their findings and their impact on social contexts. Somehow, researchers are obliged to guide the public in its interpretation of the produced knowledge (Pring, 2000).

2. INVESTIGATING THE SUBJECTIVE REALITY OF EDUCATIONAL CHANGE

This study is concerned to understand individual perceptions of educational change in Greece. It seeks insight rather than statistical analysis and so it adopts a qualitative approach focusing on individual understandings and responses and taking into account the fact that some elements of individual thinking are unique and that the interpretation of personal ideas is an intelligible action (Pring, 2000). While, quantitative approaches, based on scientific models, often neglect individual experience in favour of explanations based on deductions from a main theory, qualitative approaches, with their emphasis on exploiting participants' own situated experience, can benefit from the use the richness and significance of this experience as a basis for the generation of new theory (Symon & Cassell, 1998).

The nature of this study lends itself to 'analytic induction', a methodology which involves "intensive examination of selected cases so as to establish empirically the causes of a specific phenomenon" (Symon & Cassell, 1998, p. 28). Through this approach, observers reflect upon their experience, eliminate exceptions, revise hypotheses and attempt to formulate explanations. Analytic induction attempts to maintain a faithfulness to empirical data gathered from a relatively small number of cases, then moves from the data to the construction of categories and from the elucidation of their case features to generalisation. As relatively small samples are normally used, the validity of this type of research derives not from its representativeness but from its approach to data analysis makes the use of statistics sometimes unnecessary (Symon & Cassell, 1998).

Investigating perceptions and opinions of individuals in the field of education, dealing with innovation and reform necessitate engagement in research that probes for a fundamental understanding rather than merely examining numerical features and qualitative methods are powerful tools for enhancing people understanding in that respect (Johnson, 1995). All knowledge concerning education, including that gained through quantitative research, is ultimately referenced in qualities and there are many ways to represent public understanding of the world (Eisner, 1991). Although statistical research may be able to take account of the many interactive effects that take place in educational settings, a predetermined hypothesis may ignore effects that are important, but are not statistically significant (Cronbach, 1975).

The typical ability of qualitative research to describe in depth educational and social phenomena, such as changing teaching strategies or redefining school culture, is an important consideration not only from a researcher's perspective, but from a reader's perspective as well. The insights into a participant's experiences may be epistemologically in harmony with the reader's experience and, therefore, more meaningful (Lincoln & Guba, 1985).

A proper description of any educational activity cannot avoid reference to the involved persons' mental state, which means the involved person's perceptions feelings and valuing. This mental state can only be understood and interpreted through phenomenological approaches (Pring, 2000).

Qualitative approaches are deliberately open-ended, take a developmental view and permit the use straightforward data resources (Hitchcock & Hughes, 1989).

3. RESEARCH DESIGN AND DATA COLLECTION STRATEGIES

Sampling Strategy: The Study Population

The specification of the population to which an enquiry is addressed is shaped by the following criteria:

- The purpose of the study, which in this case is the investigation of the issues of managing the implementation of change in primary school science in Greece.
- The qualitative nature of the study.
- The extent of the study.
- Practical factors such as the accessibility and availability of the subject and time limits.

In determining the study population, the dominant strategy in qualitative research is purposeful sampling. It seeks information-rich cases which can be studied in depth. Several types of purposeful sampling have been identified and described and these include extreme or deviant case sampling, maximum variation sampling, snowball or chain sampling and convenience sampling (Patton, 1990). For small samples, the most appropriate strategy for a phenomenological approach is considered to be maximum variation sampling (Lincoln & Guba, 1985). This strategy aims at capturing and describing the central themes or principal outcomes across program variation. In a heterogeneous population, where individual cases differ from each other, maximum variation sampling is appropriate and according to that, any common patterns that emerge are of particular interest and value in capturing the core experience and centrally shaped aspects or impact of a phenomenon (Patton, 1990).

The participants of the study were found through calls at schools, the Internet and the help of the Pedagogical Institute and the departments of Education at various Universities in Greece. The sample for this study has been designed taking into account the above. It of :

- 130 primary school teachers from 61 schools from all 13 prefectures of Greece, including 14 head-teachers, working in a spread of primary schools in Greece during the academic years 2001-2005[20].
- 10 school consultants, from 8 different prefecture of Greece
- 312 primary school pupils who, at the time of the interview were being taught science. There were pupils from schools of both urban and rural areas of Rhodes, Athens, Symi and Patras.
- 3 policy makers working in the Pedagogical Institute in Athens[21], involved in design and dissemination of plans in the Greek educational system about change implementation in the area of science education.
- 78 parents of fifth and sixth grade pupils from schools of all different 13 prefectures of Greece
- 80 secondary school teachers of science from schools of all different 13 prefectures of Greece
- 9 University tutors in primary science education and school management and organisation.

During the year 2002-2003, 11 teachers, 3 consultants, 3 policy makers3 University tutors, 10 pupils and 4 parents were interviewed. 35 teachers answered questionnaires. There was also one observation of a 5th grade at a school in Rhodes.

During the year 2003-2004, 6 teachers, 2 consultants, 4 University tutors, 21 pupils, 15 parents, and 6 Secondary Science Teachers were interviewed. Moreover, 57 teachers, one consultant, 14 Secondary Science teachers answered questionnaires. There were also two observations of a 6th grade, as a school in Athens.

During the year 2004-2005, 5 teachers, 2 University tutors, 281 pupils, , 8 secondary science teachers, were interviewed. 16 teachers, 5 consultants, 58 parents and 64 secondary science teachers answered questionnaires.

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[20] All were teaching Fifth or Sixth grade pupils, who were between the ages of 10 and 12. These are the two years in which primary school pupils in Greece study science. As it happens usually, with primary school teachers in Greece, the interviewed ones were responsible not only for the subject of science. They were also teaching their students other subjects, such as Greek Language, Mathematics, History, Geography and Religion. Consequently, as they had to be prepared and trained to teach all those subjects, most of them had a background in science, which was reasonably good for their work, but they could not be considered as experts in the certain field of study. This was not the case for everyone though. There were some that had the chance to gain some more knowledge, about science or science education and teaching (EURIDICE, 2000).

[21] These three were the only responsible ones for primary science curriculum design.

Interviews took place at schools and lasted one or two hours. Only one lasted for until four hours. Questionnaires were distributed at schools.

The data coming from the interviews were also triangulated with observation activities and documents as the new and the previous primary science curriculum, textbooks and the law about school functions and management.

Data Collection Techniques

Investigating the Existent Techniques

An important part of research design IS to decide the techniques that will be used to gather the data required. This decision should be made on the basis of what information the researcher needs and why, how the researcher is going to collect the information and, when obtained, what is to be done with it (Bell, 2001). There are many methods that can be used for data collection: analysis of documentary evidence; questionnaires; diaries; observation and interviews (Bell, 2001).

- The analysis of documentary evidence is very useful in research studies when it is difficult to maintain direct contact with respondents. In longitudinal studies, for example, where members and employees of an organisation investigated no longer work, documentary evidence are a valuable and often the only data source. Documentary evidence can also be used to check the validity of data obtained by other techniques.
- The use of questionnaires is mainly associated with quantitative approaches. It can provide the researcher with the chance to work with larger samples, which can produce more information, in a shorter period of time.
- The interview has the major advantage of adaptability. When interviewing, a researcher has the opportunity to pay attention to subtleties like the respondent's voice and movements. Moreover, it gives the opportunity to clarify responses.
- Diaries are considered an attractive way to gather data concerning the way people spend their time. They are usually records or logs of professional activities, providing information about work patterns and activities. They are not highly recommended for people who are very busy, as it is problematic to have to stop work constantly to make an entry to the diary.

- Finally, observation is regarded as one of the more difficult options. It is a technique that can reveal characteristics and data that are very difficult -if not impossible- for the researcher to gain through other techniques. Direct observation is a more reliable approach of what people say (Bell, 2001).

This study is an investigation of individual perceptions about the issues and dimensions of the implementation of change in primary science education in Greece. It accesses active members of the educational who form an accessible, extant sample. Consequently, the research relies very much on personal contact, rather than on documentary evidence, for information, though, important information potentially derives from newspapers and other published sources.

Questionnaires are useful for gathering data from large sample, but it should be said that questionnaire responses are generally taken at face value. Further exploration of beliefs and opinions is impossible with questionnaires. Therefore, it was decided that the most appropriate type of data gathering technique that could be applied in this research was the interview, which is possible to arrange with individuals and provides the opportunity to gain clear and complete information relevant to the research questions. The interview is the technique that should be preferred by researchers seeking information about knowledge, attitudes, preferences and beliefs (Tuckman, 1972). The interview can be used in the process of verifying data collected by other techniques or in testing hypotheses, in the cross-examination of unpredicted data (Kerlinger, 1970) in the process of valuing other research methods, or in a deeper analysis of the motives of given responses.

Even though the focus of this research is on individual perceptions, there was an obvious need to examine how teachers actually work with students. Therefore, it was decided to carry out a number of observations of teachers in the classroom.

There are various cases where triangulation seems appropriate if not required. Examples of such cases could be the holistic assessment of student performance or the evaluation of teaching methods and of different opinions about it. As educational change is relevant to these cases (Fullan, 2001a), triangulation is useful to a research concerning it. More specifically, a combination of interviews with teachers, students and classroom observations is thought to be suitable for such research (Cohen & Manion, 1994).

In conclusion, the most appropriate data collection technique that this study seems to need is the interview, assisted by the use of questionnaires, documents and observations.

The Interview

The interview is one of the most well known research methodologies. According to Moser and Kalton (1971, p. 271) "it is a conversation between interviewer and respondent with the purpose of eliciting certain information from the respondent". Simple and straightforward, though this conversation might seem the attainment of a successful interview that provides the necessary data is very complex. Cohen (1976, p.82) argues "interviewing is an activity requiring careful preparation, much patience, and considerable practice if the eventual reward is to be worthwhile".

Kitwood (1977) describes different conceptions about the use of interview. As a research tool the interview is always a valuable source of information despite influences and preconceptions that can affect the given answers. There is usually a central nuclear of human personality, which the individual is going to speak about no matter what responses are socially expected or desired.

The interview is related to the phenomenological approach of the investigation, which aims to uncover subjective consciousness and stresses the importance of the interpretation of events or others' actions in the light of the subjective meanings. However, these can often refer to either associated ideas and feelings or intentions of the agent. The researchers' impact cannot be denied. Moreover, research, almost always, takes place within a framework of community values. Community is the larger social framework within which the transaction between teacher and learner takes place. Researchers can easily be led to see things as the wider society sees them in an interview process (Pring, 2000).

There are four kinds of interview that have been described. The first one is the structured interview. This is described, commonly, as a formal, closed situation where the sequence and the wording of questions are pre-planned and scheduled. The second kind, the unstructured interview, on the other hand, is described as a less formal open situation, as the interviewer is provided with flexibility and freedom to carry out the conversation. In the third type, the non-directive interview, the initiation and the progress of the discussion

depends mostly, if not completely, on the respondent. The role of the interviewer is rather subordinate. Finally, there is the focused interview, which differs from the others in the sense that it requires a prior analysis of the situations in which respondents have been involved. The conversation is focused on the experience of the subject and is carried out under the guidance and construction of the researcher (Cohen & Manion, 1994).

In this study the focused interview has been chosen as the tool for gathering information for the following reasons:

- Investigation of individual perceptions focuses on the interpretation of personal experiences, beliefs, opinions and ideas. Thus, focused interview seems an appropriate data collection technique that suits phenomenological approach supporting direct experience study, taken at face value (Cohen & Manion, 1994).

- The direct contact between the researcher and the respondents creates a positive climate. It is, therefore, expected that the interview will be a conversation during which respondents should feel at ease and give non-calculated or detached responses (Kitwood, 1997).

- The interview will provide respondents with a straightforward description of the tools of the research. This minimises the probability of misunderstanding and allows the interviewer to elicit specific types of information (Cohen & Manion, 1994).

- The interview can be conducted at an appropriate speed. Other techniques such as observation need more time; others such as questionnaires are often filled in too hurriedly, not allowing the respondents to express analytically their thoughts (Cohen & Manion, 1994).

So, within this research, many people related to the educational change studied were interviewed. More specifically:

- 22 primary school teachers, including 4 head-teachers. The other teachers and head teachers of the sample answered questionnaires.
- 312 primary school pupils.

- 5 school consultants in various regions of Greece. The other five answered questionnaires.
- 12 parents of fifth and sixth grade pupils, while another 56 answered questionnaires
- 14 secondary school teachers of science, while another 64 answered questionnaires.
- 9 University tutors in primary science education and school management and organisation.

The data from the interviews were transcribed directly in English. The transcripts were emailed back to the respondents in order to have their accuracy assured. Whenever it was necessary, respondents read the transcript with the help of English teachers. The questionnaires were also transferred in a word file on computers in order to be analysed electronically with the help of NVIVO software which is described in the following parts of the chapter.

Documents

As Duffy (2001) claims, many educational projects are likely to require analysis of documentary evidence. Their use might help as a supplement to the data gathered by interviews and questionnaires.

Bell (2001, p.108) defines document as "a general term for an impression left on a physical object by a human being". Documents are commonly divided into primary and secondary sources. Primary sources are written or printed during the period, which is under research, while secondary sources are interpretations of the primary resources. Of course, this distinction is not always clear and simple (Bell, 2001).

Elton (1967) introduces a further division of primary resources in two categories. 'Deliberate sources' (Elton, 1967, p.101) are produced, in order to attract the interest and attention of future researchers. Examples of such sources are autobiographies, diaries, and documents of self-justification. On the other hand, "inadvertent sources" (Elton, 1967, p.102) are documents, used by researchers for various reasons, different to the ones for which they were originally produced. Laws, records of legislative bodies and authorities, surveys, websites of official organisations, letters and newspaper articles are some examples of these sources, which reflect or refer to the educational system.

As far as the approach in analysing documents is concerned, there is the division introduced by Tosh (1991, p.54) into 'source-oriented' and the 'problem-oriented'. The former refers to cases when the project and the research questions are determined by the documents. The later refers to cases when the research questions are formed after reading the resources are read. In fact, the initially read sources are usually secondary resources.

There is also the division of Bell (2001, p.112) into 'external' and 'internal criticism'. This axis of this division is based on aspects of the identity or the content of the document that each type of criticism aims to examine. The first focuses on the originality and genuineness of the document. Within external criticism it is important to answer questions concerning the certainty that the authors of the documents are known to be in the place where it was written or published at the time it first emerged, the consistency of the letter with all the other information known about the authors, the similarities of it with other documents written by the same persons. The second focuses on the content of the document, in order to answer questions about its kind, its purpose, the meanings and information contained in it, the conditions under which it was produced and came into existence. It might also include comparison with other documents of its type or period. Internal criticism is concerned about the authors or the producers of the document, of course. Issues about their social background, political beliefs, views, their relationship with what they describe and the time gap between the periods when the facts described in the document took place and the production of the document can also be included in internal criticism.

These two types of document critical analysis, as Bell (2001, p.112) concludes, can "overlap to a large extent". It is not necessary for researchers to examine all aspects of external and internal criticism. It is important though to be critical about the sources and documents used and their reliability. Any gaps in the evidence are likely to indicate prejudice and determination to ignore a proposed change on behalf of the authors.

Critical document analysis would require from the researcher to evaluate and estimate whether "fact or bias is the main characteristic of the document" according to Barzun and Graff (1977, p. 154). The difficulty of this task derives from the fact that researchers have to locate and uncover, the assumptions hidden in a document, as the authors or publishers of it don't present them usually in a clear way.

The evidence, based on which the authors justify their arguments and opinions could serve as an indicator of whether the authors are objective or biased. According to Bell (2001), there is a series of questions the researchers need to answer, in order to

conclude about the objectiveness of the document. These questions could examine whether the evidence provided are adequate to support the author's ideas and points, whether they are restricted to the authors own interest or go beyond it, or whether the author is known, probably by other sources to be affected, pressed, frightened or abided by external factors when producing the specific document.

However, Bell (2001) believes that even a biased document can be useful in a research study. Biased sources can help the researcher collect different views and opinions of the authors or publisher on a certain issue or problem. Of course, such a document needs careful analysis, which could require contradictions and comparison with other resources.

This study focuses on the effects of change in Greek primary school science. As a result, its accomplishment can only be reinforced by any documents relevant to the Greek educational system and statements, opinions and facts about primary science teaching in Greece. There are the relevant documents written and published by official government or policy-making bodies, in Greece as is the old and the new primary science curriculum since it negotiates issues of the kind of teaching and instruction offered and what its purposes and objectives are (Kelly, 2004b). There are also laws, law modifications, ministerial announcements and decisions relating to primary science education in Greece. There are also the old and the new primary science textbooks, which are distributed to and used by all students of public and most private primary schools in Greece (YPEPTH, 1985).

Observation

Observation of participants in a natural scene context is the classical form of data collection in naturalistic or field research. Observational data are used for description of settings, activities, people and the meanings of what is observed. Observation can lead to deep understanding of certain situations because it provides knowledge of the context in which events occur and enable researchers to see even things that participants themselves are not aware of, or that they are unwilling to discuss (Patton, 1990).

Observation is carried out by almost every person, within the context of everyday life. There are fundamental distinctions, though, between observation in every-day life

and observation in research. The former usually happens in a spontaneous and haphazard way and can well be stored in memory.

In research, however, observation must be planned and conducted systematically, recorded and analysed according to systematic procedures and directed by specific aims and clear objectives. In addition, the researchers must keep testing the data gathered by observation, in order to be sure of their accuracy and validity (Sappford & Jupp, 1996).

There are different types of observation, depending on the level of researchers' participation. In a participant observation study, the researcher actually participates in the situation or the settings that are under observation. In a non-participant observation study, the researcher does not participate in the activity, which is being investigated but watches while sitting "on the sidelines" (Wallen & Fraenkel, 2001, p.436).

Qualitative observational research is an inquiry into the nature of qualities of observable group behaviours in order to learn what it means to be a member of that group. To produce worthwhile information, research requires careful observations, systematic recording of those and an attempt to generalise from them (Pring, 2000).

Observational researchers must attempt to maintain a non-judgmental bias throughout the study. Their goal is to observe and describe group patterns, similarities and differences as they occur. Preconceptions or expectations of an individual or group's behaviour, interferes with the researchers' ability to tell the group or culture's story in a fair and accurate manner.

If researchers follow methodically the steps of naturalistic inquiry, if they are properly assisted with technologies and computers' packages, and if they are aware of ethical issues, they can produce valuable and relevant evidence that may be generalized and promote worthwhile knowledge (Patton, 1990).

A short-term observational study that can be undertaken in the context of a study focusing on primary science education can provide evidence about classroom behaviours and interactions concerning teacher attitudes, student participation, patterns of communications and barriers to understanding. These observable situations make sense only within a broader framework, which contains or refers to relevant concepts. The natural setting of a classroom reflects a framework of policies, pedagogical values and beliefs. In education, no activity makes sense in and of itself. It is engaged within a spectrum of activities that have unifying purpose and embody a set of understandings about what is worthwhile and how learning should be pursued (Pring, 2000).

When undertaking a research study focusing on science education, researchers should consider that classroom interactions encapsulate pedagogical trends, cultural influences, parental involvement and broad curriculum influences. Moreover, it embodies traditions, understandings, appreciations, criticisms and ways of thinking about the concept of science and the goals of primary education (Pring, 2000). In the context of educational research, short-term observation can be used to produce public, theoretical or empirical, knowledge produced, which derives from a process that captures the character of naturally occurring human behaviour and can only be achieved by first-hand contact with it. While studying natural and not artificial settings, mainly classroom situations, educational researchers seek to minimise their effects on the behaviour of research subjects and to increase the possibility of generalisation from their study (Hammersley, 1998).

So within this research study, three observations of science classes took place. Two of them were in groups of the fifth grade and one on a group of sixth during the years 2003-2005.

4. THE INTERVIEW GUIDES

This study is concerned about change implementation and the ways that members of the community recognize and respond to the challenges of redefining scope and practices of teaching primary science. Investigation is based on the collection of information by letting people "speak for themselves" (Pring, 2000, p.39).

For the investigation process, interview guides, which are lists of questions, have been designed. Each of them refers to a different group of participants. Because of the flexible nature of the research, there are no predetermined responses but predetermined inquiry areas within which it is possible to probe and explore, to focus attention on areas of particular importance or to exclude questions that can be proved to be unproductive for the study goals (Lofland & Lofland, 1984).

The complete interview guides that contain the list questions addressed to individuals who are involved in an educational change situation can be found in the appendix of the study.

Interview questions focusing on the first topic of investigation

With respect to the forces that call for change, primary school teachers, head-teachers, university tutors, school consultants, policy makers and secondary science teachers, were simply asked to express their information or opinion on the reasons for the introduction of the particular change. Within this question, the participants made brief comparison between science teaching as it used to take place before and after the implementation. There were also questions regarding other changes, similar or not, that have taken place recently.

The questions addressed are based on the assumption that school leaders and educators need to be aware of the current social and economic tendencies that affect the content and the scope of educational procedures as well as the values that characterise the culture and mission of the learning organizations at all levels of the system. It is assumed that management's decision-making and planning should be informed by the issues related to the concepts of globalisation, sustainability, technological progress, enhancement of the information and knowledge basis of social and human development and the current philosophical orientation towards a post-modern conception of science

and natural or social reality, where the elements of uncertainty and unpredictability must be taken into consideration.

Interview questions focusing on the second topic of investigation

Referred to the investigation of attitudes towards change and the understanding of the meaning and demands of a desired reform of primary science, primary school teachers, head-teachers, university tutors, school consultants, parents, policy makers and secondary science teachers, were asked questions concerning: their beliefs about their work and responsibilities; teaching and learner supervising styles and use of materials. They commented how they were affected by the reform and expressed their their opinion on the new curriculum.

Primary school pupils were also asked about their impression of the new science teaching strategies and textbooks.

Observations of the teachers in their actual working environment are also expected to reveal how the teachers behave and act towards the new curriculum.

It is assumed that teachers both as leaders and practitioners of change in the classroom procedures exert a crucial impact on the success and sustainability of innovative attempts. It is also assumed that teachers' profession should be re-cultured, which means that teachers should change not only teaching strategies but also attitudes towards their work, their responsibilities as members of the learning organisation and the community (Fullan, 2001a). In a direct sense, educational change depends on what teachers do and think.

Interview questions focusing on the third topic of investigation

With respect to the dimensions and foci of the process of change implementation, teachers, consultants, policy-makers, parents and university tutors are asked to talk about: the curriculum, generally and specifically about the one designed for the science subject; goals of primary science education instruction strategies; equipment; school organization and management; and assessment and learning approaches.

Parents were asked to talk about the activities in which their children participate at home which relate to the subject of science.

Secondary science teachers were asked to provide their opinion on the potential of this reform to lead to improvement of the performance of pupils in science, when they enter high school. They were also asked whether they take into consideration any scientific knowledge that children have gained from primary school or not.

The questions related to these themes are based on the assumption that effective implementation of change depends on the combination of all factors and interrelated components of educational activity. Single-factor theories of change are doomed to failure. Management should not think of sets of factors in isolation from each other. They should rather think of a system of variables that interact to determine success or failure of change implementation and continuation (Fullan, 2001a).

Interview questions focusing on the fourth topic of investigation

Regarding individuals' views related to the public understanding of science education and the public's attitudes and dispositions towards the implementation of reform and innovations in the school practices, teachers, consultants, university tutors, policy makers, parents and secondary science teachers were asked to clarify, in what they believed that science teaching should aim and describe whether it was improved or not after the reform implementation.

Parents were asked to rank the subjects their children studied in schools with the criterion of importance.

Regarding their views around school and change management, teachers, consultants, parents and policy makers were asked to desctibe the way they deal with problems, as equipment, time that emerge and any actions they take to work them out, as co-operation with others. It is important to see if they treat their problems as a motivation for action and further reconsideration of functions of the educational system. This attitude can contribute to the desired school re-culturing (Fullan, 20001a).

The discussion of these data was combined in many ways with the data coming from the other research questions. That is because this fourth one is examining the extent at which the ultimate goals of any reform in primary science education have been achieved. These goals are the establishment of a change-friendly school environment (Fullan, 2001a; 2002) and the improvement of the public understanding of Science (Osborne *et al*, 2003)

It is assumed that educational management must enhance its responsiveness to external environments, looking beyond the boundaries of the immediate learning communities they serve. Within the framework of the challenges that external relations management face (Foskett & Lumby, 2003) is the enhancement of the public's awareness of the significance of science education and the need for improvement and reform of the procedures of teaching and learning science (Davis, 2002; Pinto, 2005).

5. PLANNING THE DATA ANALYSIS PROCEDURES

Outlining the Steps of the Data Analysis Process

A typical approach to a qualitative data analysis in which interviews provide the 'raw material' (Patton, 1990) requires (a) interview transcription, (b) data organisation, (c) breaking the output into manageable units and synthesizing it, (d) searching for patterns, and (e) discovering what is important, what is to be learned and what is worth-announcing. Qualitative researchers tend to use inductive analysis, in which the critical themes emerge out of data (Patton, 1990). Such an approach is followed in this work.

The interviews are recorded. The first step of the analysis is to transcribe from the tape or recorder and provide a preliminary framework for analysis. Each interview is given a code number. In this step there is also an identification of the categories into which each response belongs. There are guidelines concerning the analysis of interview data that are followed. In accordance to the suggestions of Hycner (1985), effort is made for understanding the interviewees' opinions and sayings regardless of what is expected to be said. This requires careful listening and repetitive reading of the transcript (Cohen, Manion & Morrison, 2000).

In the following step, the data are broken into manageable chunks. This is the process of clustering data on the basis of the interview guide and the overall purpose of the study. The aim is to investigate themes, which are common to most or all of the interviews, as well as individual variations, or answers unique to a single interview (Cohen & Manion, 1994). In this task, N-VIVO, an appropriate computer software program designed to aid qualitative data analysis, is used. This package organizes the content data, which are the passages of texts that refer to relevant topics (Richards, 2000).

The next step is the process of coding the answers. Coding is the act of translating of responses and respondent information to specific categories for the purpose of analysis. The purpose of coding is not only to describe but also to acquire new understanding of a phenomenon of interest. In qualitative research, responses can be post-coded in order to be interpreted in the light of the research objectives (Cohen & Manion, 1994). In this study, coding is based on the interview guides.

Answers are displayed in two phases: a) a general survey of all individuals' responses is presented in tables, in relevance to the coded questions, b) an appropriate categorisation of the responses on the basis of recurring topics that emerge in most

interviews. These are presented in separate tables along with data exemplars and an estimation of the frequency of the answers on a percentage basis.

As for the judging of the research, credibility becomes the test for its internal validity. It is assumed that the interview and observation, as the inquiry processes used in data collection, permitting a direct access to the perceptions of the respondents, support adequate description of the reality. The existence of the interview guides supports the coherence of results. The use of open-ended questions supports the richness of information gathered. It is also assumed that the respondents' perspective is meaningful, knowable and able to be made explicit. The goal is to share in the meanings that participants take for granted and then to depict the new understanding for the readers and the outsiders (Lincoln & Guba, 1985).

Regarding the external validity of the research, it is assumed that the selection of the sample permits the transferability of findings to other situations, depending on the degree of their similarity. In the sampling process, gender, age, and place of work have been taken into consideration. All adult participants have Greek nationality, as there was no other option (YPEPTH Education Act, 1985). Therefore local or particular conditions do not distort the possibility of results to be generalized or to be applicable to other situations, provided that adequate information is obtained (Lincoln & Guba, 1985).

It is believed that with this process of analysis the material from the interviews is organised and utilised in a way that facilitates answer interpretation and conclusion drawing. Within the framework of these schedules, assumptions and considerations, the study that investigates individual perceptions about issues concerning managing an educational change implementation in primary science has been conducted. The results are presented, discussed and analysed in the following part of the study, leading to conclusions consistent with the purpose of the work (Lincoln & Guba, 1985).

Qualitative Data Analysis with a Computer

Computer-Assisted Qualitative Data Analysis Software: An Academic Challenge

The introduction of new technology has both expanded the ways in which qualitative researchers can collect data as well as the settings and situations from which data can be collected. The other major impact of technology on qualitative work has affected the ways on which analysis is done. It is common experience of researchers carrying out qualitative

analysis that such work requires careful and complex management of large amounts of texts, codes, memos, and notes. The prerequisite of really effective qualitative analysis is the efficient, consistent, and systematic data management (Gibbs, Friese & Mangabeira, 2002).

Computer assisted qualitative data analysis software (CAQDAS), a term introduced by Lee and Fielding (1995) as a name of their networking project, refers to the wide range of software now available that supports a variety of analytic styles in qualitative work. In the research process, words, text and visual images are regarded as qualitative data, when at the point of data capture they have not been pre-structured. They get captured without a predetermined set of categories or codes related to specific responses or observations. Data analysis is a process of transformation that involves description, analysis and interpretation. The emphasis is on the search for patterns and themes in the data (Lee & Fielding, 1995; Wolcott, 1994).

The main functions of any qualitative package are a) importing data from a word-processor into the program, b) giving text line numbers and formatting the file, and c) nesting codes within the files, marking codes with memos, creating hierarchy of codes and performing various types of searches. On the basis of these functions additional possibilities have been developed that characterise different packages (Yeh, 1999).

CAQDAS mostly assumes that the analysis of qualitative data is based either on the steps of a grounded theory or on a case-oriented quantification. Grounded theory is a method of generating theory inductively by finding conceptual categories in the data, by finding relationships between the categories and by integrating the categories about central phenomena at a higher level of abstraction. The operations that are common to these approaches are:

- Coding the data. Codes, also known as indexes or categories, are words or phrases that indicate abstract concepts. They are not usually in this case, combinations of letters and numbers that represent something (see image 1).
- Making comparisons, which is facilitated by some CAQDAS programs
- Linking, segments of the text documents and codes.
- Attaching memos, to these segments and codes, which can facilitate selective coding,
- Using diagrams,
- Verifying of hypotheses and
- Building of theory (Kent, 2001).

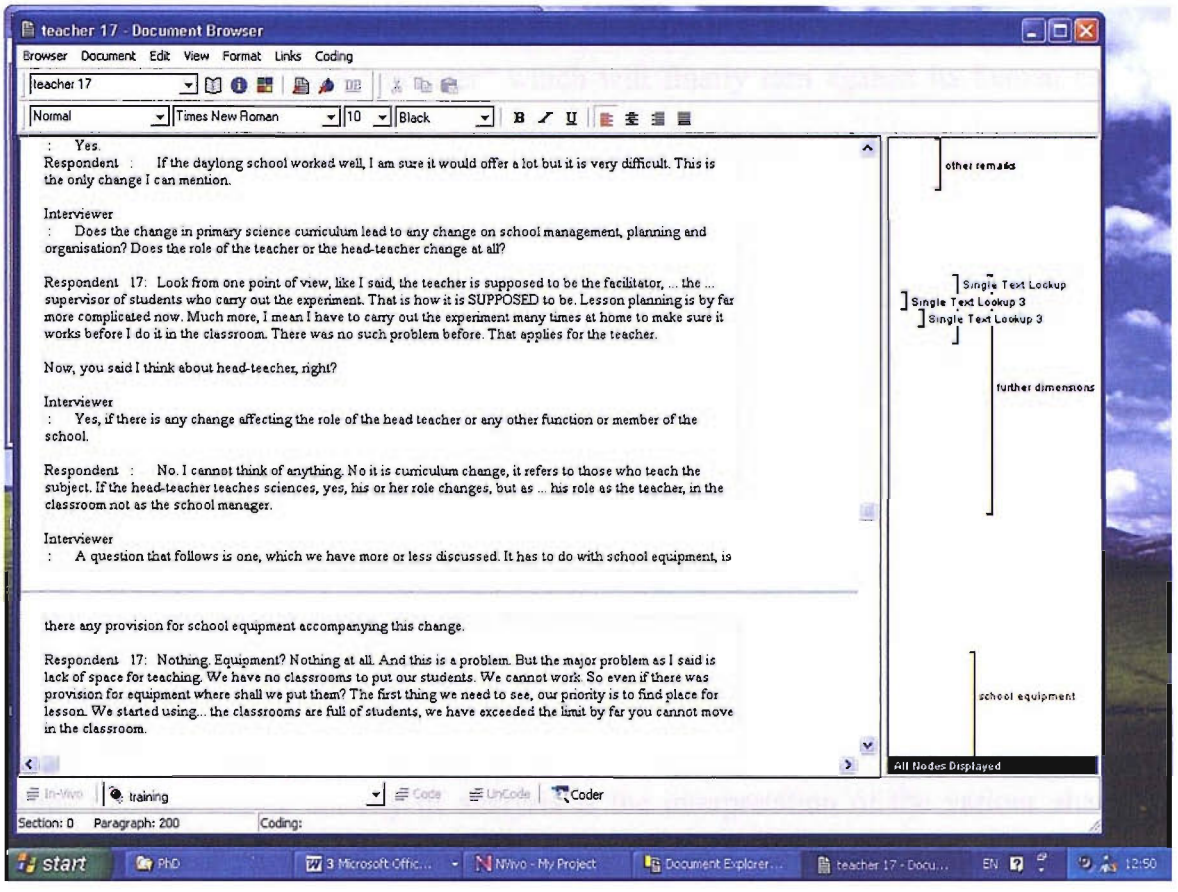

Image 1: data coded. A transcribed interview text with its codes in the N-Vivo software

The case-oriented quantification aims to integrate qualitative and quantitative approaches by linking hermeneutic method, which tries to understand the single case, with positivist methods that focus on finding and testing regularities and patterns in relationships between measurable variables. In this approach, the cognitive processes of classification, abstraction, and typification are used by individuals to understand their everyday social, economic and political world (Schultz, 1967).

Discussing about the Potential Disadvantages of Computer Use in Qualitative Research

There is no doubt that, in general, technology can benefit and enhance the qualitative analytic process. However, in the literature, there are many criticisms and worries about the limitations of CAQDAS and its impact on the kinds of analysis that can be undertaken. The main concerns are:

- That it will distance people from their data,
- That it will lead to qualitative data being analysed quantitatively,

- That it will lead to increasing homogeneity in methods of analysis (Barry, 1998), and
- That it might be a "monster" which will finally turn against its human creators (Lee & Fielding, 1991, p.8).

It was certainly true that some of the early software made it hard to track back from extracted text to the context of the original documents from which it came. Most programs, though, now emphasise their facilities for the recontextualization of data. Another complaint is that some software seems too influenced by grounded theory, which may push analysis in one direction rather than another. A related danger is the over-emphasis on code and retrieve approaches. These might have been convincing arguments about some of the early programs, but not about the current software, which is more flexible and more sophisticated (Gibbs, Friese & Mangabeira, 2002).

There are people who remain sceptical about the overall philosophical position represented by the use of software for qualitative data analysis and interpretation. They argue that the central activity of analysis is the interpretation of the various shades of meaning found in conversational and linguistic material. Computers, founded as they are, on a digital and quantitative view of the world, are limited in how far they can help with such an interpretation. In fact, the strength of any analysis depends to a large extend on the well-established strategies used in analysing qualitative research data (Gibbs, Friese & Mangabeira, 2002).

Nevertheless, this is an assumption, which is taken for granted and shared by all of the more experienced CAQDAS users. Software cannot improve the quality of an intellectual work, by itself. Computers, as tools for processes, can help with the mechanical tasks of analysis, but only human reasoning can undertake its conceptual aspects (Gibbs, Friese & Mangabeira, 2002).

Choosing the Right Qualitative Software Package

A range of different types of software is now available to qualitative researchers. These include word processors, storage-and-retrieval-systems and Non-formatted textual database systems.

Word processors are tools designed for the production and revision of text. They are used extensively in efforts made to assemble and transcribe data, to prepare them as plain text files and to import them into CAQDAS programs.

Storage-and-retrieval systems include text retrievals, text base managers and code-and-retrieve packages. They specialise in finding and counting all instances of words, phrases and combinations of these in one or several files. They all require that codes should be set in advance. More sophisticated forms organise the text more systematically into records and fields. Examples are Metaphor, The Text Collector, ZylNDEX, MAX, FolioVIEWS, ETHNOGRAPH, QUALPRO and Kwalitan (Kent, 2001).

The non-formatted textual database systems, also known as theory builders, are informed by the grounded theory approach and are mostly developed by qualitative researchers. They keep the original textual data unchanged during coding and they enable researchers to look at connections and relationships between codes, to develop higher order categories, to formulate positions and test them against the text. Examples are the NUDIST, ATLAS-ti, AQUAD, winMAX (Kent, 2001). Among them, the QSR NUD*IST Vivo (N Vivo) is a package that offers a new stage in software development providing very new choices for management and analysis of data and supporting new project structures and new research processes (Richards, 1999).

Bearing such a typology in mind, it is possible to identify criteria which are applicable in the procedure of deciding what package suits better the researchers' needs either on a particular study or to meet the demand likely to arise over a period of time. The researcher needs to know something about qualitative analysis before choosing. Another issue is whether the researcher is engaged in team research or works alone.

There are important considerations, but there are also user-related issues that should affect the package choice. Examples of such issues are the possibilities of the system of data entry and storage, coding, memoing and annotation, data linking, search and retrieval, in relationship to the researchers' working style, preferences and objectives (Fielding, 1995).

There is no single answer to the question about what the best package is. Whenever making choices, it is important to know what sort of manipulation or presentation is required and on what scale. CAQDAS can handle large data quantities in many different files. Probably a minimum of 12-15 cases or documents is needed to make it worthwhile. The researchers have to decide how much time to invest, in order to learn how to use the package, whether sub-groups can be handled or not. They also have to find

out whether the original documents should be revised, if the data are structured or unstructured and of which sort exactly document sources are. Finally the researchers must decide if they are going to proceed on a team basis (Kent, 2001).

In short, a main criterion on which comparison and evaluation of software packages can be focused is data management. The help offered by the software in producing well-grounded results without involving any unnecessary analysis or facing the danger of disorientating the researcher has to be taken into consideration. Moreover, attention should be paid in other functions or opportunities offered by the package such as connection to Internet and permission of teamwork. All these should be related to the objectives of the researcher, the nature and the scale of the study (Fielding, 1995).

The recent types of CAQDAS help researchers develop new methods of handling data. New links can be established in terms of chronology, causality, explanation and contradiction. Analysis can be carried out in ways that were not previously predicable. However, while making choices among software packages researchers should bear in mind that data analysis is not expected to be defined through the logic of the software program but through the human mind. Besides, no textual analysis can be as fine-grained analysis as a personal discourse (Kent, 2001).

The Development of the Nudist VIVO Package Mirroring the Evolution of Qualitative Software

From the Code-and-Retrieve to the Theory Building Programs

The first software packages have been developed in the early 1980s, and have been used in the field of ethnographic studies, as computer – based tools for code-and-retrieve processes. They were technological approaches that depended on procedures for coding the text. They marked the texts, in order to tag particular chunks or segments. Code words were attached to discrete stretches of data, facilitating the attachment of these codes to the strip of data, and allowing the researcher to retrieve all instances in the data that shared a code.

Its underlying logic of coding and searching for coded segments differed little, if at all, from that of manual techniques. There was no great conceptual advance over the indexing of typed or even manuscripts notes and transcripts, or of marking them physically with code words, inks and the like. Although these packages have been

upgraded periodically, they still exist as simple and not highly sophisticated programs. Their current versions allow on-screen coding and the attachment of memos to coded data. They are not, though, very suitable for someone to use on networks and they do not allow simultaneous access to data files by multiple users (Fielding, 1993).

In terms of software design, execution and functionality, these programs serve mostly as tools for coding and compiling patterns in the data. They do not impose the identification of large themes in the data. Moreover, they do not do any analysis or test hypothesis. Foreign language software cannot be used in them and they have no ability to handle matrixes or tables. Their code words are usually restricted to only a few characters and their code instruction is hierarchical. Besides, they can search theme within a file but not across different files (Yeh, 1999).

In contrast, the NUDIST packages are specifically designed for multi-access use. They allow the researcher to do more than just coding. They permit the user to do things like attaching analytic or other memoranda to specific points in the text. They index on-line and off-line data, provide audit trails of retrievals, and they have an interface to the quantitative data management program SPSS. Relationships in the data are displayed in tree structures, which users may initially find daunting (Fielding, 1993).

Compared to the early ethnographic packages, the NUDIST versions emphasise the conceptual relations between codes rather than on the construction of typologies where the relationship of data to code is the pre-eminent concern. In the context of the new philosophy about information technology, the interface is common across platforms and advisory support is available. The aim is to incorporate many of the key tasks of grounded theory strategies within the software application. There is, therefore, a close relationship between the processes of coding and the use of computer (Fielding, 1993).

The evolution of qualitative software over the last decade, from the early code-and-retrieve ethnographic programs, to the theory-building system of NUDIST, shows that packages have different personalities and different structures. This, partly, is a result of two long-term trends. The first of these is the move along the continuum from simple, binary, serial, sequential processing at one end to complex, connectionist, networks at the other. The second is the improvement in user-friendliness and the human computer interface. As software becomes more complex in its structure it is also becoming user-friendlier, more intuitive and easier to learn and use (Winograd, 1996).

Moreover, recent development of qualitative software, especially that of NUDIST, verifies the classical belief that the primary goal of qualitative research is the generation

of theory, rather than theory testing or mere description. Theory is not a "perfected product" but an "ever-developing entity" or process (Glaser & Strauss, 1967, p.32), which is "sufficiently general to be applicable to a multitude of diverse situations within the substantive area" (Glaser & Strauss, 1967, p.237).

Considering the Features and Options Available in the NUDIST Software in the Framework of an Educational Research

In general, the main advantage of the various versions of the NUDIST software is their capacity to offer:

- Comprehensive Document Management
- Excel/ SPSS Links
- Loops Search Requests and Results Available for Future Reference
- Three Index to Code and Record Ideas
- Sophisticated User Interface (Anderton, 1998).

Thus, NUDIST facilitates on-going systematic and complete data analysis, the development and the exploration of ideas. It allows flexibility in revision and preliminary identification of emerging themes. It is capable to store interviews and field notes. It creates categories of ideas and manages them in a flexible system. It searches all texts for common themes. It allows data reduction through the process of selecting, focusing, simplifying, abstracting and transforming data (Barry, 1998).

While setting out on the path to draw an image of the patterns that would be followed by a researcher in the educational fields while carrying out a big study, attention should be focused on the potential of the specific software for a certain qualitative study.

As far as data management is concerned, it would be a good idea to proceed from the initial inspiration to the final results in a well-organised manner, without being lured into conducting inappropriate variable analyses (Mason, 1996). Since in a research in primary education the researcher might work as an interviewer and an observer, exploring all phenomenological evidence and contextual information for variable and relevant outcomes, might be crucial.

In the certain study an important point is that there is an intention to integrate qualitative and quantitative approaches to interpret empirical evidence around topics

concerning science education. This happens as apart from the qualitative data that may derive from interviews there may be some quantitative data coming from questionnaires. Through a comprehensive, in-depth inquiry, and through the use of the widest possible variety of sources and functions of the software, there is a hope to make clear the concepts that will arise from the data and provide complex answers to the research problem.

NUDIST's more systematic and sophisticated nature seems to comprise a number of features that aid such a complex work. It facilitates keeping track of progress on large studies with the emphasis on study management. It is suitable for the handling of different data types. Data can be linked by case, or they can be analysed by time of data collection. Where a study employs both quantitative and qualitative data, NUDIST has a number of features for importing and utilising the quantitative facts known about cases in analysing the qualitative data. The fact that it allows teamwork may also provide new opportunities for the research. Its sophisticated searching options can be used to explore the data in real depth by cutting the data on any number of different dimensions (Barry, 1998).

The drawback of all these options in NUDIST is that it does take time to learn how to do all of them. It would be very ambitious to expect to be able to use all of them at the first stage. It would be more realistic only to expect to use the basic functions for the first few months. It would be advisable for researchers to have a prior overview, a map of the toolkit of a specific version and its uses (Barry, 1998). The QSR NUD*IST Vivo (NVivo) version of the NUDIST packages, as a program that combines the coding of rich data with familiar ways of editing and revising rich texts, consists of techniques that can be easily introduced and understood during the conduction of the study, even by novice researchers, who are usually thrown into computing and qualitative methods simultaneously (Richards, 1999).

Exploring NVivo as an Environment for Doing Research

Doing research with NVivo, presupposes the creation of a study that can hold the information, data, observations, ideas and most important the connections between them. A typical study is simple and symmetrical, and is developed in such a way so that it will be capable to manage the research data on the basis of three fundamental systems: documents, nodes and attributes. The parts of the study can be represented as live models. They are brought together by processes, by which values are given to attributes and documents and nodes are linked, coded and shaped in sets (Richards, 1999).

Documents are plain or rich text records that can include links to audiovisual items and other computer-handled data. Nodes are the NVivo containers for categories and coding, representing concepts, ideas, people and places. They can be kept freely or organised hierarchically in Trees. Usually, the document and node systems are symmetrical since qualitative researchers normally move between documents and ideas about them. Both documents and nodes can have attributes, whose values can represent any property the researcher likes. The study stores information about any document or about the object, person or concept that is represented by a node (see image 2). The processes of the study through which, values are given, are independent but integrated (Richards, 1999).

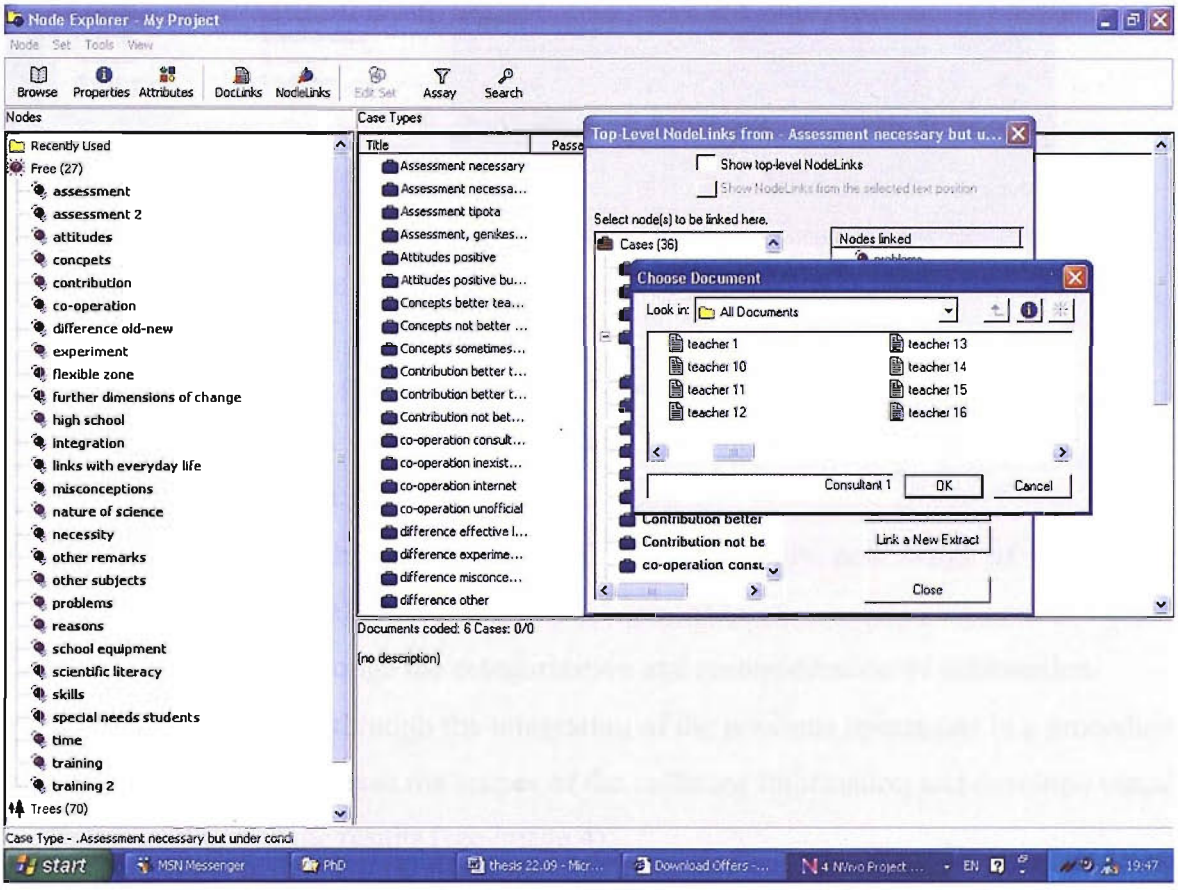

Image 2: list of nodes in NVivo

All parts and processes are handled by two symmetrically organised tools, which are the explorers and browsers (see image 3). Explorer windows contain information about a whole area of the study. Browsers show the contents of a single data item. Tools and parts can be used and combined differently by various researchers, in interlocking processes of data management and analysis

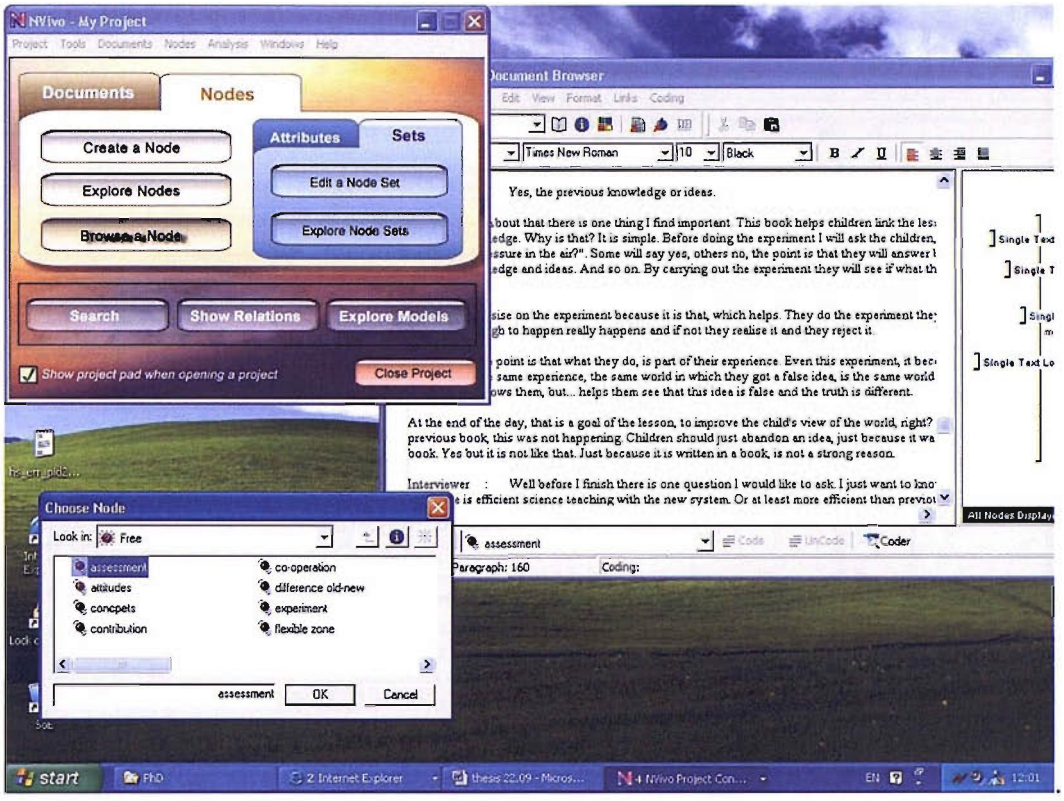

Image 3: NVivo browsers and explorers

Generally, NVivo provides the fundamental patterns for:

- Organising processes, through the selection, description, grouping, accessing, storing and using information.
- Linking processes, through the use of several entirely new ways of connecting information to external multimedia files.
- Coding processes, through the categorisation and reconsideration of information.
- Searching processes, through the integration of the previous operations in a procedure that specifies and retrieves the scopes of the collected information and develops visual representations of the results (see image 4).

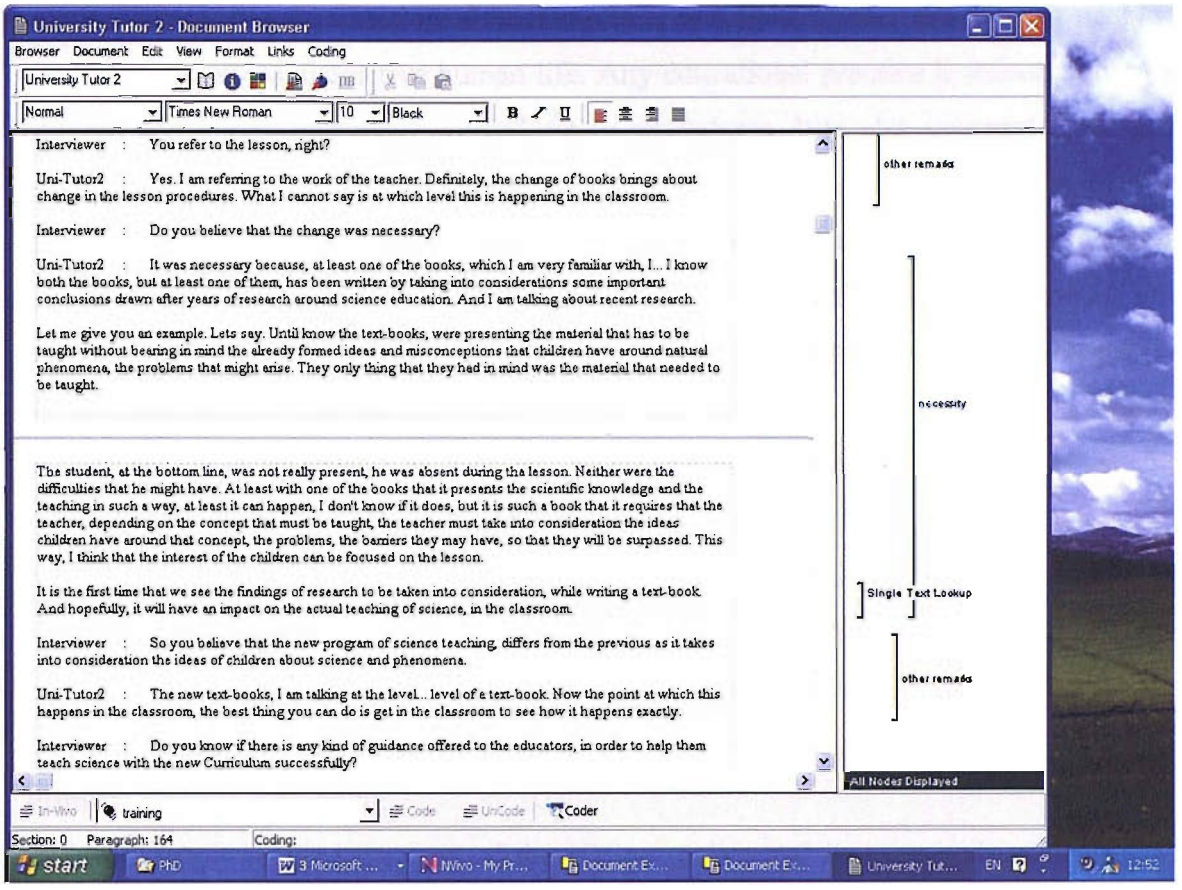

Image 4: searching and coding an imported text in N-Vivo.

- Modelling processes, through the formation of qualitative multidimensional representations of the existing relationships between nodes and attributes. Models are drawn, linked to live data, get changed, styled, grouped and layered as the study theory develops (Richards, 1999).

NVivo is a comprehensive and dynamic management and research package that supports project data, as well as study specifications, study management and monitoring, data analysis and reporting facilities. In fact it is not a mere technological tool, or a helpful electronic mechanism for carrying out stylised operations, but a challenging intellectual process that enhances the qualitative spirit of the research (Richards, 1999).

Maximising the Potential of NVivo in Qualitative Research

A study concerning "Management of Change and Reform in Primary Science Education" is a study that comes under heading of qualitative educational research. Central to educational research is the attempt to make sense of the activities, policies and institution,

which, through the organisation of learning, help to transform the capacities of people to live a full and more distinctive human life. Any educational practice is informed by a set of aims and values and by an agreed set of procedures. It is also interpreted by many interacting elements, including the beliefs and understandings of the people involved in the school or classroom interactions. Especially learning science is an educational activity that incorporates many pedagogic concepts, forms of judgement, ways of enquiring as well as a range of underlying principles of the environmental and technological aspects of science education (Pring, 2000).

The ultimate goal of the research is the production of new knowledge pursued by the employment of systematic and rigorous methods of data collection and analysis. Considering the complexity of the physical, social and conceptual constraints within which the educational transactions take place (Pring, 2000). NVivo seems to be the most appropriate software to support a complicated investigation (Richards, 1999) that encompasses three major fields: Educational Management, Educational Reform and Primary Science Education.

Bearing in mind the map of the NVivo toolkit and its uses built upon its three-system structure, which is documents, nodes and attributes, a study can be designed addressing the main themes under investigation that is Educational Management, Educational Reform and Primary Science Education primarily through the appropriate coding process.

As far as educational management is concerned, relevant codes could be referring to managerial skills as: organising; planning; assessing; recording; communicating; co-operating; searching; gathering and using resources; dealing with problems. The study needs to examine the level and ways that teachers, students policy makers and all people that are involved in the phenomenon studied develop and activate these skills (Crainer, 1998, Craig, 1997).

Codes relating to the field of Educational Reform could be: reasons for change; objectives; aspects and dimensions of change; teacher preparation; school conditions and equipment; financial issues; time issues; and evaluation of change. These are fields that concern every effort and study around change and reform (Fullan, 2001a).

The field Primary Science Education could include categories that relate directly to its actual aim, as: curriculum design; scientific concepts and content; scientific process; assessment; structure; social-constructivist views of learning; scientific literacy; and students' misconceptions (Gilbert, 2004).

It is believed that through the on-going systematic examination ad the tentative environment of the documents, the information derived from the different conceptual areas will be interrogated into a body of relevant evidence and reflected upon a series of conclusions, which are held to be true. At the same time, that evidence will be disseminated through the use of NVivo techniques and can be constantly tested, questioned or adopted to new situation.

Through NVivo, the knowledge developed can be reinvented and rediscovered all the time in the light of new evidence, which is referred to the process of "triangulation" (Pring, 2000, p.130). NVivo permits a constant interpretation, testing and critical scrutiny (Richards, 1999), that is an on-going process, which feeds into, and can be put to the test in the educational fields (Pring, 2000).

Summary

Software packages are useful and sophisticated tools, which can benefit and enrich the research process. They automate and speed up the basic analysis tasks and allow the instant access to data once coded. NVivo tends to win out on sequential structure, study management and sophisticated searching. Its great advantage is that it permits the integration of qualitative and quantitative data, which may lead to worth-knowing findings and theoretical views concerning educational situations (Friese, 2000).

The analysis of software structure and potentials facilitates the process of deciding among different versions. Moreover, it raises interesting issues of which work style is preferable for a quality outcome. Considering software personalities and types of processing in the context of using CAQDAS, may lead to a greater awareness of the need to integrate the different paradigms of analytic thought into the research patterns. It may also prompt the members of the current learning communities to think more creatively, conceptually and perhaps more holistically (Barry, 1998), according to the tendencies of the post-modern intellectual perspectives (Pring, 2000).

CHAPTER V:
PRESENTATION OF FINDINGS

"Evidently we have to acquire knowledge of the original causes (for we say we know each thing only when we think we recognize its first cause), and causes are spoken of in four senses. In one of these we mean the substance, i.e. the essence (for the 'why' is reducible finally to the definition, and the ultimate 'why' is a cause and principle); in another the matter or substratum, in a third the source of the change, and in a fourth the cause opposed to this, the purpose and the good (for this is the end of all generation and change). We have studied these causes sufficiently in our work on nature, but yet let us call to our aid those who have attacked the investigation of being and philosophized about reality before us. For obviously they too speak of certain principles and causes; to go over their views, then, will be of profit to the present inquiry, for we shall either find another kind of cause, or be more convinced of the correctness of those which we now maintain".

[Aristotle, Metaphysics, Book 1, Part 3]

PRESENTATION OF FINDINGS

INTRODUCTION

In this chapter, the data from empirical research are presented. These data are categorised according to the four research questions.

The first research questions which refers to the reasons for reform in Greek Primary Science Education, is answered through the data coming from primary school teachers, consultants, university tutors and policy makers.

The second research question, which refers to the attitudes towards the reform, is answered through the data coming from teachers, consultants, university tutors, policy-makers and pupils.

The third research question which refers to the way change is introduced and its dimensions, is answered through the data coming from primary school teachers, consultants, university tutors, secondary science teachers and policy makers, as well.

Finally, the fourth research question, which refers to the impact of the reform towards, science, science education and public understanding of science is answered through the data coming from teachers, consultants, parents, secondary science teachers.

This examination is aiming to examine whether a reform in Primary Science Curriculum is able to be or lead to a systemic and sustainable in the Greek educational system (Fullan, 2001a).

Overall, factors of gender and years of experience, even though were clarified, do not see to affect the responses, as it is seen in the tables in the appendix.

1. RESEARCH QUESTION (1): THE REASONS FOR CHANGE

Teachers, head-teachers, consultants, policy makers and university tutors answer that the reasons for the reform were the need for more effective science teaching and the necessity for schools to improve in order to keep up with the social progress. The opinions are presented below analytically.

A. Teachers' views

All teachers recognise that there was a need for change in primary science education in Greece. Specifically, 100 per cent of them seem to agree with the need for reform especially as far as teaching methods and textbooks are concerned. A teacher with an eighteen-year experience gives the typical response that:

> "*Change is generally necessary. As our life changes, life and society become more complicated, and that has an impact on education. It is reality that makes change necessary. Change in science teaching, change in other units, change in schools generally. This is our present life*" [teacher 11].

Most of them, 91 per cent, emphasised the fact that the previous book had not changed since the 1980's. They state that there was a need for new pupil-centred approaches in teaching science to make the lessons more exciting, more interesting and more attractive. As one teacher argues:

> "*The changes happened in order to make science a more pleasant and adorable subject to the pupils... to make it more familiar to them....you know that children prefer little text and many images*" [teacher 91].

A large percentage of teachers (93 per cent) believe that the overall purpose of primary science education should be the development of skills concerning the conduct of experiments, the participation in scientific activities and the development of scientific thinking. They believe that primary science education should aim at developing and building, learning processes and skills that lead to the construction of knowledge by students.

Only a small percentage of teachers (four per cent) perceive the purpose of science education solely as the transmission of knowledge about scientific concepts and natural phenomena. Consequently, the majority of teachers, adopting largely constructivist rhetoric (Driver *et al*, 2000; Pinto, 2005), are consistent with current thinking about the desired outcomes of science education, which promotes the development of a general understanding of scientific concepts and explanatory frameworks and of the methods by which science derives evidence to support claims for its knowledge.

One teacher, who has been teaching for fourteen years, argues that the change was necessary because:

"...during the last decades a great deal has been achieved on how to facilitate the acquisition and further development of understanding of the concepts of science. Besides, many issues have been emerged concerning the changes occurred to the social and cultural environment and their impact on children's experiences" [teacher 56]

Remarks relevant to the attitudes of children, as a reason for change, are also frequent. Another teacher says:

"This change has really been initiated from teacher and students, who found the previous book to be too boring and the science lesson to be too dull" [teacher 12]

According to those teachers, science was a tedious subject, which had to be memorized in the context of daily class routines. Rarely did children have the chance to participate in experiments and seldom did they seem to understand fully the topic taught. As 77 per cent of them claim, school science under the previous conditions, could not easily related to environmental phenomena, familiar to the learners. 73 per cent of them hold the view that not only was the old course-book boring, incorrect factually and incomplete, but it did not provided primary science pupils with opportunities for integrating science with other subjects. These teachers claim that the learners' attitudes towards primary science units have now improved drastically.

Moreover, answers from various other questions show that 84 per cent of teachers think that teaching science under the previous curriculum was difficult for culturally diverse or special needs pupils as it had 'difficult text' [teacher 55]. Children that come from minority cultural backgrounds or have difficulties in speaking or understanding the

Greek language, especially scientific terminology could not at all share the meaning of the lesson.

77 per cent of the teachers state that the traditional way of teaching science had not served the purpose of science enquiry well. Current thinking is that pupils should investigate, observe, construct and test ideas and explanations about the natural work and teachers are therefore expected to help children learn how to learn. In Greece, this fed demand for new teaching strategies and a new textbook, consistent with effective pedagogy. Similarly, 45 per cent of teachers suggest that there was a need for a new teaching approach to take into consideration the basic conclusions drawn after years of research in science education. The following comment is typical:

> *"Research in Science Education over the last 15 or 20 years has proved that new approaches have to be introduced in the ways of teaching. Therefore, yes, changes were necessary, as research would say. We needed a more recent teaching approach to scientific knowledge"* [teacher 42]

These teachers typically relate reform with the need for constructivism (Driver *et al*, 2000) in school science, aware of the recent literature about the shift in the paradigm of learning. There is a consensus among teachers about the importance of constructivist procedures through which young people build knowledge about natural phenomena, but in describing the new classroom reality, their positive comments refer mainly to the introduction of experiments and to the philosophy of inquiry-based strategies, which the advantages of a process approach, empowering children with scientific skills and helping them in developing their scientific thinking.

Despite the fact that the majority of teachers (55 per cent), do not focus their attention on pupils' prior knowledge and misconceptions, which is the essence of constructivism (Driver *et al*, 2000; Pinto, 2005), it seems to be generally admitted that:

> "*It is the first time that the educational community sees the findings of research to be taken into consideration, at least, while writing a text book*" [teacher 14].

Other teacher mentions the need for more 'project' work in science classrooms, which could encourage students' cooperative habits and a scientific way of thinking. There is a

demand for a practical understanding to natural phenomena via an active investigation of these phenomena through the conduct of simple experiments. As children have hitheto not been encouraged to develop their own explanations of natural phenomena they cannot form a bridge to the scientific explanation. Another experienced teacher indicates the need for a teaching method that recognises how what pupils already know could interact with new ideas. Another teacher emphasizes the demand for making pupils engage with science in a way that leaves aside rote memorization of facts and figures, and enables pupils to make sense of new experiences by linking them to what they already know.

Some teachers attribute the particular reform to a 'change in the philosophy, which had been developed around the process of learning that is based on personal experience' [teacher 70]. Others refer to the 'need for improving pupil understanding, which has been proved to be incomplete', up to now. It is also mentioned that there is need for an up to date modification of the kind of knowledge, which pupils are supposed to gain, in science lessons, to enable and empower them to adjust to contextual conditions.

Approximately, one third of teachers (30 per cent) refer to the relatively poor achievement of Greek students in science at least in comparison to students from developed countries as determined by international tests organised by OECD. In fact, four teachers argue that under the perspective of the previous curriculum, primary science was considered to be a subject of low priority, since the curriculum did not emphasize the importance and significance of science education nor did it meet the current demands for the promotion of scientific literacy.

A very small percentage (eight per cent) describes the current reform as merely a political set.

To summarise, the majority of teachers share strongly the opinion that reform in primary science education in Greece was necessary. They admit that there is a need for the type of radical change that leads to an improvement in teaching methods, replacing the old textbooks and emphasizing practical classroom work and experiments. Old textbooks were theory-concentrated, unattractive and not associated with contextual situations. Teachers also indicate that there was a demand for teaching methods that ensured a teaching-learning process characterized by enjoyment, fulfilment, student interest and practical work. Such processes were not achievable through traditional methods of teaching science, which valued memorization rather than understanding. Due to a lack of

experiments and practical activities, pupils traditionally reacted negatively or apathetically towards the learning of science. There was an urgent need for a change to make the lessons more exciting, and relevant to the needs, concerns and personal experiences of students. New textbooks were required to support this shift and teachers seemed to be aware of the need to promote scientific literacy. Most respondents speak enthusiastically about the advantages of a constructivist approach in science teaching, focusing on the importance of active engagement and experimentation, rather than on the examination of students' prior knowledge and background experiences (see figure 1).

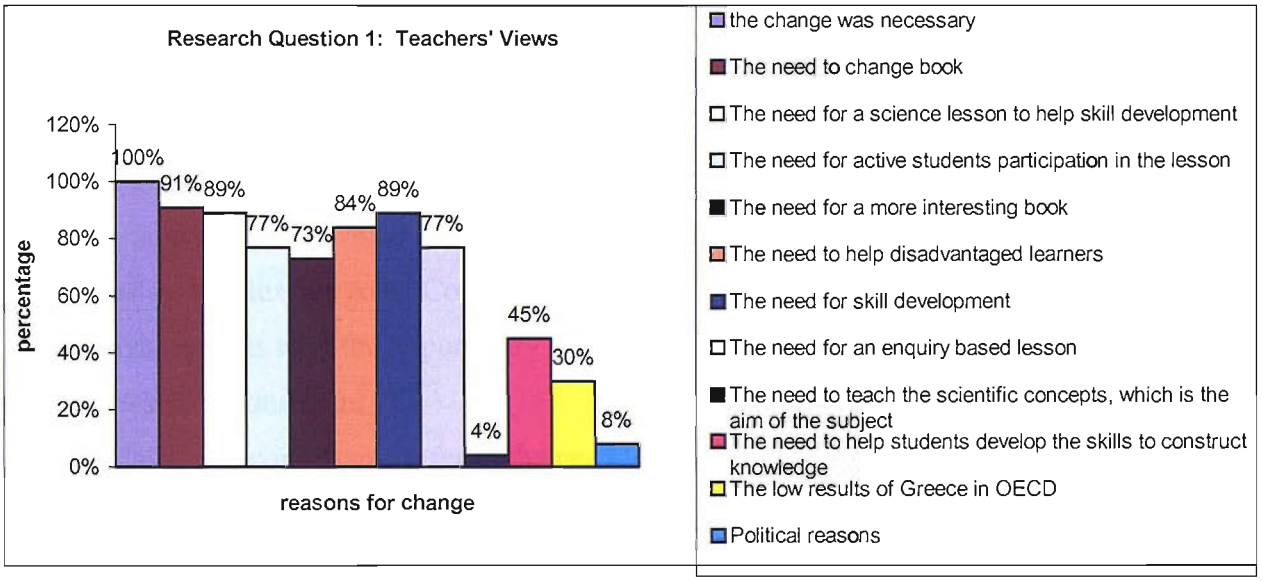

Figure 1: Research Question 1: Teachers' Views on the reasons for the reform

B. Consultants' Views

The responses from consultants do not differ much from those from teachers. They are in favour of the primary science education reform and in fact many would like to see it extended beyond the subject of science. Specifically one of them, argues that:

> "*The change should have been introduced earlier. If we want our education to survive, we need to accept changes. In fact waiting for 20 years to change the books is not helping at all. My experience shows that. The previous book might have been perfect for the period it was published but now it had to be replaced as things have changed.*" [Consultant 3]

Their comments on the old curriculum and text-books show that, as with the teachers, they perceive that science teaching was considered ineffective. All of them see a need for reforming on the kind of science teaching that emphasises skills too, rather than simply concepts, which they found major characteristic of the old text-book. They believe that science teaching has been improved, by the current reform. Lessons now centre on experimental tasks that require 'simple materials'; materials that they are harmless, easily found and simple to use.

Active student participation is in the consultants' opinion, a significant characteristic of lessons in the new curriculum, something that was missing while the previous textbooks and curriculum were in use. The experiments are done in the classroom by pupils, which increases their understanding and retains their interest. They also help pupils appreciate the relationship and contribution of science to everyday life, which was another reason for the reform. This connection is enhanced, in their opinion, by integrated activities, which are promoted by the new textbooks as well as other programs as the Flexible zone. Consultants consider these activities as important, since they provide pupils with the opportunity to '*apply what they learn in contexts outside the science lesson*' [consultant 8].

Only four consultants refer to the need to negotiate children prior ideas and misconceptions around phenomena, and the difference between the previous and the new curriculum concerning their emphases on that topic. One consultant states:

> "*When starting the experiment, the teacher asks, what do you think will happen... Write the hypothesis on the board... we compare what we hypothesized with what we found*" [consultant 2].

Most of the consultants however made no reference to learners' ideas being a cause of change but state their opinion about the effort of the new textbook to accommodate a relevant learning approach. Two consultants believe that there was a '*strong necessity*' to introduce methods of teaching more focused on team-work, which they thought offers many benefits to the lesson:

> "*Children co-operate, so they enjoy the lesson... Weak students can work with good ones and be helped like that... they understand that scientific knowledge is a product of co-operative work*" [consultant 1].

Finally, another two consultants mention the low results of Greek students in international assessment tests, specifically those organized by the OECD as a reason for the reform (see figure 2).

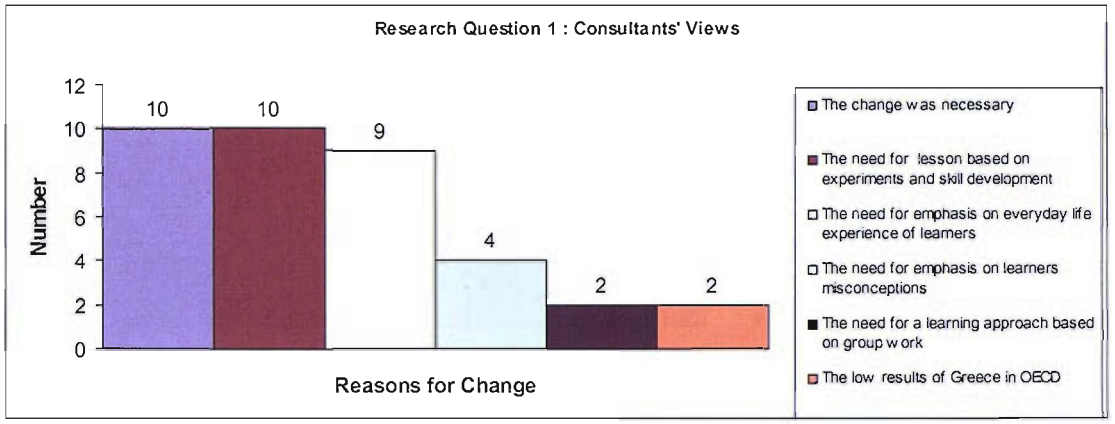

Figure 2: Research Question 1: Consultants' Views on the reasons for the reform

C. University Tutors' Views (working in areas as primary science, school management, curriculum)

University tutors identify the need for the curriculum to update itself in line with recent research findings; specifically the implementation of a constructivist approach in classroom. One tutor explains:

> "*... for the first time we see the books used to be reflecting the theories derived from recent research. They try to negotiate the students' previous ideas in the lesson. They help the teacher do that. For that reason, yes the change was needed.*" [university tutor 2]

Three tutors speak of the need for a general 'modernisation' [university tutor 1] of the curriculum and the way, in which schools help pupils approach knowledge and learn how to learn. Another tutor also makes reference to the results of the OECD and the need for a stronger emphasis on integrating activities that make lessons more effective and help children understand better the importance of science. Finally two tutors refer to 'political reasons' [university tutor 7] as a change for the reform in primary science education

All those points, though, as well as the constructivist approach were rationalized as necessary as they would agree with the findings of recent research (see figure 3).

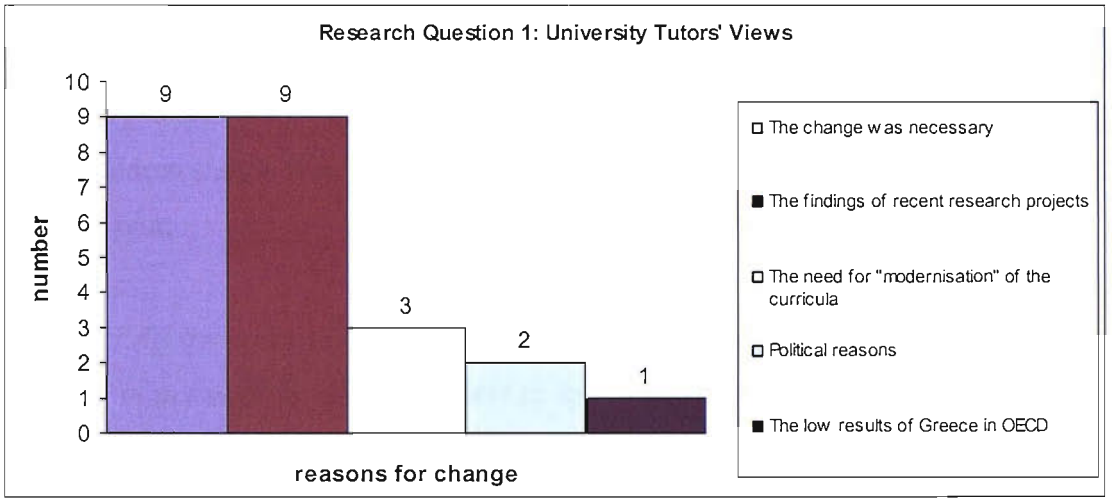

Figure 3: Research Question 1: University tutors' Views on the reasons for the reform

D. Policy-makers' Views

Findings indicate that from the point of view of policy-makers, the change was necessary to broaden the scope of primary science education and introduce the new paradigm of learning in the teaching strategies proposed by current curriculum. One respondent says:

> "*...yes, the changes should take place.... as more attention should has been given to certain phenomena ...the basic reason was definitely the need for making science subjects be familiar to the young people. That had to be achieved through the active participation of students in the lesson during their effort to understand natural phenomena.....the overall motive has always been the need for better science teaching....*" [policy maker 2]

They also say that there was a need to make students realize the importance of science and understand the contribution of science and technology in every day life. In relation to that, one policy maker argues there was a need for a system that should provide the children with the theoretical scientific knowledge and ensure that they will have the opportunities to use this knowledge in practice. It is also mentioned that there was a necessity for the

educational system to reform the strategies of primary teaching so as to provide children with the chances to develop '*their talents in arts and engineering and their creativeness*' through practical work and hands-on activities. Besides, it is claimed that schools should be reformed because so far they have ended to be just 'exams centres' [policy maker 1].

A policy-maker to the phenomenon of globalisation pays attention too. This person states that children should learn to deal with the challenges of present life, which he explains by stating that:

> "*All these things have to do with scientific knowledge and applying this knowledge in action It is very important to approach knowledge by working not detachedly but holistically...We were not aiming at filling the brains of the children with knowledge but at giving them the opportunity to be able to keep up with the challenges of present life*" [policy maker 1].

As far as the need for changing the textbook, all policy-makers agree that the old textbook had to be replaced because the previous book was "*just narration and nothing but text*" [policy maker 2]. Another reason presented is the recent rapid progress on science and technology and the new knowledge produced or discovered during the last two decades, which the textbooks used before the reform, old as they were, could not include or describe.

Policy-makers argue that there was so far a need for integrating science with the other primary subjects. A respondent speaks of integration, which is thought to be a "*wise issue*". It is considered to be important as, thanks to that, pupils will understand that all phenomena "*do not exist alone by themselves*" [policy maker 3]. That is why, according to the policy-makers' views the reform has been accompanied with the introduction of the flexible zone, which provides the teacher with opportunities to teach science through relevant studies.

Political influences are also included in the forces for the primary science curriculum reform by one policy maker.

Responses also indicate that policy-makers admit that there was a need for change on primary science to introduce a teaching strategy that would promote the scientific literacy, improve children learning and enhance their understanding through experiments, hands-on activities and collaborative group work in classroom. They give emphasis on the

issue of integrating science with other primary subjects Policy makers seem to acknowledge the current shifts in the paradigms of learning as indicated in the literature and the evidence of current educational research. Their interest is concentrated on the educational reasons for change that called for a reform of the teaching strategies and the introduction of new textbooks, which are in accordance with international pedagogical trends (see figure 4).

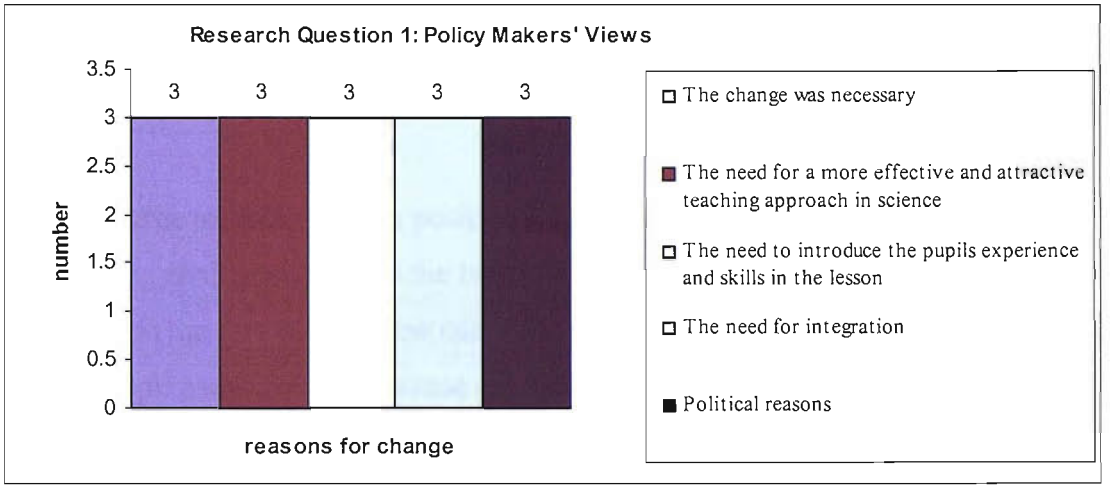

Figure 4: Research Question 1: Policy Makers' Views on the reasons for the reform

2. RESEARCH QUESTION (2): THE ATTITUDES OF THE AGENTS OF THE REFORM

Teachers, head-teachers, consultants, pupils, university tutors, policy makers and parents expressed rather positive comments about the new science curriculum. Most of them say that it has helped science lesson to become more attractive, interesting and effective. However, they also mention that there are barriers to reform implementation, as guidance, support, school structure and equipment. Their opinions are presented below analytically.

A. Teachers' views

By and large teachers express positive feelings about the changes. They describe it as an interesting challenge as far as the task of teaching is concerned. Most positive comments focused on the fact that the new curriculum, textbook and pedagogic approach emphasise active pupil participation, increase on pupil enthusiasm, group activity, the development of skills and an understanding of the nature of science.

All teachers (100 per cent) say that pupils enjoy the lesson of science. Many of them mention that after the reform science became one of pupils' favourite subject. 98 per cent of teachers reveal that they are developing positive and responsible attitudes towards the implementation of reform, and reflect recent thinking about the purposes of science education and what young people are supposed to achieve through it. Almost all teachers agree (98%) that the new approach serves better the development and learning of scientific concepts, scientific processes and skills and scientific attitudes, which teachers consider essential for the development of 'scientific literacy' [teacher 9]. They also believe that thanks to the new textbooks, science has become a very attractive and interesting subject for pupils.

Teachers believe that the new textbook and teaching method enables pupils to understand scientific concepts in a way that concentrates on a range of ideas, rather than memorising facts, relevant to the natural world. They believe that the new program enhances pupil participation and helps considerably in developing process skills by providing them with opportunities to explore materials and phenomena at first hand. They share the idea that the approach is based on the way pupils make sense of new experience to develop ideas that explain them. Teachers make obvious that they will try to promote pupils' understanding of science and that they realise they have crucial part to play

in the construction of new knowledge. They agree that the reform takes into account pupils' ideas and provides teachers with opportunities to guide pupils through scientific reasoning starting from misconceptions. The new curriculum provides pupils with the knowledge and experience necessary for young people to explain natural phenomena. As one teacher puts it:

> "*Now, children have to approach the new knowledge themselves. Teacher is supposed to be an assistant. We are helping, guiding the students to get the knowledge, while doing the experiments, while doing the conclusions. Yet, the teacher is still mostly responsible for the efficiency of the lesson*" [teacher 20].

This research found no evidence of any teachers' intention to resist or oppose the reform, or that teachers consider it meaningless or not worthwhile. On the contrary the vast majority of teachers agree that the new approach to teaching primary science will not only enhance pupil understanding and improve learning outcomes, but will create an active, pleasant and attractive classroom environment. A teacher says:

> "*All those years in school there is nothing that worries me more than seeing children coming drudgingly for the lesson, bored. Waiting moment by moment for the bell to ring to go home... So now that the children are fascinated by the lesson, that is significant. Lets hope that this will continue for every subject as well and not only for science*"[teacher 62].

86 per cent of teachers believe that the new approach helps children develop an informed attitude towards the essence of science and the nature of scientific task. Usually, young people do not get the necessary practical experience of scientific activity and its consequences to form opinions about science and scientists. If they do hold such attitudes it is as a result of accepting adult prejudices and parroting views which are not their own. This response shows that teachers are concerned about giving children experience in scientific activity as a basis for a more thorough understanding, which might only come later, of what science is, and is not, and of what scientists do. In explaining that one teacher remarks:

> "*This* [the teaching of the nature of science] *definitely happens better than before. The new book is full of activities, that help the child construct the knowledge by itself. So at the end I have to clarify to the child that the scientists approach knowledge in a similar way, at different level of course...*" [teacher 24].

Teachers also say that the new approach significantly helps children appreciate the important role of science and technology in daily life and its impact on everyday activities, though it seems that it is taken for granted that the pupils are willing and able to try to apply Information Technologies provided the equipment is available in a class setting.

95 per cent of teachers welcome the new method as being of benefit to collaborative group work in the classroom and are willing to encourage such settings, making clear that they will do their best in trying to accomplish the aims of the reform and meet the objectives of the new curriculum. In particular, teachers seem to be happy to work with the new textbook, which as they state, provides children with opportunities to gain a general knowledge about scientific concepts and an image of the natural world. One teacher explains:

> "*The lesson is now more practical. The students are forming groups. Each group has its own materials and they have to carry out the same experiments...this is really exciting for students. The idea of doing an experiment, the idea that they do scientific work... which is very important*" [teacher 30].

These teachers can see wider benefit in working with pupils through collaborative tasks, in the sense that it can help teachers overcome other barriers that they had while trying to teach science in the old curriculum. As an example one teacher says:

> "*With the previous text-book, a weak student, a child with learning disability or a culturally diverse had no chance to learn anything. Now I can involve them in group activities, which they enjoy... this way they work with others and they will learn something*" [teacher 12].

60 per cent of teachers indicate that they are willing to try to integrate science with other subjects and are of the opinion that the new textbook is more appropriate for that. They are aware that integration is demanded by the new primary science curriculum and is regarded a prerequisite for effective teaching under the new approach, although they admit that they are not sufficiently trained or informed. Teachers believe that through integration, a broad and general grasp of some of the basic concepts of science can be taught in a interactive way providing tools for thinking about the world and ways of structuring one's experience of it. The new approach aims at ensuring a qualitative and descriptive student understanding rather than a quantitative and detailed one, which was the orientation of the old curriculum.

In general, teachers feel that the new teaching approach will help all pupils develop skills and positive attitudes toward science. They are willing to change their traditional ways of teaching and the majority of respondents seem to appreciate the need to assume responsibility for effective science teaching under the new conditions. Despite the occurred changes in teaching methods, the role of the teacher in ensuring that understanding is being developed and curriculum is being covered remains a central one and they obviously intend to support that particular change. Their positive attitudes derive from their consideration of the advantages of a student-centred strategy, where children are actively involved in the learning process in contrast to the teacher-centred methods where all responsibility belonged to the teacher.

Generally speaking, the respondents from teachers reflect positively on the introduction of the new approach to teaching science and the new textbook. They argue that traditional procedures were irrelevant to students' interests, unconnected with the science and technology experienced by pupils outside school, and provided too little opportunities for children – especially those from different cultural backgrounds or with special educational needs – to express and explore personal views and responses (see figure 5).

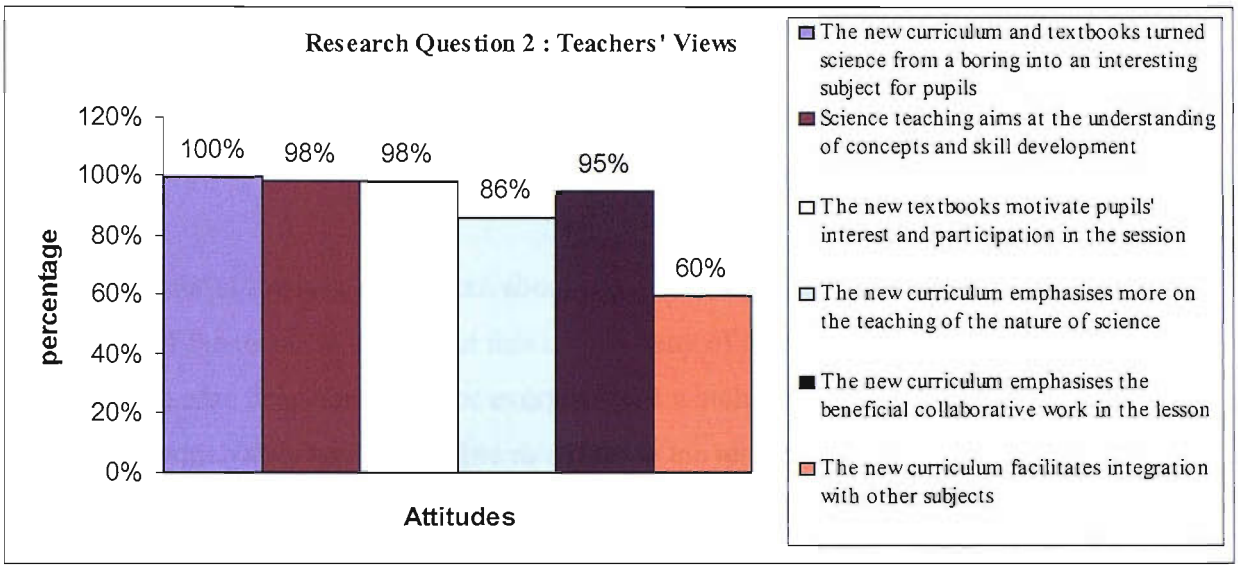

Figure 5: Research Question 2: Teachers' attitudes towards the new primary science curriculum

Even though, teachers are generally satisfied by new textbooks and new teaching procedures they have questions about its sustainability.

Guidance first of all, is an issue of the reform that teachers feel the primary science education reform designers did not pay attention to. The majority of them (94 per cent) feel that they are not provided with sufficient guidance and support to acquire competence or accomplish these challenging tasks. They emphasize the need for systematic informative and support programs specifically for science teachers, who are expected to implement the particular reforms. One teacher proposes that every school community should designate:

> "*...an educator to be responsible for the overall effective application of the reform in a continuous and proper way*" [teacher 38].

These teachers are clearly dissatisfied with the existing conditions and opportunities for professional development, which in their opinion is limited, rare and does not provide the actually required solutions.

Teachers also say that the new kind of primary science teaching requires a new type of classroom organization and management. It requires a huge effort to maintain order and good discipline during science lessons, not only to secure effective teaching and learning but also to ensure that all matters associated with health and safety are observed and accidents and injuries are avoided. One teacher suggests:

> "*... if we could have a tape, a video, some audio material ....this is exactly what we lack. Equipment. A laboratory, a projection room. In our school there is one laboratory but it also works as a library and a classroom...*" [teacher 12]

Comments about the lack of concern about the necessary equipment in schools are not rare. 96% of the teachers talk about this issue. Many of them (77%) point out that this is not only the case for science but for every subject which consequently carried out in the classroom which they find unsuitable as a place. One teacher characteristically complains:

> "*How can we do experiments in the classroom? It is a mockery. Classrooms are not a place to carry out experiments. We need a laboratory for that*" [teacher 18]

Many teachers (62%) claim that equipment in their school is so poor that most experiments are conducted 'verbally' and results are just presented by them. It is also suggested that some visits to factories, exhibitions and professional laboratories would be very useful in enriching the pupil experience. Appropriate classroom layout and good use of space, appropriate selection and use of resources, good control of group working, appropriate use of computers and good organization of displays, are all teaching skills associated with the new teaching approach.

Another problem frequently mentioned in teachers' answers about the reform is the issue of time. 87 per cent of teachers describe that the time allocated for the science subjects is limited if the lesson has to be carried out through the approach that the new primary science curriculum reform promotes. One teacher says:

> *"We need more hours of science teaching per week. In 45 minutes that they last it is impossible to carry out 3 or even 4 experimental ... that is what we have to do. We can't. We can do one and if we rush maybe 2"* [teacher 19].

While describing the time pressure a teacher characteristically mentions that due to this problem *'science is the only lesson that students have no time to talk between them'* [teacher 9]. Along that, many teachers (73 per cent) claim that they have great difficulty

in trying to manage the whole class, the groups and the individuals working on science activities. As a teacher complains:

> "*...all those tasks, the experiments, require that the students will work in groups. This is never as easy as it seems.... Children have a hard time co-operating. Besides, it requires huge amount of time spent on preparation of lessons...*" [teacher 8].

These teachers claim that there is also limited time for lesson planning and for investment in opportunities for further training or professional development.

Moreover, almost many teachers (78 per cent) claim that they have no time to examine pupils' misconceptions about natural phenomena and scientific ideas.

There is a variety of other points mentioned by the teachers around the difficulties that they come across when implementing the reform. Some teachers (35 per cent) for example claimed that they had problems with the experiments since:

> "*The book sometimes does not clarify quantities... how much salt, or soda do we use? So when carrying out the experiment we cannot get the result we actually want*" [teacher 3]

This problem is related by the teacher to the issue of time for preparation and further training. Another problem mentioned by three teachers had to do with specific parts of the contents of the new book and the new curriculum, because in their opinion:

> "*... there is no point on trying to teach the ions to primary school students. Some chapters have to be removed from the book*" [teacher 53].

Finally, while explaining the efforts done to implement and use integrating activities in the lesson, a teacher says that there is the barrier of:

> "*...limited and difficult access to laboratories, ecosystems, parks, museums and other places that the students must visit within these tasks of integration*" [teacher 60].

In conclusion, teachers express satisfaction towards the new primary science curriculum and the textbooks. They approve of the kind of science teaching it promotes. They describe that science, which used to be an uninteresting subject for pupils has now become one of their favourites. Teachers, however, argue that current science lessons must be organized and managed carefully and skilfully if effective science teaching and learning are to take place. This requires consideration of their professional development, the equipment of schools, time and other issues, which in their opinion are inappropriately dealt with (see figure 6).

Observations of the teachers' work in the classroom leads to similar conclusions. Teachers need a good preparation of the unit in order to carry it out successfully. Materials had to be used in the classroom so that the activities of the book were all accomplished as desired by the curriculum. The pressure of time, along with the difficulty of managing, observing and dealing with the groups of students is also seen, throughout the lesson, as well as the necessity for the teacher to be struggling when the overall conclusions and lesson point was being composed due to the lack of the learners to do it by themselves, even though this is asked and recommended by the teachers and learners text-book (YPEPTH, 2000; 2002) (see figure 6).

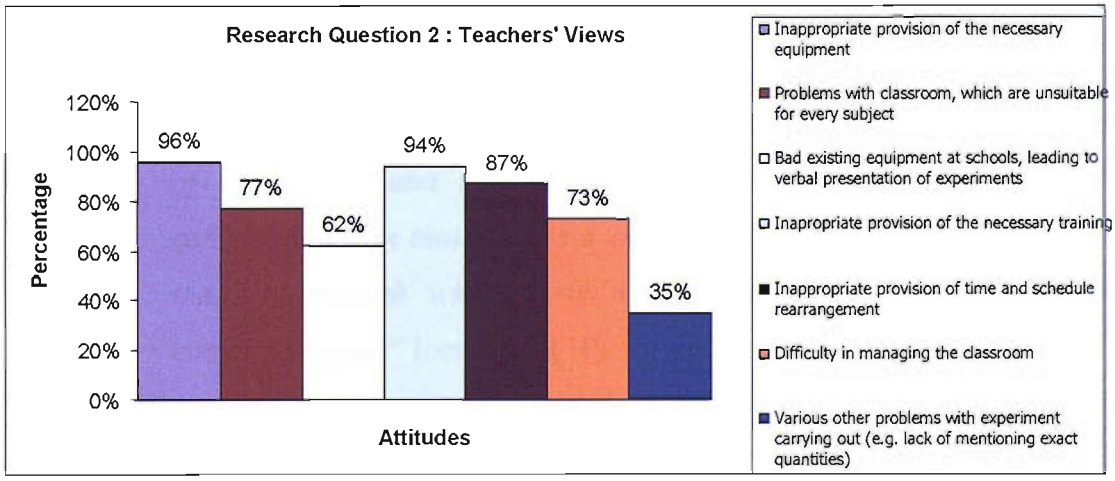

Figure 6: Research Question 2: Teachers' attitudes towards the new primary science curriculum

B. Consultants' views

As with the teachers, the consultants also approve of the new primary science curriculum and the teaching approach it promotes. When speaking about the reform though, all emphasise its impact on teachers' role.

All consultants agree that teachers are the main agents of change, as they are responsible for carrying out the instructions derived from the revised curriculum and putting them into practice. One respondent says:

> "*What has changed is the role of the teacher. The teachers' role now is to make sure that the students co-operate well and carry out the experiments ...teachers will help children in developing their scientific way of thinking, in classrooms*" [consultant 5].

Consultants expect teachers to support pupils in group work. Nine consultants express the belief that it is the teacher that should ensure that every group has their ideas exposed, and '*makes clear hypotheses and then to move on to experiments*' [consultant 4].

Six consultants wonder whether teachers' initial training is adequate to help them implement the introduced change effectively. Consultants are not convinced that teachers are adequately qualified to establish, supervise and manage practical science laboratory sessions. One respondent explains that:

> "*... the role of teachers now changes. Teachers are not any more the senders of information and knowledge to children. Their role is now far more complicated than that...this is a challenge for the teachers nowadays, to find the way through which their work would be transformed into a more complicated task*" [consultant 10].

As far as seminars and conferences are concerned these six consultants considered them as being inadequate to provide the primary teachers with the necessary information and guidance around the new approach in teaching science on a constructivist basis. One respondent says:

> "*There are every now and then some seminars, few seminars. And how much can a seminar serve? ....this is not further training.... It covers only some practical parts of the issue...*" [consultant 2].

All consultants recognize the need for the reform to be accompanied by the establishment of laboratories and teachers' training on how to use the equipment in it. They admit that sustainability of the reform and the level of its large scale impact on the educational system depend a lot on the way by which classroom activities –especially experiments- will be carried out by children themselves. According to eight consultants, managing school conditions in such a way as to provide science teachers with the appropriate supportive tools to help children participate actively to hands – on activities, is the main consideration of school management. A consultant notes that schools need equipment, referring to science laboratories, computers rooms.

Five consultants speak about the poor quality of existing school equipment and the difficulty of its use. It is suggested that school management should take care so as instructions are given to people involved in science lessons and more important, equipment should be innovated in accordance with new issues of science and technology. Class surroundings are often full of unnecessary and useless materials and resources that produce confusion in pupils' minds and disorientation of experiments and hands – on activities. Everything has to be rearranged in the school environment to encourage implementation of a sustainable reform.

Finally, four consultants speak about the problem of time that teachers face, while teaching. The time available in their opinion is 'extremely limited' [consultant 7] (see figure 7).

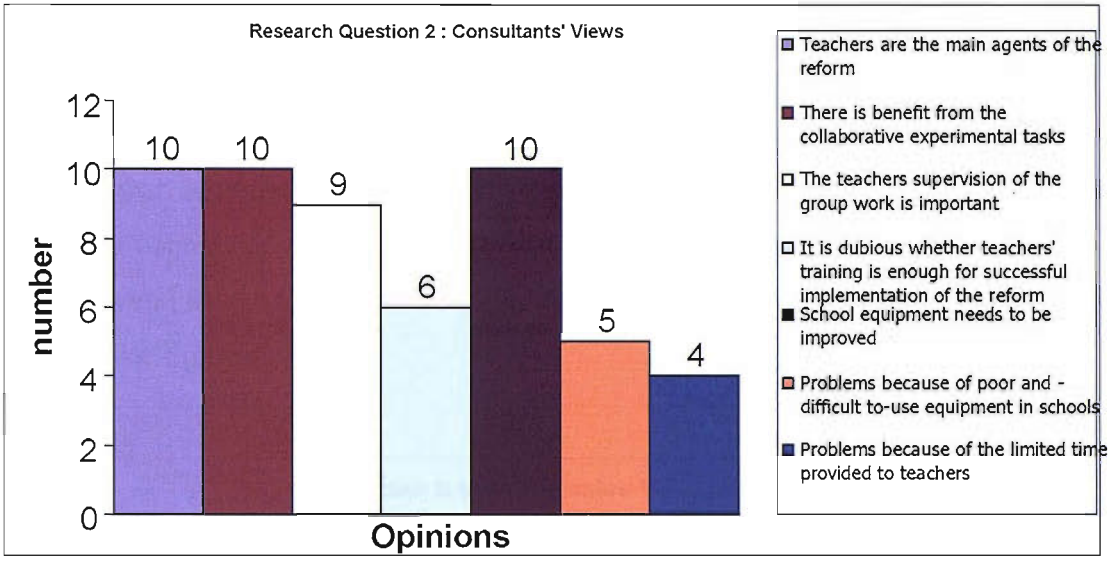

Figure 7: Research Question 2: Consultants' attitudes towards the new primary science curriculum

C. University Tutors' Views

Along with teachers and consultants, the university tutors express positive attitudes towards the reform. The five of them, who are specialised in science education, agree that:

> *"The new books take into consideration the findings of the research and do not include texts that could actually reinforce pupil misconceptions, like the old ones"* [university tutor 1].

These tutors also approve of the type of science lesson, based on simple experimental tasks, which need materials that can be easily found.

All tutors say that the new primary science textbooks promote cross-curricular activities and like the lesson with the pupils' every day experience, which they consider important.

There are however doubts among all tutors about whether the reform is really applied in the classrooms. Specifically as a tutor describes:

> "*The lesson is supposed to be taking the pupils experience into account. Now, what really happens in the classroom? I don't know, I can't say*" [university tutor 2]

Moreover, two university tutor express doubts, firstly about the effort of the reform to promote the constructivist approach, as the way lessons are required to be done was '*simply an improved version of the traditional model*' [university tutor 3] of science teaching that does not permit in-depth examination of pupils' misconceptions, secondly about the content of the book as some chapters that referred to issue as '*the nuclear energy* [were] *unsuitable for primary school children*' [university tutor 1] and should be omitted (see figure 8).

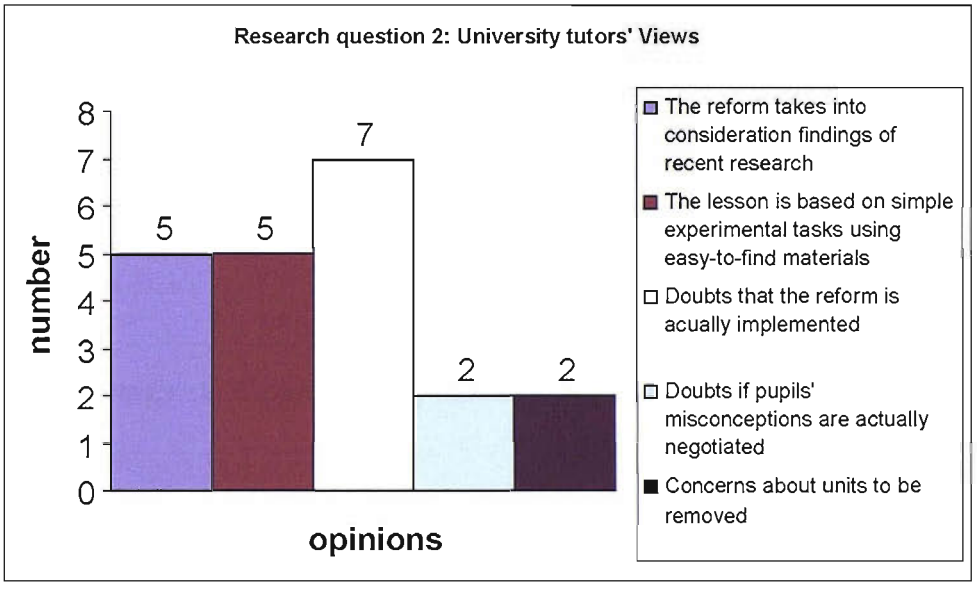

Figure 8: Research Question 2: University tutors' attitudes towards the new primary science curriculum

D. Policy Makers' Views

All 3 policy-makers say that the new textbook has taken consideration of findings of research around science teaching. They emphasise that the aim of the new textbooks is to motivate students to participate "*with enthusiasm*" in the lesson and "*construct new knowledge by themselves*" (policy maker 2).

They state that no new kind or method of teacher training was introduced along with the new primary science curriculum. However, one of them states that there is "*discussion*" [policy maker 3] about this issue as it the effectiveness of the already existent opportunities is questioned.

Around the issue of school equipment they reveal that there was no concern about it, as the tasks and the experiments included in the new books "do not require special equipment" [policy maker 1] (see figure 9).

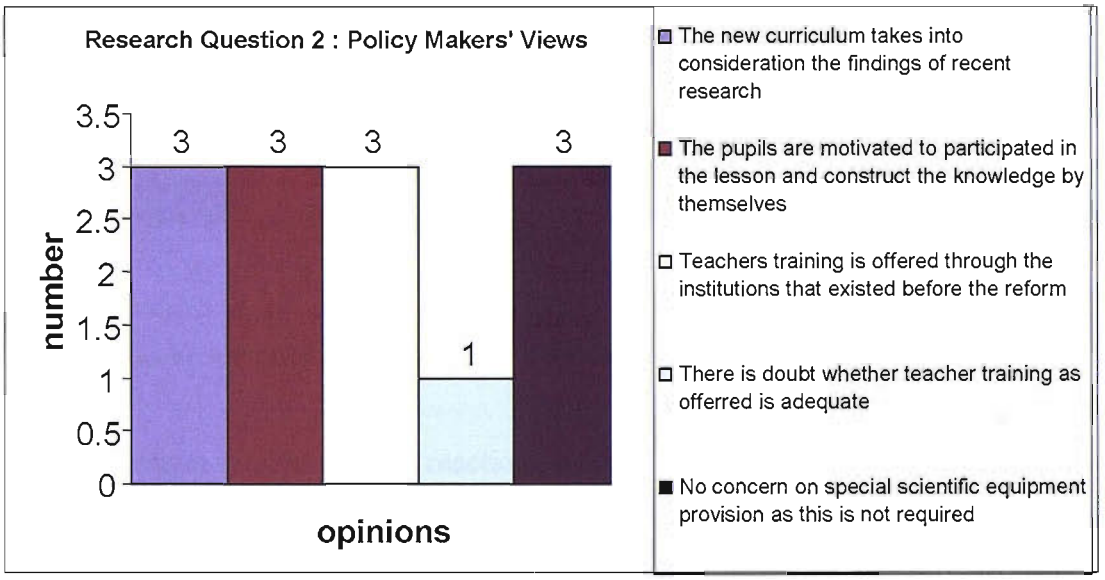

Figure 9: Research Question 2: Policy Makers' attitudes towards the new primary science curriculum

E. Pupils' Views

The answers of pupils justify the comments of the teachers concerning the positive reactions of the learners towards science. All 312 (100 per cent) pupils included science among their favourite and most pleasant subject. Observations of their attitudes in the lesson also show enthusiasm expressed by them. The pupils show that for no other subject. 73 per cent of them say they like language, 71 per cent mathematics, 77 per cent geography, 70 per cent history and religion, 53 per cent Politics, 85 per cent arts, 86 per cent gymnastics and 80 per cent English (see figure 10).

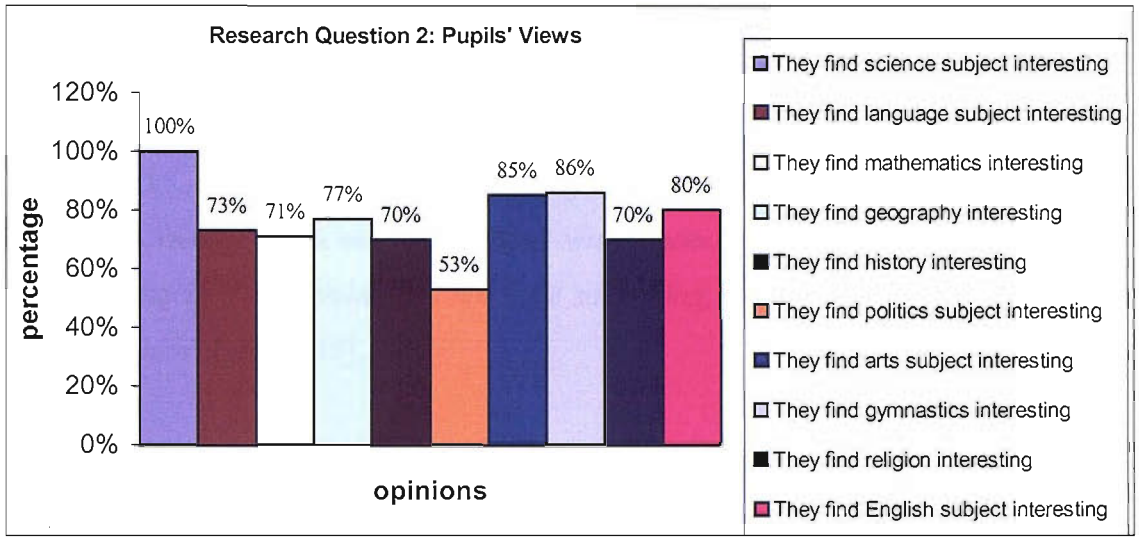

Figure 10: Research Question 2: Pupils' attitudes towards their subjects

The main reason for that positive reaction on their behalf is the practical nature of the unit and the wide variety of practical tasks that are included in textbooks. When describing science lessons, every student starts by saying "*we are doing experiments*", assuring this way the responses of the teachers who refer to an emphasis on practical activities as means to construct the knowledge.

While explaining what exactly happens in the classroom, 253 pupils (81 per cent) make no mention about negotiation of their beliefs and misconceptions around the phenomenon studied at any time throughout the lesson. They state that they simply gather the materials required follow the instructions of the experiment as written in the textbook, in order to come up with the conclusion that they write in co-operation with the teachers. Only 59 pupils (19 per cent) state that the teachers usually ask them to form a hypothesis based what they believe will happen, which they discuss after having accomplished the experiment. One pupil says:

> "*Usually we write on the board what we expect to happen, before starting the experiment. If we have time at the end of the lesson, then we discuss about what we found and if it is not what we wrote, why it ... why it is different*" [pupil 60].

All pupils also justify that there is time pressure, as they say that most of the time they can do only one or at the maximum two experiments per session and not all three or four, which are included in the textbook.

268 pupils (86 per cent) mention that they carry out the lesson in the classroom, which sometimes is a problem for them. More specifically one pupil says:

> "*...sometimes we spend a lot of time in the beginning, to fix the desks to arrange ... to see who will sit with whom, to see if we have everything we need, if any child does not have something, to see if anyone has extra to give him*" [pupil 119].

Among those, seven pupils (2 per cent) say that they had heard that their teachers or parents are working out the problem of finding or establishing a laboratory. At present though, only 31 (10 per cent) pupils mention that move to a different room, for the science lesson, which is specifically organised for that unit, because '*It is a big room... we have all the materials there... there is also a projector*' [pupil 119]. There are twelve pupils (four percent) who say that they don't move to another room because their classroom is the schools science laboratory. This situation supports the teachers' statements about the issue of the equipment (see figure 11).

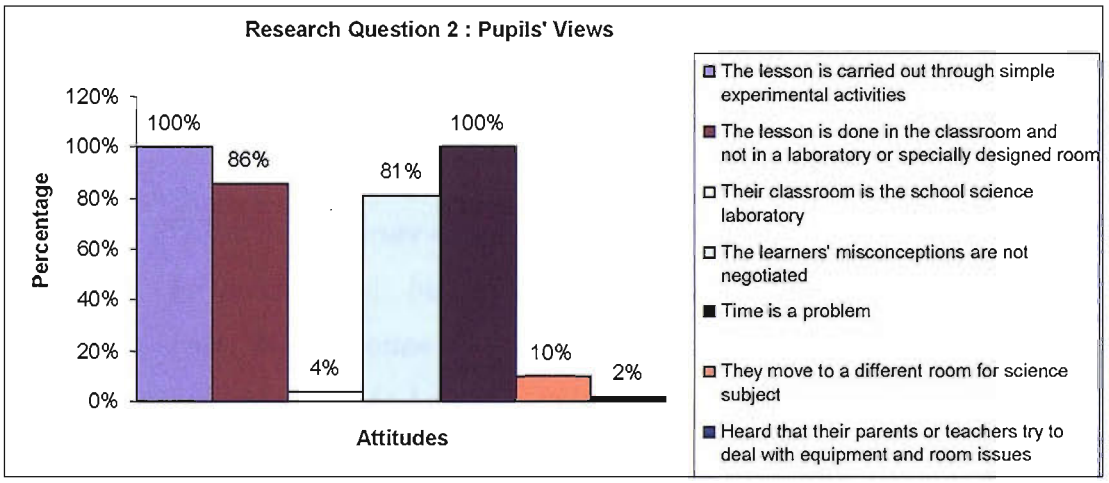

Figure 11: Research Question 2: Pupils' attitudes towards the new primary science curriculum

F. Parents' Views

Along with teachers and pupils, 91 per cent of parents express positive attitudes towards the new science text-book, which they also consider attractive, well-structured with small texts without difficult vocabulary, enriched with nice visual material and full of '*simple, harmless and easy-to-do*' [parent 3] activities. Only 4 (5%) say they are not satisfied and 3 of them (4%) not very much satisfied. The others claim that all these traits make science lesson interesting for the pupils and the construction of new knowledge easier. Moreover, they believe that it makes it easier for them to help their children. As one parent says:

> "*The book of science is very nice. It is thick, very thick. You cannot imagine how much children love it. ... the lesson is done through simple experimental tasks that the children do ...these are easy things that the child sees or does at home every day ... although the teacher has to meddle sometimes... but it is easy. When I was at school science was the most difficult and boring subject. My child's book is not like that*" [parent 18].

Despite the fact that new textbooks satisfy parents, complaints are not missing. About half the participants (53 per cent) claim that the structure can sometimes create difficulties in their effort to help the children study. A parent explains that by saying:

> "*I like the structure of the book and the fact that the conclusion has to be made by the children... but sometimes, if the child has not written something in the book, has forgotten to note it in the lesson, then he cannot study. I think it would be nice to have the conclusions typed in the book sometimes*" [parent 10].

Moreover, 64 per cent of parents present negative comments about the issue of the limited school equipment, due to which parents have to make sure that the child has the necessary materials for the lesson, before leaving, which according to a parent:

> "*... is not something difficult. I mean these materials we always have them. But it is annoying sometimes, we have to make sure the child has the books, the*

notebooks, pencils, everything in the bag... now we have to check the materials for the science lesson too. It can be tiring" [parent 56].

Generally though, parents' answers reveal their enthusiasm towards the reform in the curriculum and the new science textbooks (see figure 12).

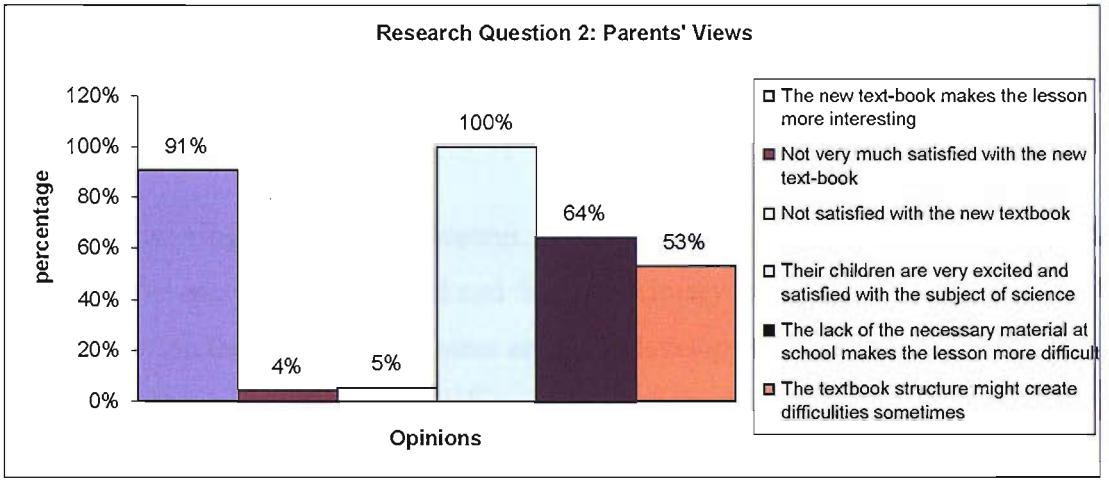

Figure 12: Research Question 2: Parents' attitudes towards the new primary science curriculum

3. RESEARCH QUESTION (3): THE DIMENSIONS OF THE REFORM

Teachers, head-teachers, consultants, university tutors, policy makers, secondary science teachers and parents express that the change was limited only to the primary science curriculum and textbooks which was not enough for a systemic and sustainable reform, which can affect deeply the educational system (Fullan, 2001a). Their opinions are presented analytically below.

A. Teachers' views

When answering the relevant question, most of the teachers (85 per cent) mention that the major difference between the old and the new primary science textbooks is the emphasis of the new on the use of experiments and skill development in the lesson. This is justified also from the new textbooks, which contain 120 experimental activities while the previous ones had barely 30 (YPEPTH, 2000).

Another difference, mentioned by 64 per cent of the teachers is the links with everyday life, which according to the teachers is done better with the new primary science curriculum. Moreover, 45 per cent of teachers mention that the new textbooks and curriculum emphasise on pupil misconceptions. These are the same teachers who include the need to introduce misconceptions and constructivism as a reason for the reform.

Ten teachers (eight per cent) mention that the new textbooks contain more group activities. Five per cent of the teachers mention that the new textbook emphases concepts.

Other 3 (2 per cent) teachers mention that the science lesson with the new textbook is like "research type lesson" [teacher 2]. One teacher (1 per cent) mentions, "pupils now learn language" [teacher 8] instead of science (see figure 13)

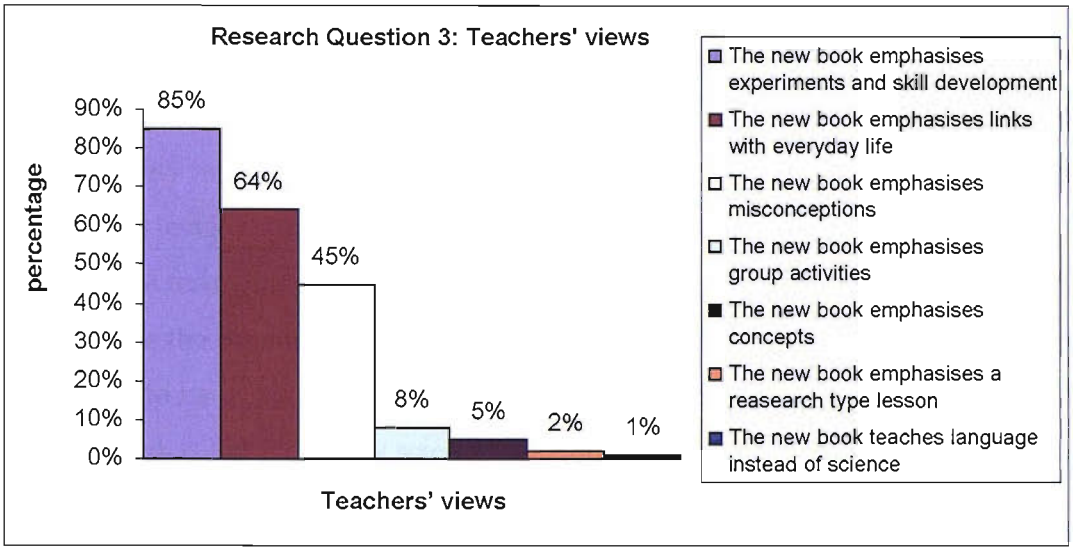

Figure 13: Research Question 3- Teachers views on the difference between the old and the new primary science curriculum and textbooks

Nearly all teachers (96 per cent) who share the philosophical and pedagogical principles of the primary science education reform in Greece and are aware of its potential impact on the improvement of student understanding, admit that the change has not been accompanied by broader reforms across primary education.

According to the majority of teachers (91%) effective implication of the primary science education reform requires broad school reorganization, provision of and space for laboratories and better equipment, as well as systematic guidance. As already described in the last question, according to teachers, none of these issues are affected by the primary science reform in Greece, which concerns only the curriculum and the text books.

85 per cent of the teachers claim that there is a much uncertainty around assessment. Every teacher makes some suggestions concerning assessment of both teachers and pupils, about which nothing specific and official had come down to schools. There is no evidence –at least according to teachers - that any kind of assessment is planned as far as near future is concerned:

> "*Assessment is a sensitive topic. It is a thorn for teachers…. Until now, there was no official assessment in schools. The only person who could carry out assessment was the consultant…*" [teacher 1]

At present, assessment of teachers work and of the implication of the reform of primary science teaching is a task of the consultant or the head-teacher.

The majority of teachers (65 per cent) state that they do not know whether the particular reform can help the primary students perform better in the secondary School, where demands ought to be high. Some teachers (19 per cent) reply that so far there has not been any research study that would present the relationships between the primary and secondary levels as far as science teaching on a constructivist basis is concerned. Similarly a teacher mentions that neither the secondary science are aware of the science teaching in the primary level, nor primary school teachers are informed of what pupils are supposed to know about science when entering the secondary level. Another teacher notes that as long as the secondary science demands memorisation of concepts and as long as the whole educational system is examination-centred, the reform will not have a long enduring impact on school life.

In short, all teachers agree that the implication of this particular change concerning the curriculum, the textbooks and the teaching process of primary science should have been carried out within a framework of established procedures ensuring clearer guidance about the ways in which the subject is to be taught, better planning and more instructions about the classroom management. Moreover, they point out the need for providing and managing resources for the activities to be done effectively as well as for appropriate training enabling teachers to monitor, evaluate and check on the whole progress. Considering all these aspects will certainly require the head teachers and principals to set priorities and to manage the school time well. A well-organized change implementation that provides for progression and continuity in pupil's learning and coverage of all aspects of the Curriculum requirements needs systemic policies and schemes of work providing individual teachers with instructions about what to teach, how to teach and when, and how to integrate science with other primary subjects (Fullan, 2001a). However, contrary to the majority one teacher states that:

> "*Only the teacher alone should find the way in which the new method of teaching science will be applied .... Neither material resources, nor books or anything else will improve educational life, unless the teacher finds the best methods to introduce the meanings of science in the classroom in such a way as to challenge the young people's interest*" [teacher 119].

That means that teachers should be the real managers of educational change leading to the improvement of learning (see figure 14).

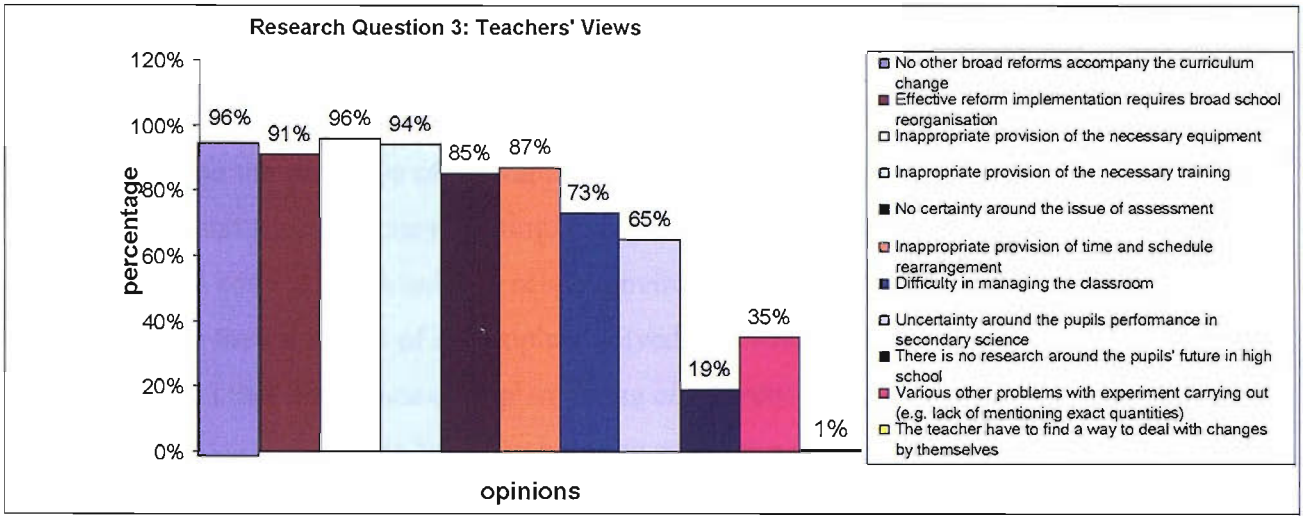

Figure 14: Research Question 3: Teachers' views on the dimensions of the reform

B. Consultants' Views

All consultants believe that the new difference between the old and the new curriculum focuses on the emphasis of the new one on experiments. Six mention that the new textbook contains more group activities (see figure 15).

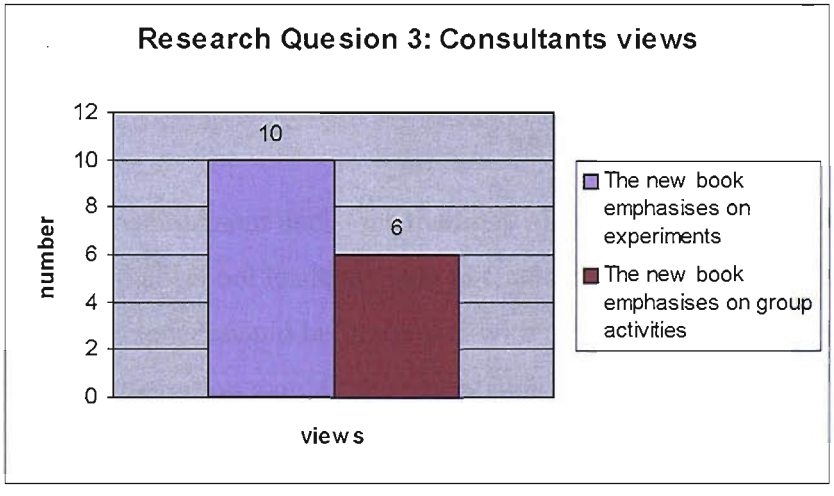

Figure 15: Research Question 3- Consultants views on the difference between the old and the new primary science curriculum and textbooks

The consultants' responses show that no other changes are accompanying the particular reform imposed in the primary science. Thus, its effectiveness and durability depends

totally on the capacity of the existing basic structures of the educational system to put into practice the new approach as it is introduced by the current curriculum and according to the instructions derived from the central educational authority. All consultants relate the implementation of change with the potential enrichment of material resources and laboratories and the provision of relevant programs for teachers' professional development and supplementary training. In any case, the reform is implemented by teachers in the context of the existing school environment throughout the country, and for the time being the initiatives of all people involved in science education for the change, are focusing on the importance of implementing effectively a new teaching strategy in the classroom, which would be in harmony with the recent theoretical issues related to the promotion of scientific literacy based on the constructivist model of learning. Namely, the general interest and concern is concentrated on the change of the teaching strategy in the classroom rather than on the potential wider reconsidering of school management in reference to the new conception of science learning.

First of all consultants consider the existing school hierarchy as being responsible to carry out the change implementation. Referred to the teachers' training under present conditions, one consultant comments:

> "*One of the major responsibilities of the consultant is to organize seminars for the teachers. During these, the teachers can watch some exemplary teaching sessions and the exchange of thoughts is being encouraged...*" [consultant 4].

As for management decisions that may affect reform implementation, seven consultants believe that school leaders can help teachers to organize activities, in the context of which, science would be integrated with other subjects, by providing opportunities in which integration would take place, such as implementation of the flexible zone or some relevant procedures such as a pilot program. A consultant states:

> "*...the ultimate aim of these programs is to make students understand that no kind of knowledge exists by itself independently from others.... And this is supposed to be taught and understood in a learning environment that is pleasant for pupils*" [consultant 6].

Referring to assessment at all levels of the educational system, nine consultants say that the issue is under investigation. They admit that attempts for assessment practices have been announced for several times in the past decade, but these policies did not seem to work out, due to the high cost of their implementation and difficulties that arise while introducing and monitoring centrally designed assessment programs.

Any six consultants agree that the new primary science curriculum provides teachers with a certain degree of autonomy to try to improve the quality of teaching processes.

Eight consultants believe that the new approach will help the primary pupils to be prepared for the science lessons of the secondary level. Only two claim that is it too early for to respond this question. The others, however, seem very optimistic around that issue. One consultant notes that:

> "*Education is a chain...it is a link strongly attached with what comes after what comes before...the new text-book prepares the pupils better not only for secondary school but for the rest of their lives*" [consultant 1].

All consultants do not expect other measures to be introduced, which would probably imply a wider and deeper reform of the system. One of them says:

> "*Every now and then we hear about measures, which are being described in vague. But nothing really happens. Probably what happens is that some people come up with ideas, they manage to get a first impression, but they need time to analyse them and present them in detail...*" [consultant 9].

It is obvious that all 10 consultants attribute the effectiveness and sustainability of the reform to the capability of teachers to adjust their strategies to the new instructions and guidance provided by the curriculum and the existing school authorities. They are conscious of the difficulties and financial barriers that prevent the learning environment from being supportive and encouraging. According to one consultant, there is always a great problem with the structures of school buildings throughout the country, as they cannot provide adequate space o accommodate the rapidly rising current pupil population.

They confess that there is a need for new prioritisation and new programming of space allocation in relation to the planned activities.

It is also suggested that school management should ensure that a level of flexibility and adaptability to new conditions exists, which is necessary to make the people involved feel themselves free to accept critically new attitudes and perceptions either in the theoretical or in the practical level. Besides, the teachers need to be provided with some kind of autonomy to redesign their timetable if they are to manage their time effectively in coping with the new demands. A respondent suggests that to avoid waste of time the school management should often call specialized scientists to come and give useful guidance to teachers and students about handling properly, safely and efficiently experiments and scientific processes.

Generally speaking ten consultants agree in the basic point that apart from the introduction of a new curriculum and a new science textbook more and deeper innovation and restructuring of school context must take place. According to a consultant:

> "*No change in the field of education can take place and be successful if it happens in a segmental way. It needs to be accompanied be general reform measures*" (consultant 8).

All consultants believe that the reform of primary science teaching in Greece does not presuppose a change in the role of school administrators or head teachers. Taking into consideration that it refers directly towards the application of new teaching approach based on the recent pedagogies about the child-centred learning process and the introduction of the new textbook, they admit that the change will not necessarily have a deeper and wider impact on the levels of school structure. One consultant specifically notes that:

> "*The role of the head teacher has not changed at all. The head-teacher works on a managerial and administrative post. The teaching processes and the educative part of the school have no direct relationship with the head-teachers' work*" [consultant 2].

It is suggested, by seven consultants, however, that school principals should be involved more seriously in the allocation of financial resources in such a way that would help teachers organize and manage class room group work. They also emphasise that:

> "*The role of head-teacher is more than the role of a coordinator. Head-teachers should be more sensitive in general.... But anyway the head-teacher is not actively related to issues of teaching*" [consultant 4].

In other words, the teacher has to "... *guide, consult and assist the child*" [consultant 10]. These consultants claim that it is a responsibility of the teacher to stimulate the interest of the children and make sure that they are fully focused on the lesson. Thus, according to the consultants' views the main agent of change in school environment is the teacher. Besides, teachers are responsible for the management of the flexible zone, which can serve as an opportunity for integrating science with other primary subjects.

The promotion of scientific literacy of young people depends a lot on an encouraging learning environment, which would be created through the systemic and sustainable management of human and material educational resources (see figure 16).

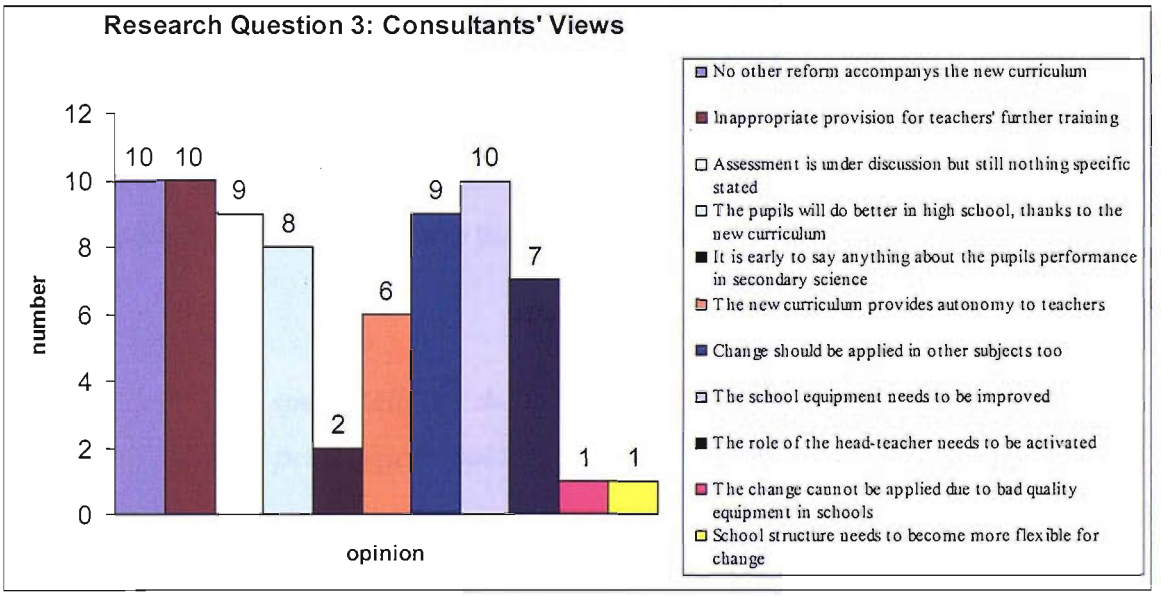

Figure 16: Research Question 3: Consultants' views on the dimensions of the reform

C. University Tutors' Views

All university tutors mention that the great difference between the old and the new curriculum is the emphasis of the new on experiments. The five of them that specialise in science education also mention the effort to introduce the constructivist approach in the lesson, while two of them also say that now the lesson is 'research based' [university tutor 1] and two of them also refer to emphasis on group activities.

According to University tutors, the major negative point concerning the reform implementation is the commencement of official assessment procedures, which they believe prevents the assurance of the reforms' progress and the identification of barriers. As a tutor mentions:

> "*How can we be sure that the curriculum needs to be change, without assessment? We are walking in blind*" [university tutor 9].

As far as the opportunities for further education provided to teachers are concerned, six of them state that there is a boom in the possibilities offered to teachers for further training, over the last ten years. They mention that there are opportunities but they cannot address to the specific needs and problems that teachers have. One tutor notes that the guidance referred

> "*...not specifically in the books, but generally about science education or general pedagogical topics*" [university tutor 2].

They emphasise though that this kind of training takes place within the already established institutions. There is no measure to accompany this change that aims to enhance the opportunities or methods for teacher support (see figure 17).

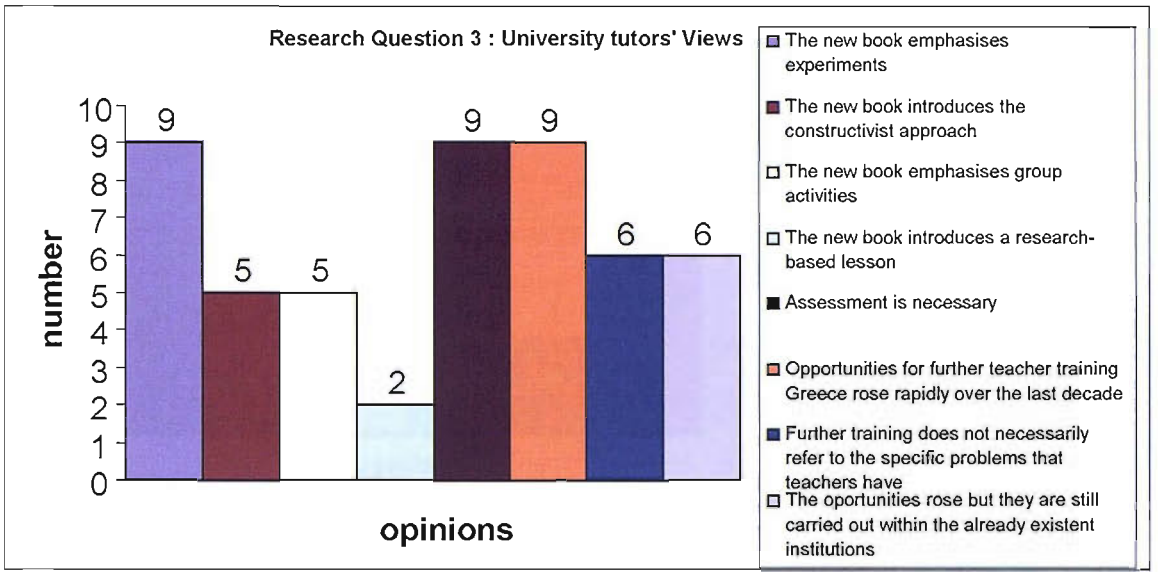

Figure 17: Research Question 3: University tutors' views on the dimensions of the reform

D. Policy Makers' Views

All policy makers mention, as do the other groups of participants that the main difference between the old and the new curriculum and textbooks is the emphasis on experiments and the introduction of the constructivist approach. Two of them say that there is now greater emphasis on group activities and two of them speak about research type lesson 'policy maker 2'

As explained previously, all 3 policy makers say that teacher training is generally carried out as it was before the primary science curriculum reform implementation without any changes. One of them expresses uncertainty around the effectiveness of the existent methods of teacher training.

As far as school equipment is concerned they explain that no measures about it accompany the reform. That's because the aim of the new primary science curriculum and text-books are to focus the lesson in tasks and experiments every-day life activities, requiring simple materials and not special scientific equipment (see figure 18).

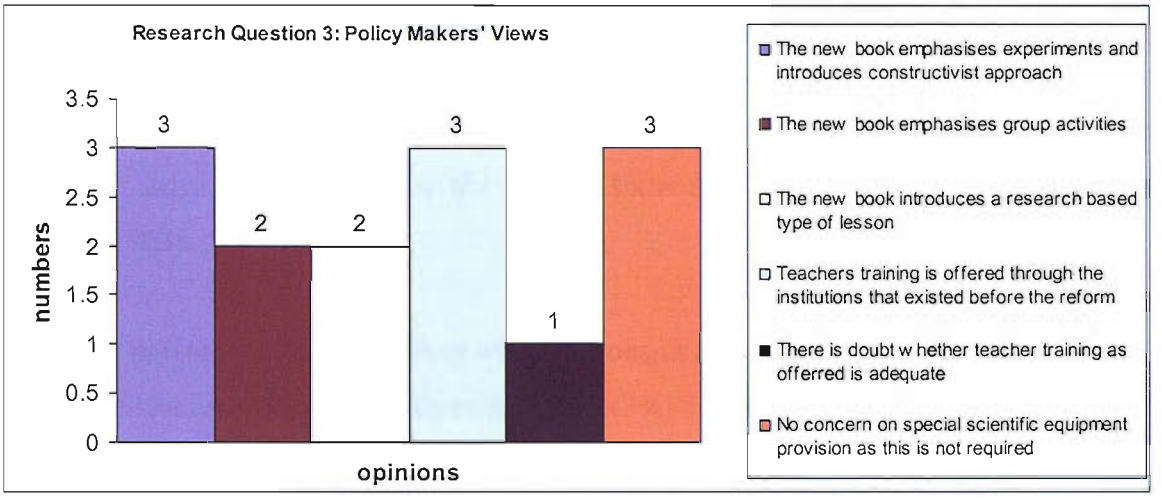

Figure 18: Research Question 3: Policy Makers' Views on the dimensions of the reform

D. Parents' Views

The majority of parents (92 per cent) say that science concerns them only as school subject and not within activities done at home. When asked they say that they don't discuss about scientific phenomena within general scientific activities. Only six parents (8 per cent), who are engineers or electricians mention that sometimes when they are with their children at home, they spend time discussing or working on activities that can be relevant to the subject of science. As they say, such cases can come up under the pretext of their work or a problem, relevant to their occupation, which can emerge at home and they need to work out. One parent describes such an example, by saying:

> "*Once I needed to fix a damaged plug. I remembered that my child had studied electricity at school... so what we did was while I was fixing the plug, we opened the book and saw everything that was in it, all the experiments that the child had done in the classroom ... the child saw how it is in reality*" [parent 31].

Even those parents, though mention that most of the time, when children make enquiries relevant to science and phenomena they sees in everyday life, the advise they usually give them is to ask teachers at school, since:

> *"The teacher knows better. If we try to explain anything, we might confuse the child. And this is not only in science but every subject... we might say something that they have not said at school or have said at school in another way. This will confuse the child. I know it because it has happened"* [parent 63].

Only four parents (5%) say that they will first consult relatives or encyclopaedias before asking the teacher. Moreover, only two parents (3%) say that their children attend out-school activities relevant to science, specifically about computers. The others (97%) say that their children attend language, sports, music lessons but nothing relevant to science.

In short, according to the parents, teachers and the school environment is the main responsible person and place for pupils' science education, whereas they and the house only serve a subordinate, minor supplementary role (see figure 19).

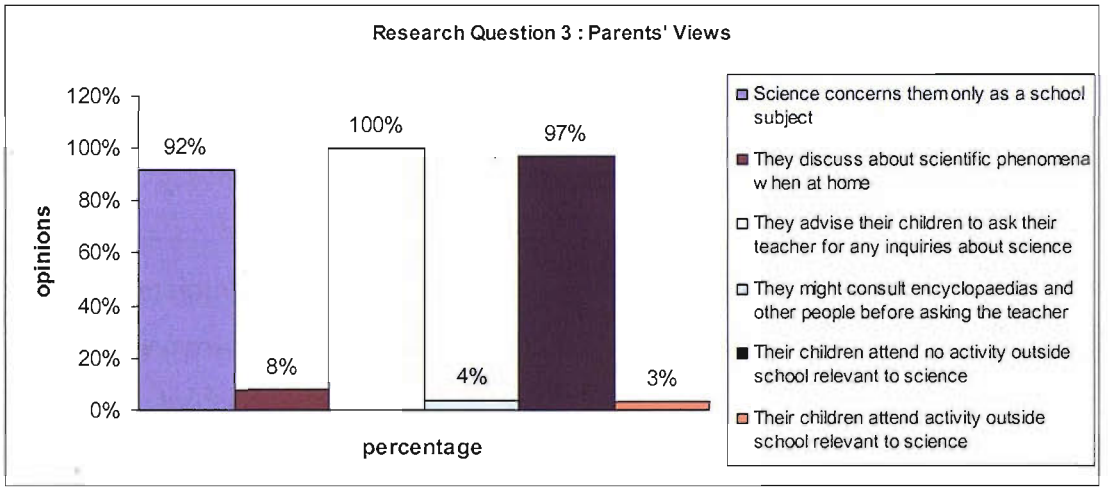

Figure 19: Research Question 3: Parents' views on the dimensions of the reform

E. Secondary School Science Teachers' Views

All secondary science teachers mention that they had been informed about the reform in primary science education, but clarified that there was no official institution through which they can learn and get information about the progress of that reform and, generally, what really happens in the primary school.

Most of them (96 per cent) believe that reform in primary science could not lead to different performance on pupils in science subjects in secondary school. In other words, primary school pupils who studied science under the new curriculum are high unlikely to perform better in secondary science, in comparison to others who had studied primary science with the old one. They directly state that they observe no difference at the performance of these students at all. As a participant says:

> "*I have students who studied science at primary school with the new book... they are at the first year and they do Biology. In photosynthesis, they still say that the plant consumes soil* [common misconception (Driver *et al*, 2000)]" [secondary teacher 4].

The vast majority of them (94 per cent) express suspicion about the actual implementation of the new curriculum and new teaching methods in primary school classrooms. One secondary teacher states:

> "*The new curriculum and text books* [on primary science] *impose the active participation of the learners through stating hypotheses, experimenting and drawing conclusions, all of which are important means to the approach of new knowledge. The question remaining, is the level at which this really happens*" [secondary teacher 21].

Many participants (72 per cent) attribute this problem not in the change itself but to the fact that the primary science curriculum is separated from the one of the secondary science. As a result change at the former cannot guarantee any change at the latter too. Particularly, one of them explains that:

> "*...having different, detached curricula, there is a gap between the primary and secondary school. If this does not change, whatever happens in science teaching at primary school, good or bad, will have little impact on secondary*" [secondary teacher 62].

Additionally, 50 per cent of them note that the problem lies in the fact that primary school teachers are not experts in science so under these circumstances the background that students have when leaving primary school will be by no means adequate to guarantee a successful performance in secondary school. An exemplary answer is:

> "*The teachers are not qualified to teach science I have seen that as a secondary science teacher, when seeing what my new students know about science and as a parent too. Their background in science subjects is limited and nobody seems to realise that unless something is done about it, no curriculum and no text-book can solve the problem*" [secondary teacher 17].

A point made by the 92 per cent of secondary science teachers, is that they never plan or carry out a lesson by taking into consideration any knowledge that pupils could already have about science and the phenomenon or the unit studied, is gained from primary school. As one of them says:

> "*I don't bear in mind any previous knowledge that they could have. That is how the curriculum wants us to work. Moreover, they don't remember many things. It is possible, only in some cases for few learners to remember something or to recall anything on the way, but very little things*" [secondary teacher 34].

A participant mentions that it is wise to consider, as this person does, that the children have '*experiential knowledge*' [secondary teacher 20] which, however referred to he misconceptions and experience pupils have with science deriving from everyday life rather than knowledge they gain from primary school. Only eight per cent mention that pupils "*have some knowledge*" [secondary teacher 3] which, as they say they cannot easily neglect and they tend to consider as satisfactory.

As far as suggestions and proposals that secondary teachers express are concerned, most of them (88 per cent) claim that there is need for provision of further education, not only for secondary but for primary school teachers as well. A participant actually describes:

> "*Secondary science teachers are specialized in science. That is what they have studied. That is a quality missing from primary school teachers, who however are more specialized in pedagogical sciences. They are more aware of learning theories and matters that have to do with teaching itself. That is something what we* [secondary science teachers] *don't have. There should be training that will balance this*" [secondary teacher 58].

There are also claims for the provision of school equipment, by 54 per cent of them. One participant actually says that there is a need for assessment of teachers and school equipment, which this person considers that is of "*bad quality, which is an alibi used* [by colleagues] *for not to do anything*" [secondary teacher 44]. Another participant mentions that changes should not only include reform in the curriculum, but should go deeper than that, as:

> "*I think that a real reform would first include a single curriculum for all levels of mandatory education and not three different separate allocations for each subject, but one single three hour session per week... I mean now the child has to do an hour of science then an hour of religion, an hour of history and two days afterwards another hour of science... we need to focus on integrating activities"* [secondary teacher 1].

Finally, 79 per cent of secondary teachers mention their mission to prepare pupils for the competitive exams that they have to sit at the end of the year and the even more competitive exams they will have to face in secondary school. They explain that because of these exams and their mission to qualify the learners for them, any effort for change in the curriculum or textbooks in primary or Secondary School is not going to make actually any difference. As a participant notes:

> "*One change we had in the secondary school was the introduction of a experiments with simple materials. But we don't do them... we have to cover the units that the children must know for the exams*" [secondary teacher 9].

In summary the secondary science teachers, in spite of the fact that their ideas about science teaching are similar their colleagues at primary school and the aims of the new primary curriculum, express disbelief that the change in primary school is a guarantee for better performance on behalf of the students. In fact, they express greater disbelief towards the work done at primary school generally, as most of them do not take it into account, when teaching science to students as soon as they enter secondary school. As seen from their suggestions there is a need for greater reform to the organization and structure of the whole educational system (see figure 20).

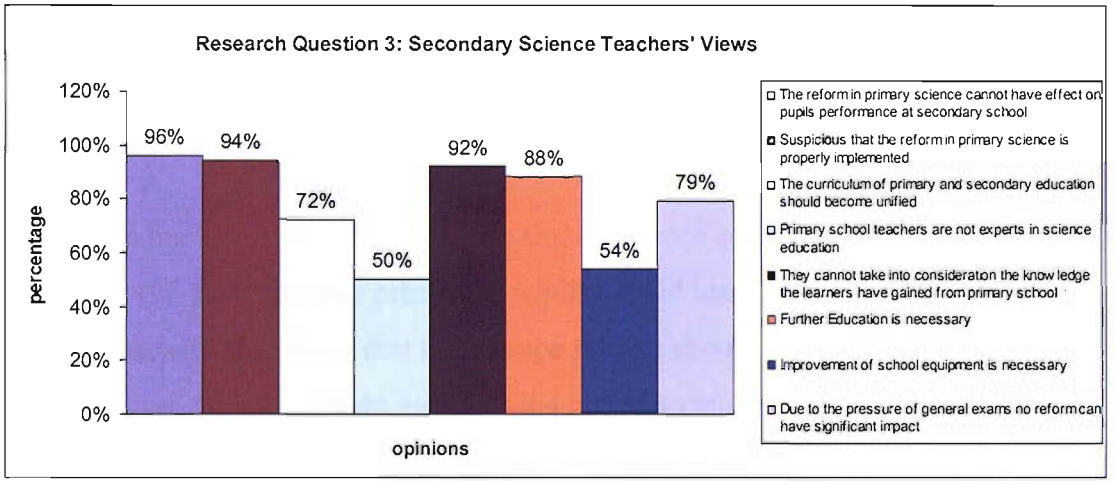

Figure 20: Research Question 3: Secondary Science Teachers' Views on the dimensions of the reform

4. RESEARCH QUESTION (4): THE MANAGEMENT OF THE REFORM AND ITS IMPACT ON THE PUBLIC UNDERSTANDING OF SCIENCE

In this final research question, teachers, head-teachers, consultants give evidence on how they manage in a case of reform, in order to help it assure its proper implementation. They explain how they try to deal with issues as a) the reconsidering of the management of time, b) the possible alterations of beliefs and the re-culturing of the roles of the people involved in the implementation of change, c) the opportunities for teachers' professional development, d) the level of the public understanding of science and e) the quality of the cooperative climate of school environment (Fullan, 2001a; Bush & Middlewood, 2005). They also show if they treat these problems as their 'friends' (Fullan, 2001a).

Finally, along with university tutors, policy-makers, secondary science teachers and parent give evidence of their ideas around the scope and aim of science subjects.

Their opinions are described analytically below.

A. Teachers' views

As far as the teachers' view about the aim of science subject is concerned, most of the teachers (98 %) claim that primarily, pupils should learn about concepts and phenomena. Many teachers also claim that the science subject should help pupils develop skills as observation, critical thought and carrying out experiments (93%), appreciate the contribution of science in everyday life (89%) and learn how to learn by themselves (83%).

The rejection of misconceptions is, as a dimension of the science subjects is mentioned by 73 per cent of the teachers.

Most of the Greek teachers though (75 per cent) when speaking about the aim of science subject, they tend to emphasise that the aims they describe are what 'the curriculum demands' [teacher 5] (see figure 21).

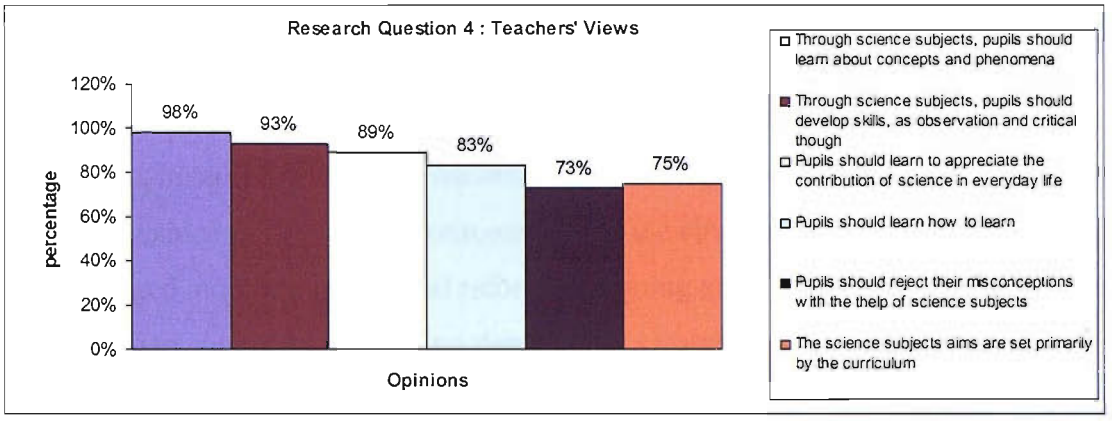

Figure 21: Research Question 4 –Teachers' views on the aim of science subjects

Teachers were asked to comment on issues about the implementation of the reform in the existing school structure. Referred to the problem of time management 87 per cent of teachers claim that it acts as an obstacle to the implementation of change since there is not adequate time to follow the new teaching patterns and accomplish their tasks effectively.

Shortage of the necessary materials and equipment means waste of time. When items are not enough they have to change hands. Moreover, lack of a permanent school laboratory in most cases makes the whole process time consuming, difficult. Besides, new teaching approach requires group work that means class reorganization. Usually, arranging the desks in a given space for group activities takes considerable time at the beginning and at the end of the session. Group work also needs supervision, feedback, intervention and direction at the same time. Lack of school space in relation to the problem of time makes the current science lessons planning more complicated task than the traditional system, where results of experiments could be announced in few minutes.

These teachers say that they try to conform to official instructions within the given framework of school time and resources. Claiming that they have to spend much more time in classrooms than the time predicted by the curriculum, and being not able to answer all kinds of questions during an actual lesson, they ask for guidance and help. They say that organized seminars usually do not refer to specific problems, such as time pressure. Instructions referred to lesson planning are often useless, since they are disseminated to schools at the wrong time. As a result, teachers confess that – contrary to the philosophy of the reform according to which students are not to be passive receivers of information - they help pupils when carrying out experiments to get earlier to conclusions, they set the experiments as homework, or they ask pupils to stay in during

the breaks in order to accomplish the demanded activities. More important, they confess that they have not time to think about integrating science with other subjects.

As for the reforms' possibility to contribute to more effective time-management strategies, in terms of learning outcomes and school culture (Fullan, 2001a), answers show that since as the school environment and the structure of the learning context have not changed, no deep or essential reforms are going to be invented and implied. Teachers are trying to cope with curriculum demands in a framework of existing traditional timetables and behaviours. Lack of materials, equipment, laboratories, proper space for student group-work and inefficient teachers' training means that despite the enthusiasm about the reform, it is doubtful whether learning outcomes will ultimately be improved.

In short, teachers argue that the time allocated for science instruction is not adequate to support the new processes. In their majority, they feel that for better outcomes, more time is needed both for planning and instruction. Regarding their roles as members of the school community, the reform does not seem to serve as a stimulus for changing attitudes and beliefs. Teachers do not feel responsible to act as managers or researchers in organising school time. They feel that their mission is limited only as providers of new knowledge to pupils.

As far as alteration and development of the teachers' roles is concerned (Fullan, 2001a), the reform does not seem to have changed traditional roles or the school culture, in general. Teachers, (99 per cent) still feel that they are called to do their job - maybe in a different way or in a more active classroom climate – but they do not behave as having upgrading roles in the learning community. They feel that they need more instructions and more guidance and, they rely on head teachers or consultants.

More important, 95 per cent of teachers do not seem to be aware of their roles as school leaders. According to the law, they are members of a council that has administrative responsibilities. They are supposed to meet formally at least once every three months and in the meantime whenever a theme to be discussed arises. The teachers' council should design strategies for effective implementation of educational policies, good management of school functions and improvement of school life. It is also expected, to manage budgets for equipment and establishments and to decide upon the importance and priority of necessities and demands (YPEPTH, 1985).

93 per cent of teachers do not seem to be aware of the potentials for school improvement by exploiting the on going programs supported by European Union. The links with the European Community could provide schools with significant opportunities

to participate in educational studies, which can support educational practices especially in association with the development of Information and Communication Technologies. The teachers' council could be an effective link between schools and the European Union, by being aware of available programs, responding to calls for participation and submitting proposals on the basis of specific needs and potentials of schools (EURYDICE, 2002). (see figure 22)

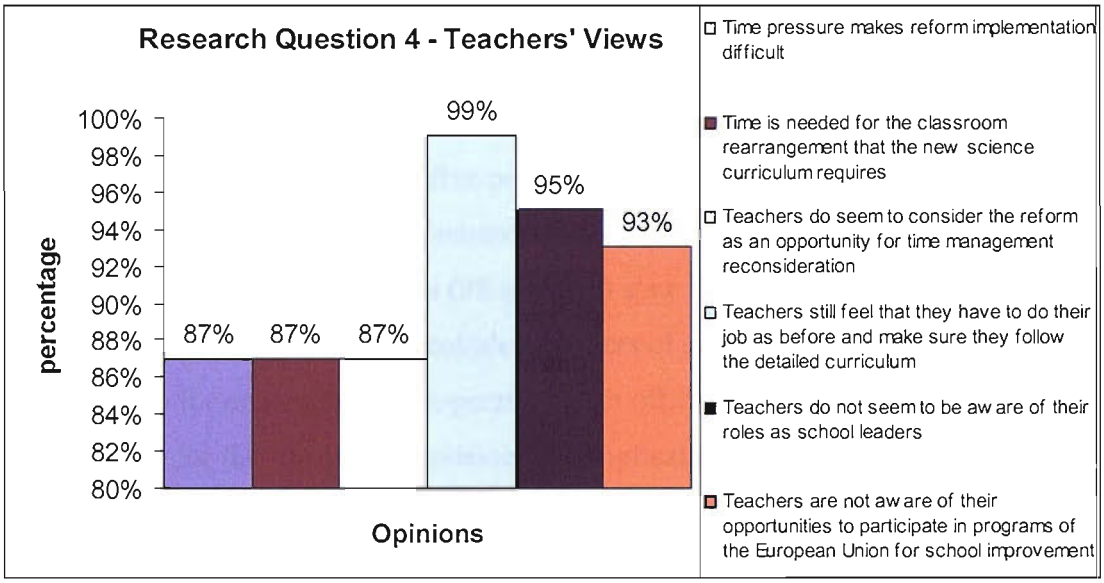

Figure 22: Research Question 4 – Teachers' views on the reforms' impact on time management, teachers' roles and professional development.

Their communication and collaboration with colleagues, as the 87 per cent of them describe, is done in a non-systematic way, and they do not seem to initiate new forms of communication, with authorities, apart from participating in seminars, or filling up questionnaires at the end of the year. A high percentage of teachers (96 per cent) also admit that they are not aware of any channels of systematic cooperative relationships among colleagues within school environment, which can support the application of the recent reform effectively. Apart from traditional ways of communication and in service training opportunities, teachers do not know whether there are any means through which additional information or detailed instruction could be given to them by policy-makers, governmental resources or experienced instructors. Many teachers (59 per cent) mention that they address consultants when facing specific problems for relevant information and

advice. The consultants, according to them are mediating between them and the decision-making bodies. However, they are not very satisfied with this method of communication.

However, as 44 per cent of them say, there are no formal barriers in trying to address to the Pedagogical Institute or to other organization for information. Only six per cent of the teachers state that they take advantage of Internet and other technological facilities to become more active and more efficient initiators of the change in their profession and consequently of the school image.

As for cooperation and communication with colleagues and other members of the community, most teachers (95 per cent) admit that there have not many opportunities for discussing and exchanging ideas and they ask for pilot programmes and more detailed guidance. Only a few teachers (five per cent) say that they collaborate productively with other teachers and school administrators.

Similarly, many teachers (98 per cent) state that neither the Pedagogical Institute nor the Ministry of Education provide members of school communities with any opportunity for contacting or cooperating with official policy makers and people responsible for the formation, revision and implication of the curriculum and teaching programs. They state that they really need more information, more detailed guidance and more support in practice. A teacher writes:

> "*New programs for communication, training, professional development, evaluation and monitoring procedures should be introduced to support the reform and make all people involved in the process of change share the new goals and orientations of the current curriculum*" [teacher 75].

Another teacher claims that information and detailed guidance come to school community always in delay and usually in an insufficient way at wrong times. Besides, there is never any direct contact that could be helpful and supporting for the people involved in the application of the reform.

Generally speaking, it is widely agreed among teachers that all changes and reforms are centrally designed and planned, without taking into consideration the need for disseminating their philosophy, their goals and their recommended procedures to the people of all levels of the educational system, who are responsible to embody effectively

these changes in the school life and work towards improving the student learning outcomes.

Besides, many teachers (84 per cent) admitted that they have no idea whether there are any on going programs of professional development other than mandatory seminars, which they could attend. Similarly, half of respondents do not know whether there are going to be applied any assessment policies, which they relate to the issue of professional development, regarding teachers' performance or students learning outcomes. Even these respondents who answered positively, they expect the assessment procedure to address students rather than teachers tasks.

Their views are still governed by the idea that instructional time is of singular value that teachers behave as knowledge deliverers, that instruction is basically textbook-centred and that decision-making rests at higher levels of authority.

It is therefore widely agreed among teachers that there are difficulties in managing classroom activities and making students work together because of the lack of laboratories, equipment, and appropriate space and time for hands-on activities, group working, observations and experiments. The reform does not seem to have any impact on the way teachers traditionally conceive their roles. They still seem to feel comfortable with waiting for guidance, detailed instruction and support rather than with trying to participate in decision-making and planning.

Teachers' answers indicate that the reform has not affected school structure. The channels of communication, patterns of consultancy and opportunities for collaboration, evaluation and professional development remain the same. Even the flexible zone that could inspire a cross-curricular and challenging organization of teaching seems to be faced as a routine centrally directed activity.

In general, most teachers (98%) claim that they cannot participate in decision-making and they are afraid of introducing new teaching strategies or the use of information technologies in the classroom. In fact, they do not seem to explore the most efficient ways to use whatever time is available. Regarding professional development, teachers confess that although they believe that professional development should be an integral part of their own life, because of their overload routine, they cannot manage their work time so as to participate in professional development programs. In their majority, they attend short-term training programs and they cannot devote more than five hours per week in studying and learning. Most teachers read books and articles of educational

interest, but only few of them use to address the Internet for information. Most teachers (98 per cent), also, consider the short lasting seminars and conferences as the more convenient instructional resource, because they do not require much of their available time.

At first, almost half of the teachers (52 per cent) claim that they have not received any systematic instruction about new strategies in teaching science neither have they been provided with information about requirements of new methods. The rest of teachers admit that they have attended certain seminars about new teaching perspectives, which were rather of a routine character and proved to be not of much help (see figure 23).

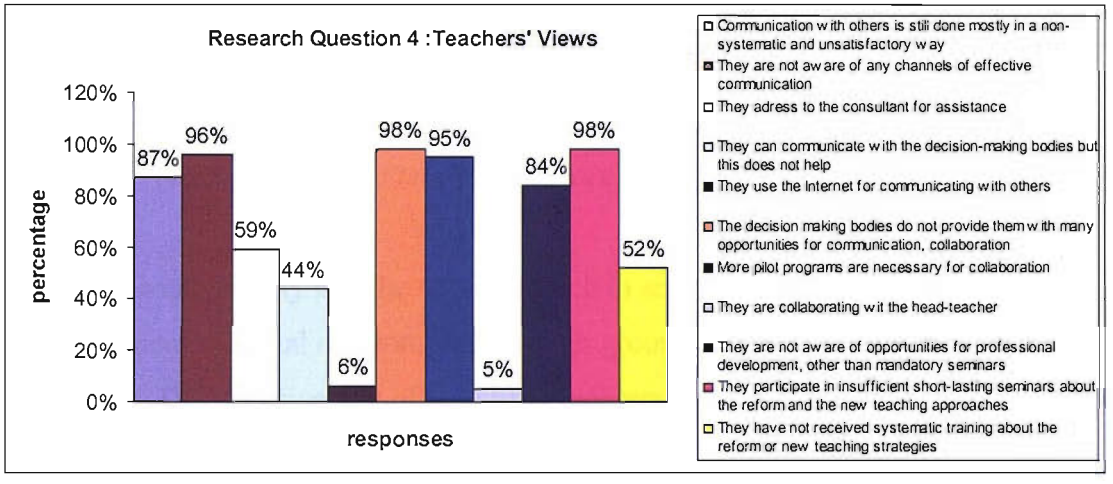

Figure 23: Research Question 4 – Teachers' views on the reforms' impact on communication and collaboration

B. Consultants' views

All ten consultants agree that science subjects should help pupils understand the basic concepts around natural phenomena. They also believe that through science pupils should appreciate the contribution of science in everyday life, develop skills and become able to construct scientific knowledge by themselves.

Seven consultants clarify that they believe this is a major characteristic of science subject only. One consultant expresses the opinion that 'science is the subject of abilities. All other subjects are just information'[consultant 2].

All consultants agree that the reform will improve teaching strategies and enhance pupils' understanding. They speak about the reforms' impact on the learning process and classroom climate, being a considerable shift towards the current pedagogic theories and

evidence derived from international fields of educational research. One consultant says that:

> "*The current method reinforces and provides opportunities for cooperative work in the classroom... this is the major difference in what concerns the classroom climate and the teachers' work ...*" [consultant 3].

Eight consultants are conscious of the relationship between the reform and encouragement of active cooperation leading to restructuring of traditional patterns of primary science teaching. One consultant perceives:

> "*Cooperation is a matter of major importance in teaching and carrying out the experiment and of teaching generally...under conditions of cooperative learning, science teaching is more efficient*" [consultant 6].

These consultants say that the new approach in science teaching encourages the development of social relationships through group work and organization of classroom activities. The effectiveness of collaborative learning depends, according to them, on the teachers' ability to form groups and allocate students' roles throughout the year. Similarly, six of them say it also depends on the teachers' ability to make students understand the importance of science and technology in daily life, which - as an educational discourse - is closely related to the enhancement of the public understanding of science at social level.

All consultants also consider the reform as a good opportunity for promoting pedagogical trends towards the integration of different primary subjects. Integration, of course, requires from teachers to be open-minded and to have sense of imagination. One consultant says:

> "*Integrating activities are very important. This, though, is a point that teachers need to know how to handle. It is up to them to accomplish it successfully*" [consultant 5].

The flexible zone and the relevant pilot programs, could serve as opportunities for integration strategies (see figure 24).

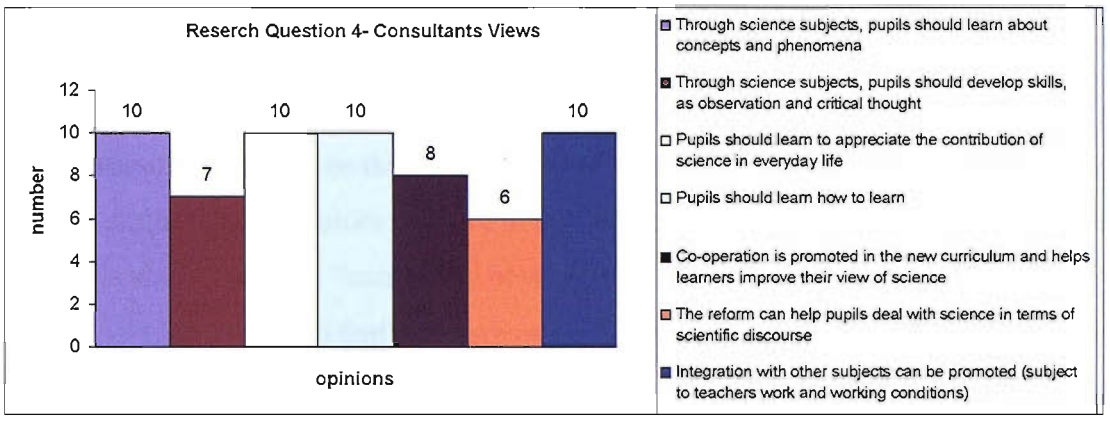

Figure 24: Research Question 4 – Consultants' views on the aim of science subjects

Nine consultants clarify that the context school life in general is not affected by the reform. Educational structures and contextual hierarchies are expected to remain the same. The only change they say they can see concerns only the role of teacher who now has to:

> "... *co-ordinate pupils to experiment and approach the knowledge ... and not just say that new knowledge verbally as it was with the old book*" [consultant 10].

Most of all, all consultants believe that generally, the reform should have been accompanied by measures that would improve school resources and equipment, because this equipment is not difficult to be found (see figure 25).

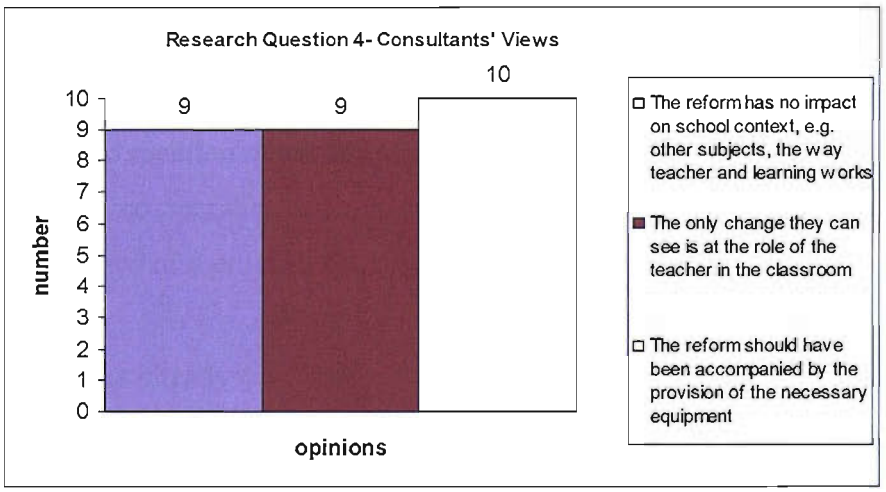

Figure 25: Research Question 4 – Consultants' on the impact of the reform on communication and collaboration

C. University Tutors' Views

All University Tutors agree that science teaching should help pupils learn concepts and develop skills. The five tutors who are in the field of science education also mention that the pupils should learn to "construct knowledge" [University Tutor 2].

All tutors mention that there are opportunities for further training, however six of them mention that it is not effective either because teachers do not respond properly or because it does not respond to teachers' actual needs and problems (see figure 26).

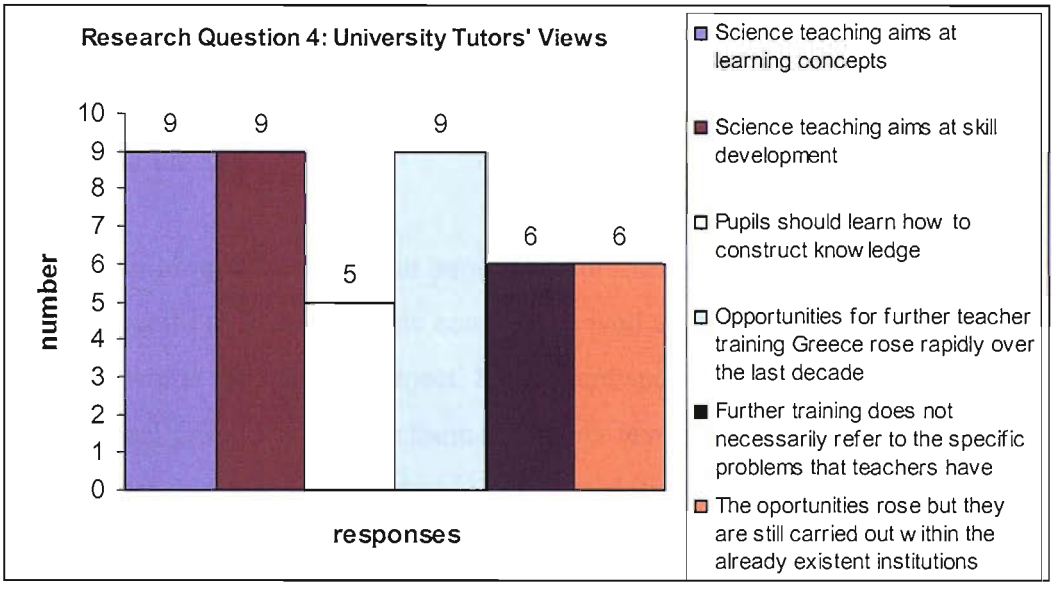

Figure 26: Research Question 4 – Policy Makers' views on the aim of science subjects

D. Policy Makers' Views

According to all 3 policy makers, learning concepts is a basic aim of science subjects. They also mention pupils through science teaching should develop skills, as critical thinking, co-operation and explanation in order to approach the scientific knowledge. Finally two of them mention that science should aim at the development of critical thinking.

As already described, all 3 policy makers comment that teacher training is provided as it was before the primary science curriculum reform. One of them expresses uncertainty around the effectiveness of the existent methods of teacher training. They also explain that no measures were taken for the provision of school equipment (see figure 27).

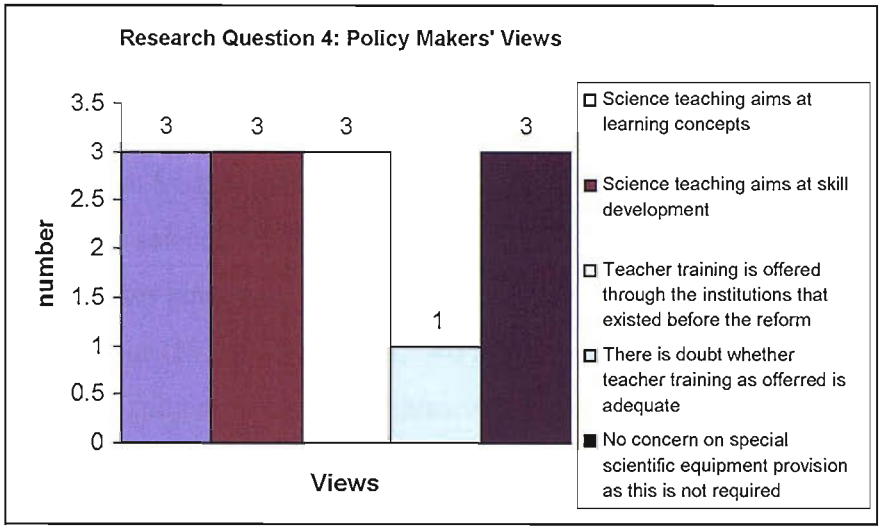

Figure 27: Research Question 4 – Policy Makers' views on the aim of science subjects

E. Parents' Views

When describing what they want pupils to gain from science, all parents mention that they want their child to learn the basic concepts as well as to develop a permanent positive attitude towards the specific subject. 87 per cent specify that they want them to obtain the required background to prepare them for higher levels of education. Only 41 per cent mention that they consider the development of skills, as observation and the ability to carry out experiments as necessary. Moreover, only ten per cent mention that they believe that the children need to learn knowledge that will help them understand or explain phenomena or situations they see or live in their everyday life experience (see figure 28).

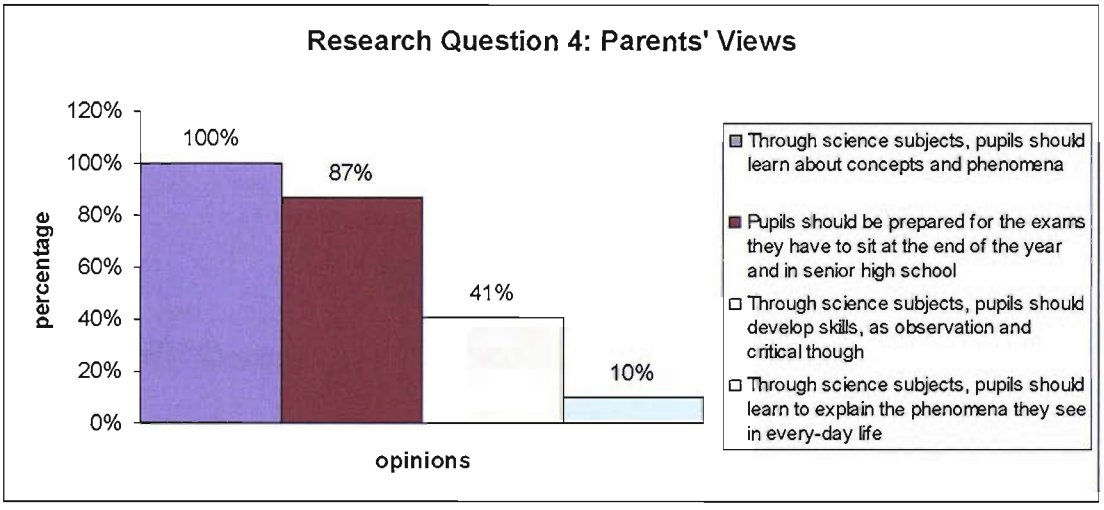

Figure 28: Research Question 4 – Parents' views on the aim of science subject

About the importance of science as a subject, 40 parents (52%), rank it as the third most significant subject after language and mathematics. 33 (42%) live in cities and the other seven (9%) in villages.

Twenty parents (26%) rank it as the fourth most important subject of the curriculum. Sixteen (21%) live in villages and rank science as the fourth most important topic after science, mathematics and religion. The other four who live in cities (5%) rank science after language, mathematics and history.

Four (5%), two in cities, two in the village parents rank science as the most important subject of the curriculum. All have works relevant to science as one is a doctor, one is a pharmacist and the other two are engineers.

Two (3%), living in villages, rank science as second only to religion. Six of them, (8%), one living in a city, five living in villages rank it as the fifth most important subject. Five of them, (6%), all living in villages rank it as the sixth most important subject. Finally, one of them (1%), living in a village, ranks science as the eight most important lesson, only above arts and music.

It is important to mention that among the 40 parents living in a city, only three of them (8%) rank religion as more important than science. The rest 92 per cent think science is more important than religion. The opposite happens in parents living in villages, where among the 38 of them only six (16%) rank science as more important than religion. The other 84 per cent consider the latter as more significant (see figures 29, 30 and 31).

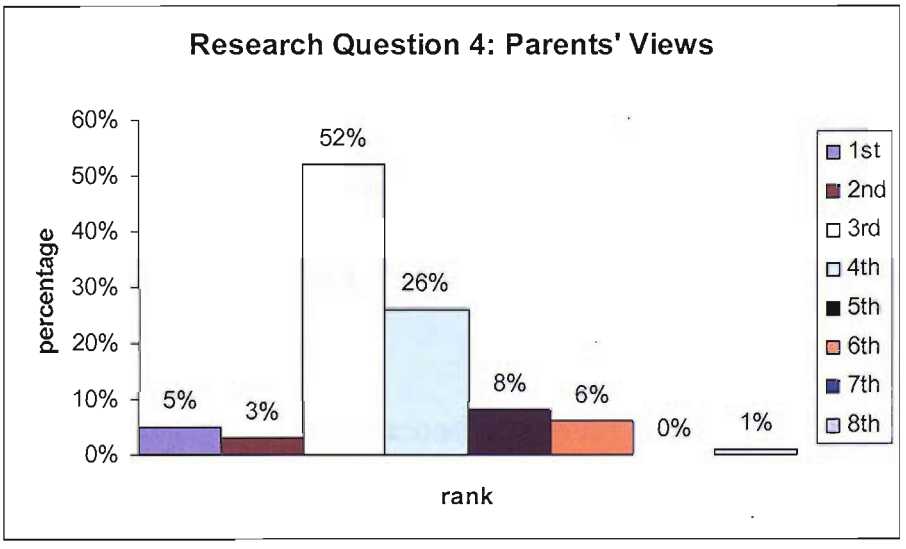

Figure 29: Research Question 4 – Parents' ranking of science and other subjects according to their significance

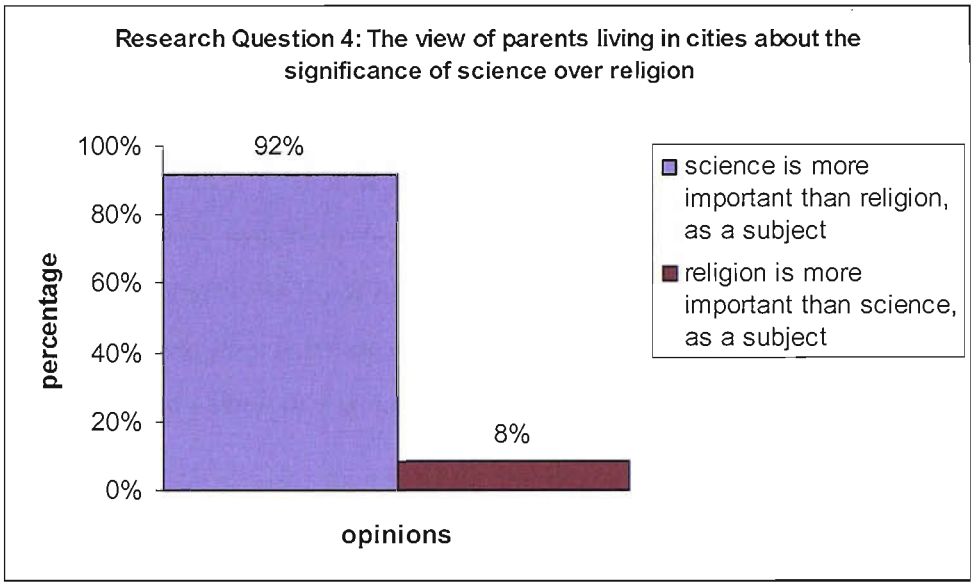

Figure 30: Research Question 4: The view of parents living in cities about the significance of science over religion

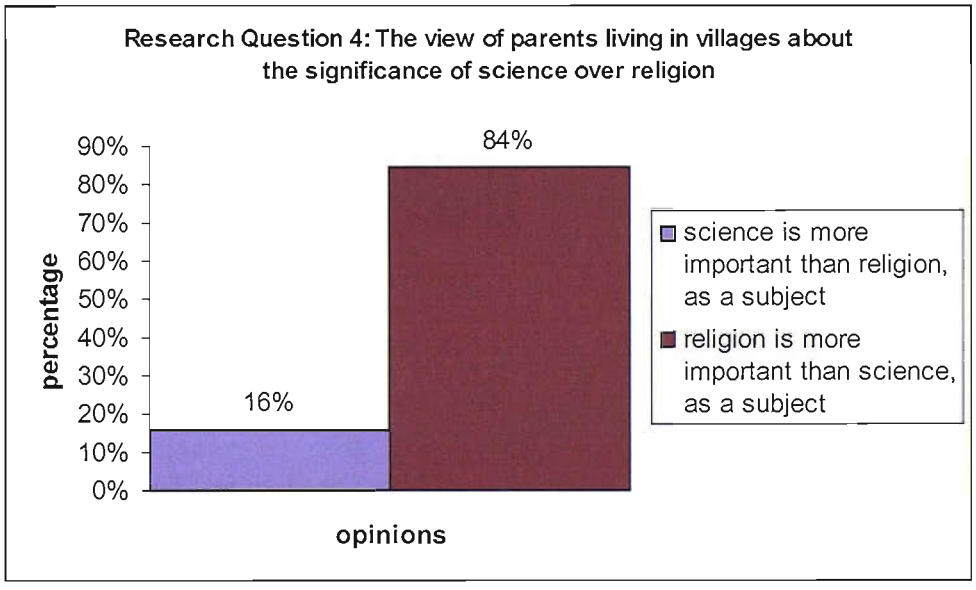

Figure 31: Research Question 4: The view of parents living in villages about the significance of science over religion

When discussing about the relationship between school and home, all parents mention that the reform has not been accompanied by the introduction of a more close relationship between themselves and the educator or any new institution that can lead to that. The connection still lies on weekly or monthly meetings, during which parents are informed on pupils' progress in science and every other subject, without receiving any advice on

what they should do at home in order to assist the learning process and the work done at school. This seems to satisfy 99 per cent of parents, as they state in the relevant question (see figure 32). Only one parent suggests that:

> "*...since it is well known that we parents are willing to help the children at home with their homework, why shouldn't we be given a list of exercises ... activities to do at home, through which the child might learn, or at least revise what they learn at school. I am happy with our relationship with the teacher... but I think this is missing*" [parent 49].

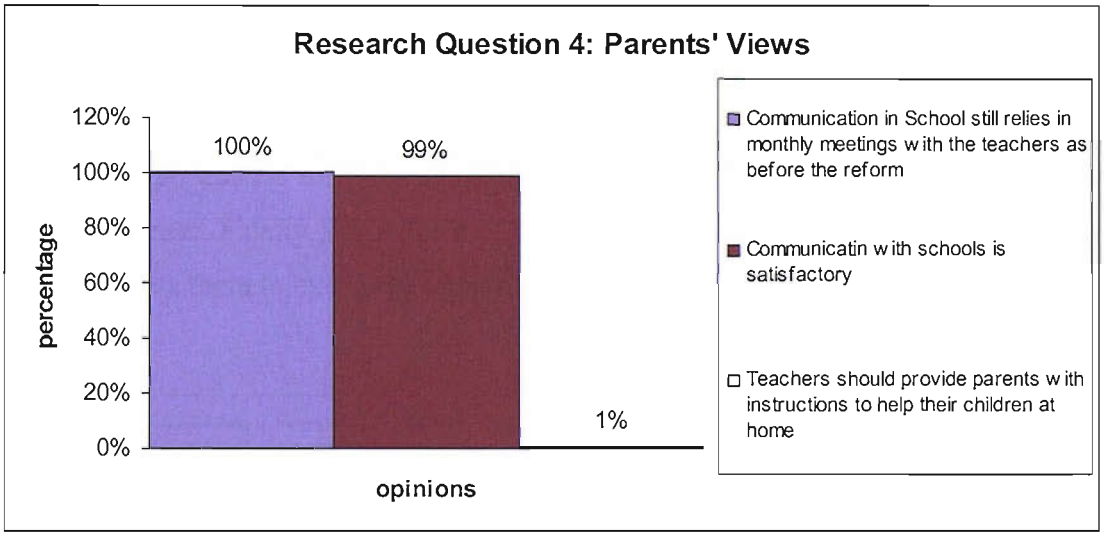

Figure 32: Research Question 4 – Parents' views on their communication and collaboration with schools

F. Secondary Science Teachers' Views

Secondary science teachers' ideas about the actual aim of the subjects and their work are not different from those expressed by primary school teachers. Specifically, 100 per cent mention as objectives the attainment of basic concepts and information about phenomena; development of skills that help pupils approach the knowledge by themselves, so as to learn how to learn. Moreover, 82 per cent add that they wanted pupils to be prepared for the exams that they have to sit at the end of the year. Finally, 73 per cent make reference to the issue of rejecting false ideas and misconception, which they claim that due to the pressure of the exams they cannot negotiate as expected (see figure 33).

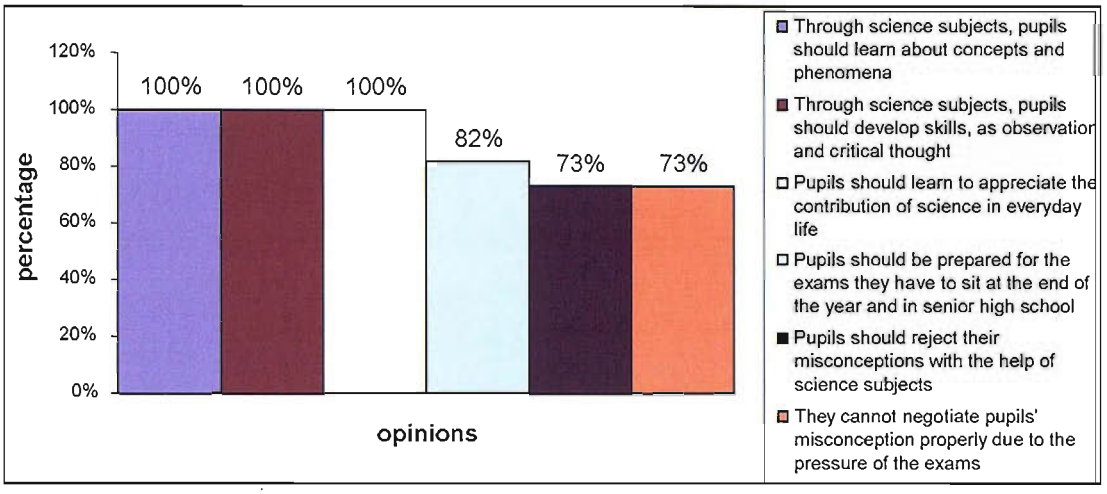

Figure 33: Research Question 4 – secondary science teachers' views on the aim of science subjects

As far as the patterns of communication are concerned, they all admit that there is no official way for them to come in touch with primary school teachers. 74 per cent of them say that there is communication with their consultant. 57 per cent of them say that there are some opportunities for meeting with primary school teachers in seminars and other training courses. Finally, 46 per cent of them speak about the opportunities that the Internet offers them to exchange ideas about science, science teaching and their work (see figure 34).

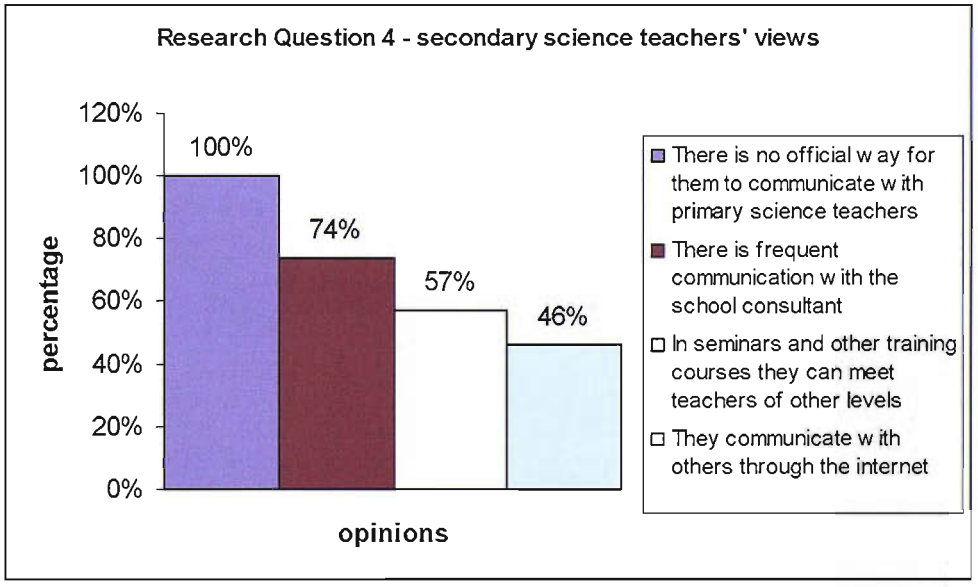

Figure 34: Research Question 4 – secondary science teachers' views on communication

CHAPTER VI:
DISCUSSION OF FINDINGS

OCEANUS: Learn to know yourself and adapt yourself to new ways.

[Aeschylus, Prometheus Bound, line 311]

DISCUSSION OF FINDINGS

INTRODUCTION

In this fifth chapter, the findings presented previously are discussed and compared to the literature as reviewed in the second chapter. Discussion of findings is done on the axis of the four research questions:

- The reasons for the reform in primary science education in Greece.
- The attitudes of the agents of the reform.
- The dimensions of the reform and the way change is managed and organised in order to be systemic and sustainable.
- The management of the reform and its impact on the public understanding of science.

By discussing the findings of each question, the possibility of the reform in primary science curriculum in Greece to be systemic and sustainable and its potential contribution to school improvement is negotiated (Fullan, 2001a).

1. RESEARCH QUESTION (1): THE REASONS FOR CHANGE

As far as the first research question is concerned there is a complex rational leading the curriculum change, in primary science in Greece as it is often the case of educational reform (Fullan, 1993). Such complexities usually refer to the conditions and the environment of the educators' work as well as to external factors, like social pressures for a better or different kind of education provision (Fullan, 2001a).

The answers from participants in this research -educators, consultants and policy makers- show that educational change in Greece arrived as a response to the poor results in science teaching in particular and generally a lack of improvement in primary schools. The change in the curriculum in primary schools attempted to first major modernisation of teachers' work and school culture in Greece. This is something else which is common across countries and educational systems: school culture is the ultimate subject for educational reform (Foskett and Lumby, 2003; Fullan, 2001a).

An important finding from this research is the vast majority of the participants express the opinion that change was needed and therefore they seem to share the 'vision for change, which according to Fullan (2001a) is a very important condition for systemic and sustainable reform. Statements made by many participants such as "*our educational system is not doing well at all...*" demonstrate a widespread recognition about the necessity of reform and indicate the 'shift of mind' or 'metanoia' as Senge (1990) would call that is a central condition for survival and progress.

The need for new teaching approaches: constructivism

More specifically, as far as the science curriculum in Greek primary schools is concerned, the exigency to improve methods of teaching and learning that is usually a driver for change (Fullan, 1993) has played a significant role in the planning and organising of this specific reform. A force for change where the disapproval on behalf of teachers, policy-makers, advisors, parents towards the old curriculum and text-books, which were distributed from the Ministry of Education, (YPEPTH ,1985; Kelly, 2004b). No more were they found to be effective. Moreover they were not appropriate for the application of constructivist approaches which recent reforms in science promote (Driver *et al*, 2000; Davis, 2002, Osborne *et al*, 2003; Pinto, 2005).

The beliefs of participants in this research about the basis and dimensions of scientific literacy among primary school pupils in Greece and the ultimate goal of

education, which usually derive from teachers' experience in the classroom (Pinton, 2005), now seem to be in contrast with the philosophy and objectives of the old curriculum. In particular, in the old curriculum, it was for pupils merely to memorise specific abstract concepts and accept science as transmitted knowledge solely through teachers and textbooks, with little time spent on activities and experiments. This kind of teaching only promoted concept and information acknowledgement, which is not the only important dimension of science learning (Driver *et al*, 2000; Osborne *et al*, 2003).

Another problem with the old curriculum was the lack of connection between the knowledge learned from every-day life phenomena and the experience of the pupils, which did not help pupils appreciate the significance of scientific knowledge and deprived them of the opportunity to apply the knowledge in life. Such circumstances could not be considered as adequate for a recent educational foundation for the 21st century Greece (OECD, 2001; Osborne *et al*, 2003). Additionally, little or no, was the emphasis on the pupils' misconceptions around natural phenomena, which is the essence of constructivism. This is no surprise since the previous curriculum had been designed and introduced before the appearance of the constructivist theories (Kokkotas, 1998), but the approach led to the persistence of misconceptions among pupils and the public cancelled efforts made by teachers to provide scientific knowledge as a basis for learning (Driver *et al*, 2000; Squire *et al*, 2003; Osborne *et al*, 2003).

These perspectives and approaches, which, it was recognised that they had to be changed and improved, eventually led to the reform of the Greek primary science curriculum as a result of multiple pressures and is expected to bring about better learning, by setting different objectives and methods for teachers follow (Fullan, 2001; Driver *et al*, 2000; Pinto, 2005):

> *"Books had to change ... they referred to issues and knowledge discovered until 1985. We had passed the year 2000 and we were still teaching the same books. I think you understand that there was a problem of lack of accuracy of information. That is not to say that they were useless ...However, I am in favour of the opinion that text-books need to be updated every two years"* [teacher 18].

Teachers reject the absolutist trend which includes resistance to change and the conceptualization of knowledge, as something achieved by the mind independently of the information provided by the senses. They do not seem to subscribe to the

phenomenological or existentialist claim that all knowledge is personal and subjective and that every individual's knowledge is the result of his or her own unique perceptions of the world (Kelly, 2004b).

The majority seems to adopt Dewey's pragmatic view that the ideal model for knowledge, is the scientific one where hypotheses are framed, tested and modified according to publicly agreed criteria, so that, knowledge has no permanent status. To a certain extent, this kind of knowledge is objective and it enjoys current acceptance by most educational communities (Kelly, 2004b; Dewey, 1966).

> "*Meaning and truth are empirical affairs to be developed and tested by operational or experimental procedures*" (Childs, 1956:143).

The need for a more attractive lesson for pupils.

According to many teachers the need for change was identified principally through negative phenomena, concerning the children's behaviour, performance and attitudes towards the lesson of the specific subject. Pupils, generally, used to treat science as boring and chore: There was great difficulty in them keeping up with the subject and internalising the knowledge acquired, which automatically repressed their further engagement in the learning process (Rowell, 1993; Levinson & Thomas, 1997; Davis, 2002). This was accompanied by the continuously observed unsatisfactory results of Greek students in international assessment tests of scientific knowledge and skills over the years (Kokkotas, 1998; OECD, 2001). These negativities necessitated and drove the change in the primary school science curriculum: a, case of an outcome-based reform, driven by external comparative standards, as noted by Fullan (1993) and others.

The need for students to investigate, understand and appreciate science *as a process* and not just as a collection of appears also as a driver for curriculum change. There is a growing realisation among educators as to the importance of teaching not only concepts relevant to specific scientific phenomena but also scientific method itself and concepts behind scientific knowledge (Driver *et al*, 2000). While explaining the previous "*false approach to the new knowledge*" [teacher 2] many participants add that science, in the old primary school curriculum, was dealt with like "*a dull set of rules and laws that had to be learnt*" [teacher 31], whereas since the reform implementation, science lessons have been based on simple tasks that help pupils engage more fully with the scientific activities and

ideas introduced and guided by the teacher leading pupils through the construction of scientific discoveries and knowledge (Driver *et al,* 2000; Davis, 2002).

All these factors can be linked to the influence that professional learning communities, have on teachers, when offering continuing progressive development through seminars where constructivism and new perspectives on teaching methods are presented. Teachers indicate that they consider themselves well informed about modern approaches to the construction of knowledge in science education, which can be seen in various comments:

> *"...with the old books and the corresponding way of teaching the children did not learn Physics and continued having problems in the comprehension of significances of Natural Sciences even in the higher levels of education. There was no provision for the interconnection of natural phenomena with the observations that the children make in their daily life, while the misconceptions of children were not taken into consideration let alone their inversion".* [teacher 48]

The influence from Universities and Educational Institutions

Thanks to an awareness by teachers of the new learning approaches and the need for them to be used, partnerships can be established which are called by Fullan (1993, p. 122) 'learning consortium' between schools and universities, which aim at improvement in education. These learning consortia assist not only in designing change but in the successful transfer of change from decision and theory to action and implementation; to classroom reality.

The influence of technological progress

Technological progress, which can be a factor inspiring efforts for educational reform (Skinner & Preece, 2003), has served, in Greece, as a driver for the reform in primary school science curriculum. Its impact, according to participants is two-fold: pupils are perceived to need and develop technological skills; and teachers are expected to use modern technology to improve their performance. Initially, because of the increased need for be familiar with the new coming technological knowledge and skills, technology drove the need to change teaching materials and textbooks. Some scientific phenomena are thought to merit more attention and investigation than others as a result of the impact of those phenomena on modern life, and skills unimportant in the past now became critical to economic and scientific development. According to one participant:

"Electricity was a small unit. There was emphasis on other phenomena that are no longer considered to be important. Now things have changed. Emphasis is given on electricity which is crucial in an era of technological civilisation" [consultant 9].

Advances in, Information and Communication Technology are also expected to be used by teachers in an innovative way to improve the teaching methods. ICT is thought by participants to ought to be designed and used to assist the teacher, the head teacher and pupils in their work, a findings which is in accordance with literature about the demands of the new technological society (Skinner & Preece, 2003). There was no such pressure in Greece to use technological innovations in teaching before the reform in primary science education. Under the old regime, lesson materials suggested for the lesson, were regarded by many participants as "*too dangerous*" [teacher 6], "*to be used only by the teacher*" [teacher 112] and generally "*not helpful*" [consultant 5].

The influence of socio-economical changes and conditions

There is also the factor of general changes in socio-economical conditions of the society, which affect school-life (Fullan, 2001a). Not few participants, mostly teachers and advisors claim that the new primary science curriculum and text-books could work in favour of pupils with special needs and culturally diverse pupils who usually cannot perform well in lessons, mainly because of the difficult language, a barrier, which in accordance to their sayings is satisfactorily limited with the new curriculum and text books. The primary science curriculum reform could also be considered as a result of the massive arrival of immigrants in the Greek society mostly from Eastern European countries, during the decade of the 1990 (Zambeta, 2000a). The effort to widen the participation of the number and groups students in a lesson, including those in science subject, has become a very popular reason for educational reform lately. After all the vision of 'science for all', and generally learning for all enjoys respect and is being strongly supported by the participants (Driver *et al*, 2000; Pinto, 2005).

In addition, learning organisations are now expected to help learners develop skills, as the ability to co-operate, think critically, hypothesise, experiment, evaluate the accuracy of their beliefs and values and the way these change and finally 'learn how to learn' (Driver *et al*, 2000; Pekmez *et al*, 2005; Liang & Gabel, 2005). This way they will

adapt to the constantly changing social contexts of the present knowledge economy and society (Fullan, 2001a; Roeolfs & Terwel, 1999). It is very common, nowadays for educational systems to undergo cases of reform, influenced by the market economy, so that they remain capable to prepare the needed human capital (Priestley, 2002). Participants include in the reforms' objectives this transformation of school to organisations working according to the standards of modern learning communities. That's because the reform emphasises the use and development of such skills, as expressed by answers as:

> "...*while doing lesson* [before the change] *the student was absent... there was no benefit for the student just a perpetual bombing of information. Now thanks to the active engagement of students in activities that are referring to actual problems of their everyday life... there are plenty of things that the child can learn from the lesson*". [university tutor 1]

The need for integration and cross-curricular science

Activities of integration, are also reported by many teachers and policy-makers as a driving force of the reform. This is probably relevant to that issue of skill development, in the sense that thanks to such activities since "*children now see that knowledge is a whole and not partial*" [policy-maker 2], as it is claimed that used to be the case with the old curriculum.

Furthermore, many respondents believe that there was a need for pupils to obtain sensitivities about various issues and problems that can be linked to science, directly or indirectly, as the ecological problem or drugs. The enforcement of such sensitivities is thought by participants to be a dimension of scientific literacy. This is another example of social problems that work as forces for curriculum reform (Fullan, 2002; Osborne *et al*, 2003).

Participants also consider that the change in primary science, apparently is not to solely aim to promote better teaching of scientific knowledge but also the practice of meta-cognitive, critical skills and problem-solving, the application of knowledge itself by pupils. This qualification, which is a major requirement set by the changing society to the current educational systems, is also dimension of the new ideas and theories on science education (Driver *et al*, 2000; Osborne *et al*, 2003).

Lack of flexibility in the educational system

Frequently it was commented that the old primary science curriculum and text-books had been in use for about two decades and were therefore, "*too old to be useful, reliable*" [teacher 12]. A number of participants also talked about similar problems in other aspects of school work, as the tenacity to teaching through methods as "*excessive verbalism that teachers need to use and students have to bear*" [university tutor 1], which were used in every subject and were found both by the teachers and the literature to be unproductive (Driver *et al*, 2000) and the provision of poor computing equipment which was out-dated.

Such statements imply a well noticed absence of the factor of flexibility in the Greek educational system. This flexibility refers to the ability of the school, the organisation and the system generally to respond successfully in the difficult task of updating its aims, function, working conditions and mission, in relation to the needs of the society. The limited flexibility of the system is also seen in a variety of remarks relevant to the general structure of the educational system and school management, which "*is required to change drastically with the curriculum.*" [teacher 119].

The paucity of this element is considered an important barrier, for effective school management, implementation of change and generally teaching (Muijs & Reynolds, 2001; Foskett & Lumby, 2003). A general conclusion that can be drawn is that the change was required not only to take place but to be also institutionalised and become an inseparable part of the whole educational system, as a mean for further efforts for school 'modernisation' and improvement, which is after all a crucial dimension and phase of every reforming study (Fullan, 2001a).

The lack of appropriate leadership

Limited flexibility can be associated with a parameter, which is crucial for schools' performance and work, which is leadership. The role of leaders is attested as important in educational change (Fullan, 2001a; Everard *et al*, 2004; Davies & Davies, 2004). Indeed, many participants respond that there is a great difficulty for the schools in Greece to control or accomplish various missions that demand the appropriate leadership.

An example of such mission is the establishment of the relevant mechanisms that will help the head-teacher, the teacher and each manager understand where interventions

have to be done, accompanied by the necessary planning and careful orientation (Davies & Davies, 2004). Teachers frequently mention comments on the problems emerged from a curriculum used two decades without any significant alteration, In spite of the fact that they had realised the problem and were informed of the new approaches to science teaching, they did not seem to have tried to introduce these approaches by themselves.

In short the teachers and the schools individually, seemed to be unable to take the initiative and make the changes themselves, even though they explain that they had understood that their work was failing by using the guidelines and instructions of the old primary science curriculum. This could be attributed to inexistence of the restlessness and dissatisfaction of liberty which are mandatory elements of leadership for systemic and sustainable reform (Fullan, 2001a).

Apparently, there was neither a mechanism to encourage the relevant skills and the strategic capacities to the teachers and all the members of the organisation who could have used them, in order to carry out the interventions required. This denotes insufficient school leadership as well (Davies & Davies, 2004).

Many teachers commented that they are not entitled for such initiatives. The restrictions they had to follow the detailed curriculum and books handed by the ministry did not give them the liberty for such decisions (YPEPTH, 1985; EURYDICE, 2002).

Globalisation

Globalisation is known as a force for change in many fields internationally including this of education. Evidence of the influence of globalisation in the primary science education curriculum reform could be: the continuous comparison and benchmarking of schools and the criteria for effective lesson and outcome as set by research findings not only at national level but world-wise; the clarified urgency for the school to be evolved to a recent learning community, able to keep up with changes and demands of the dynamically changing society and able to promote this aptitude to the learners and future citizens (Fullan, 2001a; Castels, 2000).

As a social reality, in Greece, globalisation seems to have started affecting the beliefs of stake-holders. As the theorists of globalisation (Giddens, 1999; Caldwell, 2004), participants considered this phenomenon a major trend that can assist school improvement by breaking boundaries and allowing the exchange of ideas, experience and material. Schools are expected this way achieve the goal of qualifying pupils to accept and support the knowledge economy and the innovative learning culture. This is seen in statements

which describe the new curricula as "*innovative, designed in accordance with the curricula of other countries*" [teacher 39] and suggestions as:

> *"We can benefit from co-operation of teachers with colleagues abroad. We e.g. should invite teachers from Britain, Germany, USA to come and see what we do and then our teachers to go there and see something else, different, ..."* [consultant 4]

The attraction of the idea for interconnection and repeal of isolation of a single culture from the rest seems to be apparent among participants. It is realised that the principles and ideals underlying the Greek educational system and its foundations, had to be consorted with others that exist, act and abide equivalent systems of other countries. A result of this might be the establishment of the group of collaborative sub-cultures which replace the already existent cultures that tended to work single. These networks, through the perpetual exchange of information, work and values can increase the motivations for reconsideration of the identity of the individual educator, school and system and the stimuli for improvement. This way they accelerate the rates and cases of reform in the system (Fullan, 2001a; Giddens, 1999).

Many participants see the primary science curriculum reform as one process among many that will schools to learning communities capable to prepare citizens live, benefit and contribute significantly to a globalised, rather than a single isolated society. Many respondents, seem to support the idea of Drucker (1999) that it is important for the curriculum to reflect the internationalised standards as they are formed by findings of recent discovery in science, technology, cognitive psychology and of course education.

Education as an institution and schools as organisations, in Greece were captured in the cyclone of globalisation, as it happens in other institutions types of organisations, since all of these are important parameters of social life, which globalisation is found to alternate at its totality (Castels, 2000).

Political influences

The meddling of politics in the field of education through efforts of school reform works as a factor for change in many countries (Fullan, 2001a; Giddens, 1999). This is linked to the implication of globalisation, or general social problems, in many cases, but not always. A limited number of different participants also expressed beliefs claiming that

"*every time there is a new minister –not necessarily a new government– there is a new reform*" [policy maker 1] or, "*each minister has the ambition to relate his name with a reform*" [secondary teacher 19], which could describe examples of other ways in which politics accelerated the specific reform. Similar conclusions had been stated by other research studies (Fullan, 2001a).

Summary

To sum up, there were a number of reasons that made curriculum reform in primary science in Greece mandatory. Some of them are relevant to the necessity for an updated, recent, more fruitful and effective type of teaching. The most basic of these, is the fact that the pedagogy promoted by the old curriculum was not successful as it did not take in consideration the findings of current research study and promoted various virtues and types of lesson, which were no longer considered to be beneficial. There is also the problem of the pupils' attitude towards science lesson, which was dealt with as dull (Driver *et al*, 2000; Pinto, 2005; Davis, 2002).

Other reasons are relevant to the general changes in the social context of Greek society. The impact of the development of information and communication technologies is such. Another one is immigration and the arrival of large numbers of immigrants' children in schools. Moreover globalisation boosts the utility of educational reforms by causing foundational changes, setting new values, new realities and new demands from people in the society, in which a school is expected to respond efficiently (Fullan, 2001a; Foskett & Lumby, 2003).

Lack of appropriate leadership and mechanism has also invigorated indirectly the reform. That's because even though the significance of the reform in primary science had been appreciated by participants, schools individually were unable to update their way of work, conditions, environment and goals, by their own decision (Fullan, 2001a; Davies & Davies, 2004).

All the above, simply show that the reform arrived as a response to the realisation of the need for a shift in the school culture and the need for a re-organisation of the school environment. The taught material, the techniques and learning approaches that were used, the aims and goals of the curriculum, other dimensions of teachers' work, were considered unsuitable for effective lesson. Consequently, they had to be updated.

These reasons simply reflect support towards a wide vision for sustainable education and sustainable future for the society, where there is the harmony between

peoples' development, concern about economy, environment and the future instead of a chaotic (Sterling, 2001). The problems schools used to face, with the old curriculum in combination with the general comments about the conditions and contexts in which schools and the whole educational system worked show clearly the need for an in-depth reform to help schools encompass the ideals of Smith and O' Day (1991) who underline the importance of a coherent systemic strategy. This adds content to the restructuring movement, and that establishes expectations that all students will acquire deep understanding of subject matter and complex thinking skills.

It is significant to mention though that there seems to be compatibility between the announcement and declarations for the rational of the specific curriculum change as described by the policy makers and stated officially by the government (EURYDICE, 2000) and the requirements and remarks from the teachers for the new curriculum. The teachers seem to welcome the reform through comments as "*changes were definitely necessary. There is no doubt about it*" [teacher 1]. In other words, the reasons by which the change is justified by its designers seem to be accepted as real and substantial by the agents of the educational reform. The factor of disagreement between policy makers and teachers as far as the necessity and the form of change is concerned, which can sometimes form an obstacle to the implementation and success of the change (Fullan, 2001; Everard *et al*, 2004) does not seem to emerge in the case of the primary science curriculum reform in Greece at first sight.

While explaining the reasons for the change, teachers, policy-makers, advisors often use the term 'book', which shows justifies the conclusion around the book-oriented character of the educational system in Greece (Kelly, 2004b; EURYDICE, 2000; Kokkotas, 1998).

The comments and the answers show clearly a focus and concern on the issue of learning outcomes which is usually a criterion taken into consideration in cases of educational assessment and reform (Fullan, 2001a) and can explain the fact that the change was restricted to a new curriculum and text-books. The problem of the pupils' learning is perceived probably as simply an issue of the curriculum and the text-book and not as a problem deriving from the general school culture and structure which is not found to be working effectively (Zambeta, 2000a). New perspectives and learning approaches though, are affecting every agent of change, including the educators (Fullan, 1993). The comments made, concerning the educators' role as a dimension of school life that had to

be changed are limited to his or her work in the classroom and only his or her mission to transmit knowledge to pupils. The new behaviours, which have to be adopted because of the reform, are simply changes in teachers' role during the lesson where:

> *"The teachers' role now is to make sure that the students co-operate well and carry out the experiment as expected. He is what we might call the facilitator of the classroom. However, it is the teacher who has to stimulate the interest of the children and make sure that they are fully focused on the lesson"* [teacher 65].

Although all teachers declare that they do operate with a concept of education framed in terms of the developing understanding of the child, the growth of critical awareness and other such elements that seem more closely to the idea of education as development rather than to the idea of education as transmission, they still appear to assume that certain kinds of well defined knowledge will promote these form of development. In fact -contrary to their rhetoric- they do not challenge the conception of curriculum as a content-based syllabus that has to be followed in detail, promoting a common culture and ensuring that all children have access to what is regarded as intrinsically worthwhile. Teachers still believe that pupils mainly have to learn as effectively as they can what the curriculum offers to them. This belief is mainly shows no change of teachers towards the curriculum and their work (Kelly, 2004b).

Teachers seem to concentrate on instructional goals, losing the opportunity to play an active role in the educational process within which, both teachers and pupils are involved. They require a careful and detailed preplanning of outcomes ignoring the fact that every act of education takes place in its own individual context (Sockett, 1976) and thus cannot be predetermined but must be seen as a continuous, ongoing, open-ended activity. They admit, however, that in practice they support the open-ended process and the free pupil-teacher interaction, since it is impossible to specify in advance the objectives of their lessons, despite the fact that under current conditions several pressures are concerted upon them to do so. Teaching experience appears to verify Dewey's (1966) view that objectives have a tendency to change as they are being approached, allowing thus a certain degree of professional and personal autonomy for the teacher. In short, teachers, in Greece, still hold the fundamental commitment to the 'content model' of curriculum and an adoption of interactive teaching scheme as a methodology for achieving the most effective assimilation of the selective content (Kelly, 2004b).

There were very limited comments referring to the necessity for the adaptation of educators' work to the new model of 'teacher-manager' (Kelly, 2004b), who is not only responsible for observing pupil learning by engaging in the learning process but takes more responsibility in lesson planning, collection, arrangement of resources and information, as ingredients for effective learning process (Muijs & Reynolds, 2001; Fullan, 2001a). Such a misinterpretation of the vision for school transformation to a modern learning community could have negative effects on the implementation of primary science curriculum the reform.

2. RESEARCH QUESTION (2): THE ATTITUDES OF THE AGENTS OF THE REFORM

The fact that teachers, policy-makers, advisors and parents seem to welcome reform in primary science and agree on its importance enhances the possibility that the reform will be systemic and sustainable, as indeed it should be in order to contribute to the improvement of the educational system generally. Even though it is not uncommon for a shared vision for a reform, which in this case refers to the amelioration of science teaching in primary schools, to suffer reactions of misinterpretation and misunderstanding by different groups in schools (Fullan, 1993; 2001a), which in turn can form significant barriers, this does not seem to have happened in this case.

Improvement of science teaching

The research shows that there is a positive attitude among teachers towards the reform, which does not derive solely from their acceptance of its goals. The positive attitude is also justified by teachers' comments about change in the classroom teaching and procedures, where teachers clarify that the reforms respond to the major problems they faced teaching science under the old regime. Teachers, head-teachers, consultants and university education tutors seem to share the view that since lessons escaped the 'traditional' schemata to one of a more practical nature, the improvement in learning was marked. The new primary science curriculum transformed the lesson of science completely, as it is designed (YPEPTH, 2000; EURYDICE, 2002) and found by participants to emphasise a) pupil participation in lessons, b) skill development, c) the use of "*low cost ... needing easy materials*" [teacher 33] experiments and d) establishment of a link between the units taught and pupils' experience from everyday life. Participants believe that concepts are studied at a greater depth, as they are approached by the active engagement of the children, in the lesson. Virtues, skills and experimental activities are given the necessary attention, so that pupils will develop them. Moreover pupils who traditionally have a problem in performing well in science education, as culturally diverse or children with special needs (Davis, 2002) are helped by the new curriculum, according to many teachers and parents as:

> "*the lesson is based on worksheets and experiments with simple, easy-to-find materials, the barrier of difficult language, which made the lesson hard to*

follow, for all the children and not only those just mentioned, does not exist anymore" [teacher 52]

Those findings agree with literature (Driver *et al*, 2000; Valadares Tavares, 2000; Davis, 2002; Osborne *et al*, 2003; Pinto, 2005). The provision for those 'at risk' pupils (Fullan, 1993, p.48) can strongly assist the progress of the reform, under the condition of the provision of flexibility, training and support to the teachers (Fullan, 1993).

An important result that many teachers observe right after the reforms' implementation is the drastic change of the pupils' attitude towards the lesson of science. Many teachers state that:

"*There are just two things that must be mentioned about the new book. It demands huge amount of work done by the teacher, but it really fascinates the learners.*" [teacher 2]

Comments as "*science has become the most popular subject*" [teachers, 42; 79, consultant 6] are not uncommon, especially by teachers, most of whom consider that a major success, as this was included in the major targets of the primary science education reform (YPEPTH, 2002). That significant difference can be attributed to the activities that allow pupils' active participation in knowledge construction process and relate the phenomenon studied with their every-day life (Driver *et al*, 2000; Davis, 2002; Osborne, 2003). The validity of those comments is strengthened thanks to a triangulation (Cohen, Manion & Morrison, 2000) of teachers' responses along with those of pupils and parents who seem to be accepting it as true. Many parents express that:

"*... the book of science is the only decent book the children study. Other books... history... language... they are full of bad points ... the science book is fantastic*" [parent 19]

Others also enhanced teachers' view of comparison between the two cases, as one that stated:

> *"... my daughter adores science. And it is reasonable. The lesson is nice. Interesting. No resemblance with the old book. My older daughter had the old book, and...it was terrible"* [parent 40]

These positive phenomena are likely to affect not only the performance of pupils in primary school but in their relationship with science subject in future too (Osborne, 2003).

This enthusiasm and positive reaction on behalf of the pupils could facilitate teachers in their effort to introduce the constructivist approach in the classroom as its essence is the participation of the learner and more specifically the negotiation of children ideas and misconceptions around phenomena. There would be no point in trying to convince the pupils to reject their strongly internalised beliefs around scientific phenomena without stimulating their interest in this process. After all it is the pupils themselves who -under the teachers' carefully planned instruction- have to go through the socio-cognitive conflict and understand the falsity of these beliefs in order to accept the scientifically correct ones (Driver *et al*, 2000).

Misapplication of the reform

However, the implementation of constructivist approach in the lesson does not seem to be carried out properly. Even though teachers are, in general, aware of the necessity of this approach, in their majority they do not seem to be giving the devotion required to the elicitation, negotiation, reconstruction and review of the misconception of students. Only a minority of teachers, consultants or policy-makers include this point in the main differences between the new and the old primary science curriculum. The main remarks coded, concern the emphasis on experiments done by pupils, which they believe is sufficient to improve science teaching. This opinion which does not agree with research findings though (Driver *et al*, 2000; Pinto, 2005). There are some participants who claim that:

> *"The new books provide more opportunities for the negotiation of misconceptions. In reality though, this cannot happen as it should"* [teacher 108]

In other words, even though participants are aware of the significance of constructivism and comment in favour of it, they seem to have a difficulty to apply it in the actual lesson procedure. Similar conclusions have been drawn by different research studies on reform

aiming at the introduction of the constructivist paradigm in science education and other studies of school improvement generally. It is frequent phenomenon for teachers to realise or explain that they have realised a necessity of a new teaching approach or function, but whenever they are asked to implement it, they claimed that they have a difficulty to respond (Driver *et al*, 2000; Pinto, 2005).

It is probable for this misapplication of the new approach, to have its root on a not clear appreciation on the vision of the change. This barrier is always likely to emerge in relevant efforts and prevent the successful improvement and it is the main reason, for which the dissemination of the vision of change to its agents is a difficult task (Fullan, 1993).

The answers of different participants of the research, mainly through the interviews could lead to the conclusion that no attention was paid at that point. When they are asked about the motivations that led to the change in primary science curriculum, in Greece they often start by saying that "*Nobody ever informed us about why the books where change, but I could assume..*" [teacher 78], which shows that probably policy-makers took for granted that teachers would accept the reform as it was planned, which is by no means a policy that leads to sustainable change.

Despite the wide support of teachers for such a reform, it is not wise on behalf of those who design the reform to assume that the new primary science curriculum is going to be dealt with by the teachers through the designers' point of view. A result of that omission is confusion between what is expected and what actually happens, that might cause major negative effects to the effort for improvement (Fullan, 1993; 2001a). Indicatory answers of this situation could be the opinions held by a limited number of participants as:

> "*I get the impression that we do not have the session of science... we focus on language rather than science. ...All the time we emphasise on writing instead of learning... We spend so much time on exercises ...where we have to fill in a conclusion by using certain words*" [teacher 9].

These sayings can indirectly prove this misunderstanding. This has an impact on the effort done in the new primary science curriculum to promote integration of units, as language and science in this case (YPEPTH, 2002). Moreover it affects the effort to help pupils understand, up to an extend, the nature of science in relationship to method of

constructing knowledge, revising their ideas by themselves, developing this way meta-cognitive skills (Driver *et al*, 2000; YPEPTH, 2002). The general acceptance of the reasons for a reform and the acknowledgement of new ideas around school functions and teaching methods do not guarantee total acceptance of the reforms' vision. As the vision, is not understood at depth, evaluated and respected by some participants it cannot be transferred in classroom. This reduces the possibilities for the reform to be systemic and sustainable (Fullan, 2001a; Everard *et al*, 2004).

It is significant, however, to mention the statements of Fullan (1993) that crucial though the shared vision is, it should not be expected to exist from the very beginning of the reform effort. It is being gradually built dynamically through the on-going process and interaction of agents. Dedicating huge amount on planning the reform and more specifically, advocating the vision in advance, is not found to be an intelligent gesture. Nevertheless, the pre-planned work on its formulation is important, as according to Senge (1990) this shared vision enjoys the respect of every-member of the organisation as it is not in contrast of each members' individual visions, which have been gathered to compose the shared. In the case of the reform primary science education in Greece, the individual visions did support the arrival of the new curriculum, which could make the climate more welcoming to the vision as perceived by the curriculum designers. The shared vision though is still being shaped.

Barriers to effective reform implementation

Apart from the misunderstanding of the vision, there are other problems with the new primary science curriculum and its implementation that respondents frequently report. These problems mainly concern: the opportunities, programs and cases providing further education and support, which should be offered to the agents, in order to transfer the reform in their work; the school structure and equipment that the teacher and the pupil is expected to have and use; the possibility of an obligatory re-arrangement of time; space in the school classroom and, finally; the financial cost that the reform may have (Everard *et al*, 2004).

The general conclusions from the findings, indicate teachers do not follow the advice of Fullan (2001a) that, difficult though it is, they should reconcile with the problems that will otherwise come up during the change implementation. More specifically, Fullan (2001a; 2002) invites teachers see them as obstacles and reasons to abandon the effort for change but as opportunities to adopt the role of the designer and

offer a contribution to the reform themselves. The teachers of the research though do not seem to act this way, which is not encouraging for the systematicity and sustainability of reform.

Taking into consideration that the adoption of this attitude could be a fundamental part of the re-culturing of the teachers' profession and the education generally (Fullan, 2001a; 2002; Parker, 2005), the teachers and the schools, in Greece, by not internalising it, cannot learn to deal with the changes that are likely to bomb their work in favour of the improvement of the learning community and outcome in future.

Firstly, in the responses there are many reports concerning the issue of teachers' further education, which is crucial for any kind of reform (Fullan, 2001a; West, Ainscow & Stanford, 2005; Bush & Middlewood, 2005) but does not seem to be dealt with in a satisfactory way by both change-designers and by educators. Overall, this is not surprising, as research has repeatedly proven change implementation is accompanied by teachers' complaints about improper guidance, and ignorance asto what they should do in the classroom (Everard *et al*, 2004). The debate about the existence or the adequacy for further education, as concluded from the responses seems to be very complicated. Even among the same groups of people there seems to be a level of disagreement around this debate, as there is a limited number of teachers who seem satisfied with the guidance and information given. However, the vast majority claim that it is either inexistent or inadequate and ask for more opportunities or programs more helpful for them. One teachers states:

> "*I have been bombarded about the new theories on science teaching ... my problem is how do I actually apply them in the classroom? I get no guidance on that*" [teacher 19]

A more specific response which was given by one school consultant in the same context, is:

> "*...not long time ago, we went there, where there was a specialised physicist scientist who did from different parts of chapters, as ... one experiment. In my opinion this is not further training. First of all, this covers only the practical part of the issue. But what is the new way of approaching knowledge in science?*

> *Nothing happened about that. There are only efforts about it, by school consultants*." [consultant 5]

So most of the teachers describe dissatisfaction towards the guidance offered. Only few disagree with that. This does not happen only at the level of the teachers' though. In the opinions of University tutors, there is disagreement as well, as according to one:

> *"...during the last years, a huge number of educators have received further education. About these issues. I would say most of the teachers... lets say programs, as the programs of "emulation" and individual seminars, long-lasting or short-lasting. All those have contributed to the further education of the teachers"* [university tutor 5]

Others though claim that there is a "*superficial training*" [university tutor 1] which could though be helpful to the teachers. The region factor, which is found to make a difference, according other research studies (Fullan, 2001a; Everard *et al*, 2004) does not explain this variation in Greece, as this small percentage of the teachers' population which expresses satisfaction is not located in a specific area.

The dissatisfaction towards the programs for further education offered can be attributed to the fact that the real problems that teachers have to face are not concerning the importance and validity of the new approaches and theories of science teaching itself. The real problem problems may lay in the fact that there seems to be no change in the Greek primary teachers' beliefs around their role in the modern learning organisation, which becomes more complicated. Unless this is realised, the systemacity and sustainability of the reform is jeopardised (Fullan, 2001a; Everard *et al*, 2004; Howe & Stubbs, 2003).

Indeed, the models developed, which discuss the transformation of teachers to leaders underline the importance of development for teachers, which though is found to be bound to failure, unless the teacher express the willingness to engage themselves to the transformation (Pallus & Drath, 1995; Howe & Stubbs, 2003). This transformation concerns teachers' apprehension of their work, role, responsibilities, mission and aim in the lesson and school organisation in general (Davis, 2002). Greek primary teachers do not seem to have updated or thought of updating their ideas about responsibility. For them

there is still a need for a detailed curriculum that will provide them with the necessary details on how to carry out the science lesson. According to one consultant:

> "*There were a significant number of seminars about the new books. The reason why teachers are dissatisfied is that we have not understood that we should not expect to have any more the detailed guideline for the lesson, with what exactly to do and how, what to say etc. The teachers believe that they need that, but they don't... We must realise that teachers need to start doing some things by themselves.*" [consultant 6]

This problem can be identified in many other comments made by the teachers that concern not only the lesson of science but other parts of the new curriculum. An example is the program of the flexible zone, which teachers mention that they are struggling with as they "*don't know what do to, nobody tells*" [teacher 23], which is in fact the actual philosophy of this program (YPEPTH, 2000) but probably teachers do not appear ready for that. The provision of detailed lesson instruction is not compatible with the characteristics of the teacher who works as a leader. Those detailed 'teacher-proof packages' (Kelly, 2004b, p. 9), which include curriculum, supportive material, centrally planned lesson plans are not considered very effective any more, as it is quite often for teachers to misunderstand the objectives set and not to fulfil them during the lesson (Kelly, 2004b).

However, due to the missing element that Pallus and Drath (1995, p.13) name 'readiness', any reform which is based or promotes teachers' more active engagement in arranging the lesson planning and school management, as the teacher leader is supposed to do, is difficult to be implemented (Fullan, 2001b; Davis, 2002; Howe & Stubbs, 2003). The reform in the primary science curriculum in Greece seems to be such a case.

The second complain of the vast majority of respondents is the improper provision of the necessary equipment in the schools, which care should be taken otherwise failure could be inevitable (Fullan, 2001a). With respect to the new primary science curriculum, equipment concerns a well organised laboratory in science education or a computer room. A laboratory is certainly needed for effective science lesson, especially if the constructivist approach should be applied, as the experimental and learning activities that should be carried out in the laboratory will help pupils develop better understanding of the scientific way of knowledge construction (Driver *et al*, 2004; Hofstein & Lunetta, 2004).

Unless such equipment is provided then the reform is not feasible and incapable to be supported by schools (Fullan, 2001a). For that reason, the reform in primary science education in Greece is less likely to be successful, systemic and sustainable.

The response given to teachers by various policy-makers and university tutors is that the overall philosophy of the new curriculum includes the construction of new knowledge by activities using simple materials. That should normally help the hurdle of the barrier of not having the equipment. Even though this is recognised by the teachers, it is not convincing them that the problem is of minor importance. It is often for teachers to say that:

> "*... if you look at the book, the experiments we have to do are using materials easy-to-find, paper... batteries... water... glasses, things that children can find in their homes. But shouldn't we have a place with the relevant arrangement for desks and all where we can have these experiments done. The classroom is not appropriate for that purpose.*" [Teacher 21]

The complaints of primary school teachers, consultants and to a certain extent parents and high school educators, about the inexistent or inappropriate equipment in schools, indicate again the expectancy that this issue should be arranged by the "*central authorities*" [teacher 35], which in other words are the Ministry of Education and the Pedagogical Institute (EURYDICE, 2002). There are comments that justify directly the existence of these attitudes among teachers who believe that there should be:

> "*... a generous investment, from the government, so that the schools will be equipped appropriately with a science laboratory*" [teacher 123].

There does not seem to be wide concern on how the individual school or educational distinct or unit should come up with solutions to collect this necessary equipment. Only a limited number of participants talk about coming up with other ways of collecting and arranging the materials required. Such solutions, suggested mostly by few head-teachers or consultants are:

> "*...what I asked them* [the teachers] *to do, was to try and find out whose child father, was e.g. an electrician. He could give us* [them] *some electric equipment*

he would not use any more. Or if someone's parents work in the bank, you know the banks ... update their computer equipment very often, so could give to schools some computers they don't use any more... " [consultant 2]

The low frequency of such comments shows that the schools don't seem to be aware of the necessity or the ways with which they can motivate and take advantage of human or intellectual capital to deal with problems (Kelly, 2004a). Teachers have a difficulty in understanding that they have to take action in order to work out how to obtain or manage resources and materials. They need to come up with an informal policy, formed of ways of reacting in similar situations, which is important for a normal transformation of a school into a learning community (Foskett & Lumby, 2003; Everard *et al*, 2004), which does not happen with teachers in Greece. This creates another obstacle to the reforming and reculturing of teachers' professions, reducing this way, the possibilities of the reform to be systemic and sustainable (Fullan, 2001a).

The problem of equipment, however, as perceived by various participants is more complicated. According to them it is far more than just a matter of provision. There are other factors meddling to. Some participants, link it with the fact that the teachers have to organise, supervise not only the laboratory but the lessons that are due to be carried out in it. This requires special training of the teachers (Hofstein & Lunetta, 2004).

One consultant also relates the problem to the general issue of building structures, saying specifically that:

"*There is definitely,* [provision for science laboratory], *but ... the problem now is that the schools have to accommodate huge number of students. Immigrants ...there are no classrooms, to put all those children. Science laboratory is necessary but it cannot be given priority...*" [consultant 1].

One teacher enhances this statement by adding the experience from her school, by claiming that "*Our school is built to accommodate 360 students. The maximum. We have 518* " [teacher 17]. Such difficulties, definitely cannot allow the agents, in this case the teachers in Greece to perform as expected. Even in this case though, it would be expected from the schools to plan, be organised and work individually on how to deal with these problems (Fullan, 2001a; Everard *et al*, 2004).

The inability of teachers in Greece to respond in Fullans'(1993, 2001a) call to treat problems as friends, especially as far as the equipment issue is concerned could be linked to another barrier, which is the financial cost. Even though the participants do not include it frequently in their answers, they indirectly show that schools are not able to afford supporting the change, in terms of teacher preparation and equipment. One consultant's response which demonstrates this situation is:

> "*The only thing that the head-teachers could probably do is to open the wallet and get some money to organise a laboratory. But at what point can this be done?*" [consultant 3]

This could be another case, where teachers and schools should take initiative and through the relationship, collaboration and interaction with the wider environment (Hargreaves & Fullan, 1998; Everard *et al*, 2004) to solve this problem, as it is probable for a modern learning organisation. Apparently teachers and head-teachers, in Greece do not move to that direction. They do not appreciate this strategy, even if it is hidden in the reasons for change. The issue of misinterpretation of the vision of the reform is brought up again (Fullan, 2001a).

In what concerns the frequently pointed out by participants problem of time, which is thought to be inadequate, as in many cases of educational reform (Everard *et al*, 2004), the measures taken by teachers to deal with it, are not helping the effective implementation of the reform. Teachers' answers show that the principle that seems to abide their work is to make sure they cover all the units asked by the curriculum. This can be seen in quotes like:

> "*... we are frequently forced to carry out the experiments ourselves, instead of asking the students to do, so that we can save time*" [teacher 96].

Solutions, as this are incompatible to the actual philosophy of the new curriculum as they do not support the constructivist approach. The lesson orientation remains centred around the teachers who, this way restrict the important element of students' active participation.

An underestimation of the specific elements' significance is probably hidden (Driver *et al*, 2000; Hofstein & Lunetta, 2004; Pinto, 2005).

Similar examples are shown in other answers. Some teachers explain that due to time pressure, they avoid the negotiation of students' ideas before and after the experimental activities or the lesson. Consequently, since these ideas, which are the essence of the new teaching approach (Driver *et al*, 2000) are not given the required attention this approach is not working (Fullan, 2001a).

The overall sum of all these findings, leads again to the conclusion that teachers in Greece focus on what is urgent rather than what is important. It is not uncommon for the agents of a reform to fall in this trap (Everard *et al*, 2004). That problem might be linked to the incapability of the teachers to act as leaders and take initiative whenever it is necessary or the barrier of a non-well-disseminated vision of change (Fullan, 2001a), because of which the teachers in Greece cannot appreciate the ultimate objective of the new science teaching and focus their work on that.

Teachers also show that they spend no time in lesson preparation. This can be linked to the problem from the side of the teachers to recognise the need for transformation of their roles as leaders and managers (Fullan, 2001a; Foskett & Lumby, 2003). The teachers of the sample again express their opinion on their work, which they believe should be arranged in detail from the main educational authorities. They do not consider themselves more responsible for issues as lesson planning and classroom organising procedures as well as, which the manager of a learning organisation should conquer.

Teachers' behaviour towards time for preparation and time management during the lesson, puts at risk the progress of the change in primary science curriculum as it prevent the re-culturing of the teaching profession (Fullan, 2001a; Gunter *et al*, 2005).

Summary

In conclusion, the fact that the teachers agree with the need for a reform does not seem to guarantee the equivalently positive response from their side that could lead to the reforms' effective implementation and positive impact on the educational system. The overall picture given by the described reactions of the teachers in Greece, towards the expected problems that emerge in a planned effort for improvement, is not very supportive.

Difficulties that concern teachers' professional development, school structure and equipment, time and financial cost are being confronted by the participants of the research

with policies that are not working in favour of the new curriculum and the ultimate goal of the reform. This is not a peculiarity of the sample of the specific research (Fullan, 2001a; Everard *et al*, 2004). This phenomenon is realised by some participants including one consultant who comments that:

> "*... the change has been planned and organised but has not been applied to school properly. There is a set of mentalities that can only be rejected with difficulty, if they can be rejected at all*" [consultant 8].

Apparently this stated set of mentalities refers to the attitudes of teachers in Greece towards an effort for a reform generally and the difficulties arising along with it. These attitudes form a great barrier to the modernisation and re-culturing of the teaching profession. The teachers in Greece for example prefer, as they say, to accept passively the new primary science curriculum and try to fit it in the problematic school environment, because of the lack of the training, the time or the equipment they feel they need. They do not try to see by themselves what should be done in the classroom, how the necessary equipment can be collected, how the time should be managed, and how the schools' intellectual capital can help to work out these problems. By working like that they miss the essential targets the new primary science curriculum has set, making it difficult for the reform to succeed (Driver *et al*, 2000; Everard *et al*, 2004).

Even though its' significance is accepted, there is obviously a set of obstacles in understanding the general points and dealing with a new curriculum, generally and a new way of teaching and working. This problem can be considered as a result of the basic characteristics that overrun the Greek educational system as the high level of centralisation, especially in the areas of school text-books, lesson plans and curricula (YPEPTH, 1985; EURYDICE, 2002; Kelly, 2004b). Within this context, teachers do not realise that they are allowed a level of latitude, which according to Howe and Stubbs (2003) usually leads to the feeling that they are at the lowest level of the educational structure hierarchy, deprived of any power of leadership. Moreover, lack of experience in similar cases of educational reforms from the side of teachers, which is described both by teachers in comments of them as "*18 years as a teacher no other change has taken place*" [teacher 5] and in literature (Tsakloglou & Antoninis, 1999; Kokkotas, 1998; Kazamias & Zambetta, 2000) could be a reason for this inability to implement successfully the new primary science curriculum.

Had there been a greater effort for the explanation and rationalisation of the change, the new primary science curriculum, its main goals and its vision, this negative situation could have been evitable. If the teachers of the sample had realised the reasons for the reform at a greater depth they could have been able to orientate their work, their methods of teaching and the solutions they come up in order to face difficulties. This is the characteristic of the model of modern effective teacher-leader (Pallus & Drath, 1995; Fullan, 2001a; Howe & Stubbs, 2003) that the change primary science education in Greece aims to help teachers adopt (YPEPTH, 2000; EURYDICE, 2002).

3. RESEARCH QUESTION (3): THE DIMENSIONS OF THE REFORM

As far as the third research question is concerned, it is very important to examine the further dimensions on the reform, which might refer to various functions or structural aspects of the learning organisation or the educational system generally that directly or indirectly are or should be affected by a new curriculum (Fullan, 2001a; Foskett & Lumby, 2003; Everard *et al*, 2004).

Assessment

An important educational topic that should be discussed when a reform is implemented, as it is essential for the appreciation of the progress and impact of the reform is assessment (Fullan, 2001a). When referring to this topic, most of the teachers, head-teachers, consultant, policy-makers and, in some cases university tutors, express ignorance. The introduction of assessment and evaluation is considered essential by various participants, as a criterion for the school function and for further activities of the reform. One university tutor suggested that there is a need for:

> "*...continuous and systematic assessment. Because we have changed the curriculum, we have offered further training to the teachers and yet... the parents send their children to private schools. Why not to the public schools? ... I believe assessment will show what is not working well*" [university tutor 2].

This attitude towards assessment, could help the development of an educational system, that will be suitable enough for change and any kind of effective effort for school improvement (Fullan, 2001a; 2002).

The right held by the consultant to assess educators, within his or her visits at schools (YPEPTH, 1985; EURYDICE, 2002) is known by many teachers, head teachers university tutors and some parents. The consultants themselves however do not really consider themselves responsible for it. On hearing the word assessment in the question, the immediate response of a consultant is:

> "*Now we are stepping in to other peoples' business... I am afraid you are talking to the wrong person. All I can say is all everyone else knows*" [consultant 3].

Responses as this show that, despite the law, the consultants do not consider themselves responsible for carrying out evaluative work. There were various explanations given for this. As another consultant, mentions:

> "*Assessment is certainly necessary. That is sure. But I cannot do it. Whenever I go to schools the only thing I have time to do is just have a cup of coffee with the teachers and talk about the problems they have*" [consultant 5].

The participants consider assessment generally as a responsibility of the Ministry of Education or the major decision making bodies working in co-operation with it, as the Pedagogical Institute. Many teachers and policy-makers state that they have heard about the introduction of written examination in the last years of primary school, in which science is also being taught (YPEPTH, 1985; 2000), but they clarify that no specific information, law had been proposed or voted yet. Alongside that, some participants have described some reasons that could possibly explain the delay of the implementation of evaluating processes. An example of such reasons is the financial cost. Indeed these can generally prohibit the normal work of school functions, including assessment (Foskett & Lumby, 2003).

Motivaiton of the Intellectual Capital

Having examined the attitudes of teachers, it is now important to look further into the opinions and attitudes of other groups of people who could also be parts of the intellectual capital of schools (Kelly, 2004a) that indirectly could be affected by the specific reform, through which its dimensions can be discovered, its general impact on the educational system and the society can be drawn, so that in this way, an overall evaluation of it could be feasible (Fullan, 2001a).

These groups of people, concerning mainly the parents, who should be working as co-educators (Fullan, 2001a) and the high school science teachers, who because of the structure of the educational system are able to assess the impact of the reform to the graduates of primary school (YPEPTH, 1985; EURYDICE, 2002; Kokkotas, 1998), are able to estimate the actual influence of the reform to the pupils' behaviours and scientific literacy. Bearing in mind the necessity for a supportive environment, formed by their relationships with parents, colleagues and generally the community that the teachers need to succeed in applying a reform (Fullan, 2001a; Hagreaves, & Fink, 2000), it is important

to examine the existence of this factor and identify forces or barriers that might act as external forces either in favour or against the reform (Fullan, 1993).

Parents, in general, seem to agree with many teachers in issues concerning the effects of the reform in children's attitude towards the lesson of science. They also agree on the problems and difficulties that teachers face in the science lesson, concerning the equipment and time.

Complaints about the former are not rare in the comments on the parents, among whom one explains that:

> "*... it is not difficult to find the equipment. These are things you can always find in a house. But the problem is that the child has to carry them to school and sometimes it is heavy. And what if... once my child forgets to take it in the school. He is doomed to stay out of the learning process. Is that fair? Children always forget*" [parent 27].

Such attitudes prove a relative inability from the side of the parents to assist the teachers in their problems in spite of a general appreciation towards the problem and a will to offer help (Fullan, 2001a). On the other hand, parents seem to be willing to help the teachers in problems concerning time. However, their contribution is not always beneficial for the reform. As a parent says:

> "*Since the time at school is not enough, sometimes the children do some tasks at home. Teachers told us to do that and it is good because the child likes science a lot. It is amusing for him*" [parent 43].

This could be helpful on one hand (Fullan, 2001a; Hargreaves, 2002), however, it should be guaranteed that the parents are able to assist the child approach the knowledge in accordance to the constructivist paradigm (Driver *et al*, 2000). As seen from the findings this not necessarily the case. That's because parents do not seem to have a perception of the desired outcome from science teaching which is similar to the constructivist view of scientific literacy. Parents frequently mention the necessity for the child to learn and understand the "*important information of science, the concepts*" [parent 1] without a special attention to skills and negotiation of misconceptions. The experimental activities

are often seen as a mean to make "*the lesson more amusing for the children*" [parent 1] and not as a significant part of the knowledge construction. The same treatment is enjoyed by the integrating activities of the new curriculum. In addition, they make no reference in the necessity to apprehend the nature of science and develop an understanding of the process of constructing scientific knowledge. All those points show that parents do not appreciate significant aspects of the most recent perceptions on science education. Under these circumstances, any kind of teaching and learning activity that takes place at the learners' home under the surveillance of the parent is unlikely to follow the instructions of the new curriculum (Driver *et al*, 2000; Hofstein & Lunetta, 2004).

In other words parents do not seem to disagree in taking part in the educating process and contributing this way to the teachers' work. This is enhanced by the enthusiasm expressed for the new curriculum. Due to false or missing ideas and instruction on behalf parents' though, the change objective is not reached (Fullan, 2001a).

The causes of this problem could be linked to inadequate effort for the provision of information from the school about the vision of the reform and on instructions that parents need to follow in order to assist students' learning. This is known as a barrier to reform. It is important for the reasons and the philosophy of the reform to be explained and agreed to the parents, who are to work as co-educators, therefore as co-agents of change (Fullan, 1993). The issue of not successful vision dissemination is brought up again. However, since this information and explanation is probably a role of schools and teachers, who claim that they don't get the necessary instruction, parents are highly unlikely to be provided with it.

Moreover, specifically in the case of primary science education, if teachers are not applying the constructivist approach and have insufficient mastery of the new teaching approach, not only are they unable to apply the primary science education reform but they cannot help the parents understand the new approach and its rational (Fullan, 1993; 2001a).

Teachers and parents mention that the already existing institutions that link parents with schools, as monthly or weekly meetings between teachers and parents, are not effective serve the mission of informing and preparing the parents' work as effective co-educators. Providence on establishing a new method of communication between these two groups was probably not taken and than seems to form another barrier for change (Fullan, 2001a).

It could be a risky statement to mention though that effective dissemination of the reasons and the theory of the reform, by itself would have been able to convince and prepare the parents to co-educate their children as the new primary science curriculum and teaching paradigms would require. As it happens with the teachers, if the reform is to be applied properly then parents have to give their consent to it. Unless parents approve the philosophy and value of the new method of science teaching they cannot give the required support to the teachers, no matter if the necessary training has been given to them (Fullan, 2001a; Everard *et al*, 2004).

In this point a basic characteristic of the Greek family meddles. As seen both in literature and in the findings parents are strongly concerned about the performance and career of their children at higher levels of education (Kazamias & Zambeta, 2000; Fullan, 2001a, Zambeta, 2002). The vast majority of parents when describing the expectation they had for their children from the lesson of science include that pupils should:

> "*...obtain that basic knowledge that is required so that he will have no problem in the subject in high school*" [parent 14].

Beliefs such as these demonstrate the hidden dilemma, which is relevant to science teaching and education generally and concerns the real benefit, by an academic point of view that students will gain from the development of skills and the understanding of the nature of science. As Bartholomew, Osborne and Ratcliffe (2004) argue, since when the students are assessed their evaluation is mostly focused on concept understanding and using, it is dubious whether emphasising skills is helpful for the children. Teachers do not deny that:

> "*... when the time for exams arrives, what will we check? Concepts. Simply concepts. I won't tell the children, to carry out an experiment.* " [teacher 19]

Parents, being aware of this situation are not very much concerned about their children developing post-cognitive skills and an accepted perception on the nature of science and scientific knowledge. They pay more attention to the learners' understanding of knowledge as it is being offered (Driver *et al*, 2000; Osborne *et al*, 2003). By not accepting and appreciating new norms on science teaching they increase the teachers' difficulty to apply it (Driver *et al*, 2000; Fullan, 2001a; Pinto 2005).

There is an intense level of worrying in the family about the learners' future success in the exams. The educational systems still insist on sets of methods of learners' assessment, which are centred in their performance in exams (Osborne *et al*, 2003; Bartholomew, Osborne & Ratcliffe, 2004). The stress that characterises Greek families, even from the younger age of the child, of the desire for successful results in exams in future, especially in the exams that judge the entrance to the University is apparent (Kazamias & Zambeta, 2000; Zambeta, 2002). A new curriculum for primary science, supporting a new method of science teaching, attractive though it may be, cannot alter this situation, which, in response, is affecting this new curriculum negatively (Fullan, 2001a; 2002).

Parallel to that, is the issue that parents perceive their role not as much as co-educators, but as assistants or substitutes for the teachers when the child is at home. Most of them answer that at home they don't spend a lot of time with their children discussing about phenomena or activities, which are relevant to lesson of science, as boiling, electricity that can be seen, found or done in the house. These phenomena are included in the actual experience of pupils and, by discussing them with their parents they could be helped to increase their background not only in science but in the constructivist approach and the development of post-cognitive skills and the ability of learning how to learn by itself (Driver *et al*, 2000). In the parental opinion, learning is almost totally a mission of the teacher and the school. Only a minority of parents considered the environment at home a suitable place to enhance the young learners' education, as a supplement to the work done in the school. This conclusion is justified by the frequent comment of the parents, who when answering the relevant question, say that:

> "*If my child tells me that he has a problem, a question around something that has to do with science, e.g. ..., the other day he was telling me about the vaccination cause he's having one soon. I advised him to ask the teacher, as I think it is the schools' work. The teachers know better*" [parent 41].

Responses as that are also given, in some cases by parents, whose occupation is relevant to science as electricians, pharmacists as claimed by them too.

This shows that most of the parents consider education mostly a responsibility of the school and not the family. This is not positive for the progress of the reform, taking into thought the fact that the new primary science curriculum wants pupils to understand

how to learn from experience and from personal curiosity. The practices, beliefs and methods that were used by the parents before the reform was introduced have not being rejected (Driver *et al*, 2000; Fullan, 2001a; Everard *et al*, 2004).

The hesitation of parents to adopt a new perspective around their role as co-educators probably can also be attributed to their concern around the pupils' progress in high-school and in the examinations, which follow. That concern leads many parents to insist in the understanding from the pupil of the knowledge which is being taught and therefore assessed in school. Parents face the dilemma whether they should emphasise on the knowledge that will be more useful for pupils in their everyday life or the knowledge that will help them succeed academically. These two kinds of science knowledge are not always compatible (Driver *et al*, 2000; Kokkotas, 1998; Osborne *et al*, 2003). In the light of this necessity for success in the exams which pupils will sit in future (YPEPTH, 1985; Kokkotas, 1998, EURYDICE, 2002), they decide to pay more attention on the latter. This is also a reason for which parents, in their effort to help their children perform well in science and in school generally prefer not to take the responsibility of the learners' school preparation in their hands, but to run into other solutions, as private tuition. A parent, who belongs to this category explained:

> "*I help my child and so far, he does well at school. Now if I saw that he had a difficulty in following the school, I would immediately get a teacher* [for private tuition]" [parent 67].

The issue of private tuition courses, which has been major in Greece and influences the reality of Greek Education and any effort for reform (Zambeta, 2002), is meddling in here too, not leaving parents to re-culture their role as educators (Fullan, 2001a; 2002).

This attitude can be related to the fact that only a limited number of parents expressed dissatisfaction of the communication and co-operation they had with the educator of their children and a need for the establishment of more close relationship between themselves and the schools. The most frequent comments by parents about this issue were, for example:

> "*...we meet with teachers, frequently, once every month, to find out how our children are doing. There is also the parents' council... they are concerned about activities of the school as excursions, celebrations... Yes, we are in*

touch with the teachers, school... other parents there is no problem in that" [parent 57].

Even though there are negative comments about the general functions of the school, parents are not very willing to change their role and increase or transform their level intervention in them, which can be helpful in cases of reform (Fullan, 2001a; Everard *et al*, 2004).

In short, the family environment, despite the enthusiasm about the new primary science curriculum and the new science teaching approach promoted, does not seem to respond by updating its role, attitudes, expectation as it should expected in order to assist the primary science education reform (Fullan, 2001a). Parents still consider learning a major responsibility of schools and insist that the role of the home in learning is not that significant. On the contrary they believe that their mission is to supervise and assure that pupils are being prepared for school. The still existent and, as described, growing concern of the family for pupils' performance in future exams (Kazamias and Zambeta, 2000; Zambeta, 2002), does not allow parents to pay attention on anything else other than the pupils' relationship with academic knowledge, which is being assessed in these exams. No mention is made on behalf of parents about a desire to change this situation (Fullan, 2001a). This prevents the re-culturing of family environment and its reformation to a field that favours learning through experience and constructivism that the primary science education reform tries to promote.

In conclusion, even tough parents agree with the necessity and the positive results of new primary science curriculum, they still act unable to offer their fruitful support to teachers in their effort to establish new norms on science teaching. This problem is probably due to missing information, instruction and collaboration with the organisation. Because of that another difficult barrier is being raised in the implementation of the new curriculum. This barrier can diminish every opportunity for future reform in this area, since no emphasis is being paid on what the role of parent should be and how it can be transformed (Fullan, 2001a).

Sequel with Secondary School

As far as the secondary science teachers are concerned, through their answers, it is made clear that the reform did not manage to improve the preparation of primary school pupils for secondary school. There is an obvious disbelief on the significance of primary science curriculum reform. This is realised in comments of secondary science teacher as the following:

> "*If we really want to change the curriculum, we have to transform it with a united curriculum for all 12 years of education, from first grade of the primary school until the final grade of senior high school*" [secondary science teacher 6].

Indeed none of the high school teachers admits to have observed better performance in science subjects, as physic, chemistry and biology, in high school, from pupils who have studied primary science with the new curriculum. This improvement in the performance though was not expected, by them either. This attitude, which has as symptom the merely automatic rejection of the outcome of the implementation a new curriculum, does not seem to encourage secondary school teachers understand their role in the reform and work as agents in the change process.

This gives evidence of a mutually preserved distance between primary school and secondary school teachers. There is a missing connection between the two different levels of education. Having in mind that secondary school can be considered a force creating a set of criteria, standards or demands for the primary school to meet, which makes it part of the wider environment of the primary school and vice versa, as well as the importance of such connections for the success of the reform, it is easy to see, the reasons for which this attitude is not helpful for the reform (Fullan, 1993).

It should normally be encouraging that there is a non negligible number of the participating secondary science teachers, who consider this primary science education reform as a "*worth praising effort*" [secondary teacher 9]. Moreover, there is generally a connection and compatibility between the beliefs of primary and secondary school teachers around the actual objective of science units, as well as the background and knowledge that pupils should be qualified with, when leaving primary school in order to attend the specific units in the junior high school. Under these circumstances the effort for school improvement, would be helped since there is a common vision around the mission of teachers and the goals of teaching process (Fullan, 2002). However, as Foskett and

Lumby (2003) argue beliefs and sayings are not always a mirror of the reality. More specifically, in the reform studied, this is seen from the responses of high school teachers who clearly state that on no occasion can they start teaching science to their new students, based on the previous knowledge that the students are expected to have gained from the primary school. This commonly given answer of certainty is that pupils have forgotten most of the knowledge taught in primary science, by the time they are due to study science at secondary school. This cancels every effort for improvement in primary science education, as the outcome is not going to be appreciated (Fullan, 2001b).

This attitude could be attributed to many facts, as the secondary science curriculum, within which, during the first year of secondary school learners only have a unit of biology, whereas the units of physics and chemistry are being taught for the first time during the second year (YPEPTH, 2002). This might justify the claim of many participants, not only secondary science teachers, for a single science curriculum, covering the whole 12 years of primary and secondary education.

Another fact that enlarges the gap between primary and secondary education is the wide-spread belief that primary school teachers, since they are not experts in science are unable to teach this subject effectively. Bower (1994) considers this attitude a myth, which emerges in every effort for improvement of science teaching and has its roots on two different phenomena. The first links to the difficulty that teachers who have to carry out a reform have, while trying to realise the procedures that they actually have to follow. The second is the linkage of desired outcomes of science teaching with the understanding of science content instead of process as modern theories on science education suggests (Driver *et al*, 2000; Osborne *et al*, 2003; Pinto, 2005).

The misapplication of constructivism in science teaching in primary school, as seen in the teachers' findings could reinforce secondary science teachers' attitude to neglect knowledge that pupils gained from primary school. Apparently, Fullans' (2001a) suggestion that change needs time in order to show results enjoys no respect from some educators.

It would be a great omission though, not to mention the influence that competitive character that high school and the general examinations at the end of the third year of senior high school have in this situation (Zambeta, 2000a; 2002). The teachers, even in secondary school are very concerned at teaching the required units in order to assure that pupils will know the material and sum of information that has to be assessed. Under these circumstances of pressure, teachers show no interest in introducing the constructivist

approach in their lesson (Bartholomew, Osborne & Ratcliffe, 2004). This is shown in comments of secondary teachers who claim that:

> "*We are given a laboratory guide, which includes experiments that have to be done, but few teachers actually use it as there is no time. Plus our work is oriented in the exams at the end of the year*" [secondary science teacher 24].

Since the knowledge assessed is included in the secondary science curriculum, teachers see no reason to take advantage knowledge gained thanks to primary science teaching. Therefore, there seems to be no interest from the side of secondary school to share a vision for the constructivist approach in science teaching in the primary school. The general structure and characteristics of the Greek educational system present barriers that do not allow such innovation, especially when tried at the level of primary education, to take place (Zambeta, 2000).

The problem in high school though, cannot be attributed only to the fact that the change took place simply in primary school. In contrast to the situation in primary school, secondary science teachers mention that changes in the text books were rather frequent in their field, which on one hand would reinforce the ability of the secondary school to accept change and the ability to co-operate with and support primary school, whenever change in the latter would take place (Fullan, 2001a; 2002). However, the changes as it was clarified to the teachers were rather "*superficial*" [secondary science teacher 5] as they were not bringing about any new method of science teaching. Rarely are they frequently to the level of the curriculum and if they were, it is not considered as important for the teachers, among whom one explains:

> "*...the only significant change I have seen was in a book that tried to make the lesson more familiarised with students' experience... and that once we had the opportunity to choose between two different books. There was no difference in the teaching method and all these have changed now.... when the priority is to prepare students for the exams, what is the point of such changes?*" [secondary science teacher 9]

These attitudes along with the influence and significance paid to the written exams justify the findings of Kazamias and Zambeta (2000) about the hindrances that cannot permit any educational change to be effectively introduced in the Greek educational system.

The basic conclusion of these findings is that for various reasons, there is no connection between the two different continuous levels of education. The disbelief that secondary teachers hold against the work of their primary school colleagues, in combination with the emphasis they are considered to be obliged to pay at the preparation of pupils for the future competitive examinations do not leave any margin for a new curriculum to lead to school improvement, especially when this curriculum refers to primary education. This situation is a clear example of the juxtaposition that Senge (1990) has described between a desired change theme and a conservative educational system, where despite the acknowledged need for a reform, the educational 'status quo', which in the case of the Greek secondary school is linked to the competitive written examinations, cannot help a change to have profound impact not only in secondary but in the primary school that, due the system structure, secondary teachers can assess and assist (Fullan, 20001a; EURYDICE, 2002).

This status quo does not allow teachers to act as agents in any effort for deeper reform (Senge, 1990; Fullan, 2001a). This is seen in responses of secondary teachers –and generally all participants– who do not seem to appreciate an establishment of the missing closer link between primary and secondary school. The most frequent suggestions and proposals of secondary teachers, specifically, refer to the provision of further training and school equipment. Unless, the need for a strong connection is realised through, any effort done to improve curriculum and teaching at the level of primary school is foredoomed to be ignored and neglected by the high school teachers, which cannot help the assessment and sustainability of the reform (Fullan, 2001a).

Summary

A thorough investigation of the wider environment that surrounds primary schools in Greece seems to provide no support for modernisation, improvement and transformation of the school to a recent learning organisation. The forces that overrun this environment are not leaving any room for change plans to show any results, which automatically prevents progress to emerge (Fullan, 2001a). The idea that currently used practices and methods have to be replaced as they are no longer found to be effective is multi-stated. Nevertheless the barriers that force their preservation are not being examined and the

reforms taking place do not seem to have them into consideration (YPEPTH, 2002), which Fullan (2001a) would not consider a correct policy to their alleviation.

Parents and high school teachers remain focused on the preparation of pupils to succeed in the general examinations to enter the university (Zambetta, 2000). Since these examinations focus only on science as matter, as a sum of concepts and information, the development of post-cognitive skills and critical thinking, the negotiation and rejection of misconceptions, the apprehension of the nature of science and generally the development of the pupils' ability to learn how to construct knowledge by themselves, which are the objectives that recent theories on science education promote (Driver *et al*, 2000; Osborne *et al*, 2003; Pinto, 2005) is receives only little appreciation. This is inadequate for systemic and sustainable reform (Fullan, 2001a).

It is not only the new teaching paradigm that is not helped by this situation. The pressure applied to pupils from family and school, which is considered to be important and inevitable does not act as a factor that can work in favour of a new school management structure and leadership practice either. The insistence on the learning of information as it is presented in the books shared by the Ministry of Education (YPEPTH, 1985; 2002), does not help the teachers formulate policies concerning the instructional material that has to be used in the lesson, as it is through to be an insignificant issue. This kind of behaviour does not suit a successful reform (Bianchini & Kelly, 2003).

Schools are also deprived from the act of evaluating their own functions as pupil assessment is based totally on their performance in the nation-wide exams, in the process of which, the school has simply the authority of an exam centre (YPEPTH, 1985; EURYDICE, 2002). Pupils' outcome management is considered to be at a large extent a responsibility of the Ministry rather than the educator or the school. The raking assessment and teacher centred system is being accepted.

The wide-spreading belief of the system' malignancy should normally lead to the replacement of such models with others that include interdisciplinary traits, student-centred lessons and activities (Foskett & Lumby, 2003). However, even though it is considered to be problematic by many participants, there is little thought from their behalf around ways that might confront it.

The dimensions of the reform are simply limited to the level of primary science curriculum and teaching. This shows again how little and negligible the impact of the reform on school culture is, which acts against the sustainability of the reform (Fullan, 2001a; Fullan, 2002; Everard *et al*, 2004; Bush & Middlewood, 2005)

4. RESEARCH QUESTION (4): THE MANAGEMENT OF THE REFORM AND ITS IMPACT ON THE PUBLIC UNDERSTANDING OF SCIENCE

As far as the public understanding of science is concerned, there seems to be no impact of the primary science curriculum reform to it. Teachers' persistence on previously used attitudes, which is shown in their responses, cannot let them change their idea about the subject and the essence of science. No reform in science education can be sustainable under these circumstances (Driver *et al*, 2000; Fullan, 2001a; Pekmez *et al*, 2005; Pinto, 2005).

The Public Understanding of Science

The impact on public understanding of science is also undermined due to the fact that teachers of the sample neglect the essence of constructivism, by taking no account of the misconceptions of pupils. Moreover, there is the justified strong concern and emphasis from the sides of teacher and parents on the general exams to enter the university. This concern, as described in literature (Kazamias and Zambeta, 2000; Zambeta, 2002), and seen in the study, does not let attention be paid on what is learnt in the science subject. There is only focus on if the subject is being learnt. Unless teachers and the parents realise the change attitude towards science and stop treating it as a sum of information to be learnt and assessed, the public views of science cannot be changed (Levinson and Thomas, 1997; Driver *et al*, 2000; Pekmez *et al*, 2005)

The complexity and subtleness of the management of change and reform in education and specifically in the science curriculum, is seen through the responses of teachers, parents and head-teachers. An examination of the curriculum, teaching practices, beliefs and understanding of people involved in education, which according to Fullan (2001a) are the dimensions that change affects directly, shows that even though the first is changed, it is very unclear whether the second and the third are affected by the primary science reform as expected, in order to achieve sustainable reform that will affect the totality of educational system and the public understanding of science (Levinson & Thomas, 1997; Fullan, 2002).

The validity of Thomas' (1997) conclusion around the need for a general shift in managerial actions is justified proved in the study. Teachers claim to be aware of the need for such a change in science teaching and express dissatisfaction. The focus of science

teaching, however, does not move to skill development and the link between science and experience, despite the instructions of the new primary science curriculum. This way, sustainable reform is unlikely to occur. This situation could be a result of the general attitude that teachers hold about their role in the hierarchy of the educational system. In other words, a barrier to primary science reform implementation could be the lack of realisation from teachers around the role they have to perform as leaders and agents of the reform, who satisfy standards of a recent learning organisation (Fullan, 2001a).

It is possible that this phenomenon is caused since the factor that Davis (2002, p.5) names as 'key ingredient' in primary science reform, which is teacher learning and acquisition of new ideas, knowledge and sills that will enhance, complete or replace the previous (Anderson & Helms, 2001), is missing from the Greek educational community. Successful implementation of new teaching as set by the new Greek primary science curriculum (YPEPTH, 2002) would require from teachers to understand new practices and make skills required for those a part of them (Fullan, 2001a). There is a promising warm welcome from teachers to the new science curriculum, the reform tries to introduce and its necessity. This reveals an effort towards this direction by policy-makers, university departments and consultants, who are mostly responsible for teacher training (YPEPTH, 1985). This by itself, though, is not sufficient to prepare teachers for their transformation to leaders and managers. This kind of training probably cannot alter the attitudes of the teachers, who even though have the knowledge cannot apply them (Foskett & Lumby, 2003).

Missing Training for Reculturing of teaching profession

Most of teachers claim that the training they receive, usually from routine seminars, does not provide them with necessary guidance to teach science effectively under the new primary science curriculum. That point that reminds of Bell and Gilbert's (1994) statement, according to which, any teacher-development program should include support, feedback, and reflection and not an overall specified program such as the usual in-service programs provided by central educational authorities. Besides, there is a need for much interaction between the teaching task and learning activities, which should take place throughout the year and not only at the beginning of the school period. There is a variety of causes that bring on this obstacle. The problem around teachers' training is described by a university tutor, who even though mentions that there is a growing number of

opportunities for teachers to receive training generally and specifically about primary science, suggests that:

> "*We need a mechanism... through the universities, the educational administrations of each prefecture... to disseminate the findings of research directly to the schools. Because at present, this happens is a vestigial way*" [university tutor 2].

Comments as that reveal shortage of information that is actually being provided to teachers through the existent opportunities for further education. These comments, in combination with the teachers' basic complaint about lack of the required instruction, show that teachers are not ready to adapt themselves in this new teaching philosophy promoted by the new primary science curriculum. The response given that the teachers demand is too detailed as it includes specific instructions and lesson plans that do not suit the recent learning organisation (Kelly, 2004b) shows the lack of confidence or awareness for their role as leaders.

The root of this problem might be located on the kind of training offered, which if unsuitable is unable to help the reform succeed (Fullan, 2001a). There is a general agreement among the participants that there is further education concerning the reform in primary science and science education generally. The barriers to the implementation of the new primary science curriculum though do not seem to lie only in the area of the actual science teaching, but the teachers' attitude towards their work, their responsibilities and their position in the educational system and in the case of an educational reform. The training that teachers need should also refer to their role, which becomes more complicated, and their perception on their profession, as members of the learning organisation. This new training is not restricted to the findings of science education research, pedagogy and learning psychology. It expands to the area of management, the skills of which are essential for an organisation as the school, which is being submitted to perpetual changes and needs to familiarise its' structure and culture with it (Fullan, 2001a; Everard *et al,* 2004).

Indeed, a university tutor justifies a need for more in-depth further training on school management and leadership issues by saying that in Greece:

> "*School management is a new unit in the Universities. Up until recently, the only opportunity that teachers had to learn about school management was during the didaskaleia* [2 year courses providing in-service training]. *Even then, the only thing taught was the law and the legislation, ... Issues as resources or personnel management have only just started to be taught to teachers or trainee teachers*" [university tutor 5].

This missing training around school management and leadership can explain many problems that teachers face and many complaints that teachers have in trying to implement the primary science reform which they approve of.

An indicatory example is the problem of school equipment and the relevant problem of financial cost, which many participants believe that should be supplied by the government. This problem could be worked out if teachers understand and appreciate that their mission as managers is to develop and activate necessary skills of managing resources or schools' intellectual capital (Kelly, 2004a), in order to come up with necessary teaching materials.

The same issue applies for the problem teachers and consultants claim that there is with time, which is limited in their opinion. Since teachers do not feel more entitled to plan lessons by themselves. They only feel obliged to follow, even unwillingly, instructions as included in the teachers' book They do not decide to make any interventions, which is a basic characteristic of teacher leaders (Fullan, 2001a; Howe & Stubbs, 2003), they ignore. Probably no information or training on this aspect of their work is provided to them.

Teachers' hesitation or inability to come up with their own lesson plans in order to carry out integrating activities that have recently been introduced and are emphasised in the new primary science curriculum in programs as the Flexible zone, health and environmental education (YPEPTH, 2002; Kokkotas, 1998) can be a result of the lack of this training as well. Since teachers have been so far applying already designed lesson plans (YPEPTH, 1985; Kokkotas, 1998) and have no instruction on how to arrange an educational activity, manage resources, time and place, they decide to follow passively these programs and insist on working in the routine they are used to. This kind of reaction is common in cases of reform (Fullan, 2001a).

In fact, the law that dictates the context in which the primary school works, that was introduced in 1985 does provide teachers with the right to form bodies through which

they can act as leaders and make decisions concerning their work, teaching materials and methods (YPEPTH, 1985). Teachers of the sample make no mention of this law. Apparently there is ignorance of this entitlement, which can be attributed to the existence and provision of specific text-books and teachers' book, as well as a detailed curriculum from the Ministry of Education. This kind of teaching packages, which are basic characteristics that label the Greek Educational System as highly centralised (Kazamias & Zambeta, 2000; EURYDICE, 2002), are found to be ineffective by research (Kelly, 2004b). Unless Greek teachers understand that, in opportunities as any course for further teacher training offered though, it is unwise to expect them to act as leaders and no change on that direction can be achieved (Fullan, 2001a; 2002).

University tutors generally commented that lack of activity of teachers as leaders and put the blame for the failure of reform efforts on that. A characteristic response from a tutor was:

> "*Teachers do not know how to act as managers ... managers in the classroom and managers generally. That's the way they are used to. And OLME* [the syndicate of teachers] *is only concerned about financial matters and not on other important issues. All those years, I have never seen any strike from teachers claiming for example more concrete freedom, more... how can I say it... flexibility for teachers to work on their own plans... Or they could demand more direct participation in decision making, which they say they don't see. But they don't claim it... OLME only wants pay rise pay rise pay rise....*" [university tutor 7]

In short the difficulties that Greek teachers describe as inappropriate instruction, funding, equipment, time and space (Everard *et al*, 2004) can be dealt with through the development of managerial skills that the teacher-leaders who work in the learning organisation are called to master (Fullan, 2001a). As Fullan and Miles (1992) state, such teachers-leaders are required that in order to have fertile efforts for change.

In the case of primary science education in Greece, the answer to the question that according to Barab and Luehmann (2003) that policy-makers and designers need to consider when a new curriculum in science is being designed a question, which concerns the possibility and the option of the new curriculum to actually tempt teachers and every person to change and re-consider their role in education seems to be negative.

Missing support from the environment

At that point it is necessary to examine the influence of the surrounding environment in teachers' work, in Greece. The importance of that issue is underlined by Randi and Corno (1997) especially for the teachers' difficult task of planning decision making. This influence might be channelled from the teachers' practical experience; the basic characteristics of pupils and; the expectation that parents have for their children from school, characteristics that differ from classroom to classroom (Pinto, 2005). It is this differentiation and its impact on teachers' work that Kelly (2004b) believes makes the teaching packages that are currently in use in the Greek Educational system ineffective. This ineffectiveness has been stated indirectly by some participants, as one consultant who states that:

> "*We need a text-book that reflects clearly the goals of the curriculum, because now this does not happen. There are many things that the curriculum wants but the books do not include and vice versa*" [consultant 8].

Remarks as the one above show that it has been realised that curricula in Greece, in their current form, do not have the ability to be applied as they are, in terms of objectives, learning methods and techniques, in a text book , even though such curricula are demanded from teachers.

Probably the option of a curricular reform, as the single dimension of change, does not encourage teachers to change. Teachers still want the detailed curriculum, lesson plans and educational material already prepared and in their majority do not present evidence of will to take initiatives. There are some given explanations for this reaction, by some teachers, as one who mentioned:

> "*I am afraid of taking initiatives. I am afraid that parents might react. This has happened to colleagues... one of them prepared a theatre play for her pupils, the theme of which were the pirates and ... when the parents saw the play... they sued her because they thought that the play had some words or scenes that were not unsuitable for children, as when the pirates were talking about earrings or rum. The parents SUED the teacher! Knowing that I am not confident of designing something on my own*" [teacher 15].

Apart from that, other presented phenomena of the surrounding environment that that prohibit teachers to undertake more responsibilities than before, in order to carry out the reform effectively (Fullan, 2001a; Barab & Luehmann, 2003) are presented in answers of teachers as:

> "*In our school we frequently try to plan visits to museums, galleries, laboratories, hospitals, all those places ... this is included within the constructivist the cross curricular approach that the reform wants. But we have limited access to these places. We call to see if we can take the children, they tell us no, it is dangerous, we are busy sorry. So we stay in the classroom ... and do the lesson as we are used to*" [teacher 57].

There are also problems of financial nature not only in terms of the reforms' cost which Fullan, (2001a) Everard *et al* (2004) describe but in terms of teacher salaries and living generally, as shown in the statement of the consultant according to whom:

> "*Our teachers* [the teachers in his perfecture] *do not have a lot of time to invest in lesson preparation. Their salaries are low. Most of them, those who have families, right after leaving school have to do a second job in order to keep their heads above water*" [consultant 4].

These responses justify Fullans' (2001a) comment about the necessity of a supporting environment for a successful resulting of the teaching profession and modernisation of the learning organisation.

The attitude of many Greek teachers to focus their work only on the attainment of standards set by the curriculum, does not encourage them to consider the official provision of feedback as part of their mission. A change process that can actually bring on desired school improvement should be treating teachers as partners, who can assist, observe, supervise and evaluate the reform and the new curriculum in action through their work and experience (Barab & Luehmann, 2003). Change is more likely to survive in an environment of the collaborative culture, where information flow and co-operation among educators or between schools and policy makers and other community members can

contribute to the clarification of the vision and the examination of the possibilities to work out problems and barriers of the reform (Fullan, 2001a; Wallace, 2003; Barab & Luehmann, 2003; Everard *et al*, 2004).

Missing Teacher Collaboration, Co-operation and Participation in Decision-Making

The acceptance of the reasons and the necessity of primary science education reform, are possible to work as impediments rather than facilitators. Fullan (1993, p. 28) states that "vision emerges from, more than it precedes, action". This means that the required shared vision should be built through an on-going interaction, collaboration, co-operation of the educators and all the organisational members the experience, skills, qualification and knowledge of which forms the intellectual capital (Kelly, 2004a) that the organisation will use in order to take advantage of this reform and influence not only itself but the whole educational system (Drucker, 1999). This shared vision, according to Senge (1990) will be the resultant of each member's personal vision. In the case studied, this personal vision is existent, as the participants had ideas and suggestions to propose for further efforts for improvement. The task that leaders, who act in the field of education are expected to perform is to exchange their visions and ideas with the other members in order to influence the composition of the strategy through which improvement will be reached (Wallace, 2003).

The teachers, in Greece still rely on the already existent methods and institutions for this purpose. These methods set consultants as a key factors, as it is them who will are expected to organise seminars, pay regular visits to schools in order to be informed about teachers' works and read reports that teachers fill in at the end of the academic year where they include comments about their working environment, conditions and suggestions. Consultants, thanks to the systems' hierarchy, are the mediators between teachers and decision makers (YPEPTH, 1985). It is therefore no coincidence that the term "consultant" comes up frequently when teachers refer to instructions and guidance they receive and their collaboration.

There is a general realisation though that new methods for communication and collaboration of educators between themselves should be introduced. This realisation is strong among consultants who claim that time pressure and excessive weight of work does not permit them to be as close and supportive to teachers as they should, a point that is shared by a minority of teachers as well. More specifically, one teacher said:

> "*I would suggest that we had seminars once every trimester, and there we would meet teachers, and others parents, high school teachers, consultants, curriculum designers to talk, tell what we see, what we want, what problems we have, what we cannot do.. This does not happen now at all. What we have now is very feeble. We are on our own*" [teacher 7].

Such comments hide dissatisfaction towards mechanisms that process individual ideas and visions. Due to this situation the effectiveness and success of the reform is put at risk (Fullan, 2001a).

There is a general admittance that co-operation and communication between teachers especially from different schools is very limited. Only a small number of teachers mentioned that they try to keep in touch with colleagues as a mean to come up with ideas about their work, which most of them found to be usually helpful in many cases:

> "*Communicating with other teachers... it is usually up to our relationships, friends etc. it does help up to a point. OK if they have the same problems with us, how much can they do, but overall it helps. At least I know that I am not the only one having problems*" [teacher 22].

This 'unofficial' [teacher 1] means of communication, collaboration and exchange of information seems to exist among certain teachers or to enjoy the respect of a measure that can lead to the solution of the problems that schools face. According to another teacher:

> "*We* [the teachers] *need to follow the examples of some schools who, managed to gather the money they needed for a science laboratory through the parents council. These strategies of the other schools need to be studied if the change is to succeed"* [teacher 13].

The idea that communication between schools can help the establishment of policies that are in favour of the reform is slowly being realised, which is sign of reculturing (Fullan, 2001a; Everard *et al*, 2004).

Parallel to that, few participants state that they search for support on the Net. Information and Communication Technologies have been proved as an effective tool that

can be very helpful during the application of a reform (Davis, 2002). More specifically, the teachers refer to:

> "*...web-pages of other schools or educational forums on the Net. There other teachers explain their experience, present educational material; how they deal with other problems... we find useful advice there*" [teacher 29].

The fact that these solutions are mentioned by only few teachers, shows again that new practices that concern communication and collaboration between teachers and schools and have to be used are not that wide-spread and their importance is not widely appreciated. Under these circumstances, teachers are unable to share their personal vision for reform and contribute to the establishment of the shared. Even though this personal vision exists, members of learning organisations finally accept the one imposed to them. Senge (1990, p. 211) would state that in this case, "the result is compliance, never commitment" from teachers' side to the purpose of change.

Forces that cause this problem, which might derive from hesitation of teachers in Greece to communicate or share ideas or ignorance of its value, can be also a result of the lack of a suitable policy on behalf of head-teachers, who, responsible for management of the learning organisation and its members as they are, they need to reinforce communication between schools, as essential part of teacher training and support. As leaders they have to develop the skill to communicate with others themselves and then try to cultivate them to the educators (Bush & Middlewood, 2005). According to participants though not only is this not happening but there is no evidence of consciousness of the urgency of this action from the head-teachers. Those few participants who discuss about the role of the head teacher in the case of the curriculum reform, usually responds by saying:

> "*The reform concerns simply the actual lesson of science. Unless the head-teacher is teaching science, there is no impact on his work*" [teacher 48].

Despite the fact that the necessity of communication between teachers is understood, there seems to be a problem in identifying factors that can establish this required communication. This is another example of a common, among participants misconception or misunderstanding of the actual root of the problem that creates the barrier to reforms in

Greece, which as is not being dealt with or realised it has to be dealt with, calls off any effort for curriculum and school improvement (Fullan, 2001a).

As far as the role and the responsibility of consultants in this topic is concerned, participants overall agree that consultants in their prefecture have been motivated in order to prepare necessary seminars for teacher preparation, as soon as the new primary science curriculum and text-books have been introduced. However, during these seminars emphasis is paid only in the teaching of the new perspective on science education and not that much in the exchange of ideas. Most consultants explain that communication between teachers themselves or between teachers and other members of the educational system and community is not enjoying the required respect. An indicatory answer given by one consultant is:

> "*If teachers have any problem or query, they firstly refer to the head-teacher who will then transfer it to us, consultants, and then we will transfer the problem in Athens* [in the Ministry of Education or the Pedagogical Institute]" [consultant 1].

This comment indirectly clarifies the missing element of the effort done by individual teachers or groups of teachers and generally members of the learning organisation to create, mainly through communicating, a policy through which problems and obstacles that arise whenever a new curriculum or a reform generally is introduced. As seen in this comment, this is considered to be a mission of policy makers instead of teachers, who this way, avoid taking responsibilities that are required from their side, as agents of change (Fullan, 1993).

Equivalently limited are the opportunities offered to Greek teachers to participate in decision-making processes as curriculum design. There are mechanisms which are set up for this reason by the law (YPEPTH, 1985) but teachers either do not mention them or do not consider them adequate. Even though policy makers claim that one reason that lead to the reform was teachers' complaints about the ineffectiveness of the previous curriculum, it seems that the bureaucratic central authorities are proved to be paying limited or not respect to the teachers' experience, when deciding what new curriculum should be (Ifanti, 2000; Bush & Middlewood, 2005). A reform planned under these circumstances is probably bound to failure as it is difficult for it to be in sufficient agreement with teachers' opinion and feasible (Fullan, 2001a). Problems that teachers and consultants

mention that they have in terms of time, equipment, and instruction are considered to be a result of their absence in curriculum design tasks.

The attitude that Drucker (1999) believes teachers-managers, who work in a learning organisation should develop to treat change as a window chance for them to affect the educational system is not being promoted in the Greek educational system in the case of primary science education reform. According to one university tutor:

> "*The only case when teachers can actually let the Pedagogical Institute know about the school reality is through published research done in the schools or when teachers participate in conferences and seminars... the teachers' experience is this special missing ingredient we need for effective curriculum...* " [university tutor 7].

The Missing element of Modernisation

The modernisation of the primary science curriculum should be accompanied by a modernisation or improvement of other functions of the system (Fullan, 2001a). It seems that in Greece this measure is not appreciated.

However there seems to be no effort in order to change this situation either. Among the participants, especially the teachers very few actually mention that they consider the increase of their participation to decision making necessary for school improvement. There are of course comments:

> "*We fill in the reports at the end of every year but the question is who pays attention to them. So many years I have seen very few things that we* [teachers] *ask in these reports to be finally done. And, never have I seen someone coming in touch with me to ask, for example for a further definition, an explanation of what we had written in a report*" [teacher 64].

Even participants who state these comments though, do not suggest that, in the light of the ineffectiveness of the currently used functions (YPEPTH, 1985), they should start having more reinforced indirect influence in curriculum design. Since they have not realised and asked for it, it is difficult for such change in the structure, function of the system and the role of educators to take place. Consequently the implementation and institutionalisation of the reform in primary science in Greece, is difficult to be achieved (Fullan, 2001a).

Explanations and justifications of this attitude are given by some participants, as one consultant who mentions that:

> "*Sometimes you might hear people coming up with various ideas about changes, minor or major but then, nothing happens. Probably they try but they meet difficulties as they block in bureaucratic procedures*" [consultant 4].

The, well described in literature, barrier of bureaucracy in the Greek educational system is again brought up (Ifanti, 2000).

Summary

In short implementation of primary science curriculum change and reform in the Greek primary school has to face a number of difficulties, as lack of official assessment, lack of initiatives for re-culturing of the teaching profession and lack of established forms of collaboration and co-operation of teacher with colleagues and others involved in the functions and hierarchy of the educational system. The vitiation of all these difficulties is considered both to be a task of the school leaders and head-teachers (Fullan, 2001a; Everard *et al*, 2004; Bush & Middlewood, 2005), a point at which university tutors and some consultants share.

Johnsons' (2003) conclusion about the influence of central control through the detailed curriculum and prepared text-books in diminution of leaders' ability to manage effectively educational reform applies in the case of primary science curriculum reform in Greece. As the content and teaching method of every subject are already decided, head-teachers or leaders consider that their role is to let teachers charged with the responsibility to carry out the annual program as prescribed. Any kind of assessment, as concluded by responses is focused strongly on whether teachers have eventually taught the pre-decided content.

Head-teachers do not consider themselves entitled to provide any support to teachers in order to achieve their mission in implementing the reform. They do not consider themselves responsible for arranging opportunities for teachers to gather and exchange ideas, or for occasions that will help schools manage resources and funds that can lead to improved structured and equipment. In fact, as far as the latter is concerned, many respondents mention that bureaucratic barriers (Ifanti, 2000) can emerge, which are likely to disable the motivation of head-teachers and even teachers to get used to applying

this method, overcome barriers whenever a change is implemented. This is the main reason why Fullan (2001a) underlines the necessity for the reform to be an opportunity for further reforms of minor or major level to take place inside and outside the learning organisation.

This attitude affects negatively the agents of the reform in Greece, not only as their work and their conditions at work are by no means facilitated but as the role models that they have are unable to teach them how to handle change situations effectively and prepare them for changes in future (Bush & Middlewood, 2005). Head-teachers tend to accept the current state of their role and follow a non-learning attitude in the case of primary science education reform by not considering their role as change agent and by expecting from others to come up with ideas or ways for pathway to implementation which has no obstacles. Unless they realise the necessity for them to develop specific abilities to update and transform their role, behaviours and beliefs for their profession and goals, as a response to their experience and their ideas for further school improvement, it is impossible to help teachers do the same and help the reform in primary science education or any other change to be systemic and sustainable (Fullan, 2001a).

CHAPTER VII:
CONCLUSIONS

"After him I saw huge Orion in a meadow full of asphodel driving the ghosts of the wild beasts that he had killed upon the mountains, and he had a great bronze club in his hand, unbreakable for ever and ever."

[Homer, Odyssey, λ, 578-581]

CONCLUSIONS

INTRODUCTION

Having discussed the findings of the study around the reform in primary science curriculum in Greece, it is possible now to draw some basic conclusions in this final chapter. More specifically the basic ideas of the literature are resumed. The factors interfering in decision of the research methods are being presented again. The basic research questions accompanied by their basic results from the empirical research are summarised, in order to conclude about the possibility of curriculum reform to affect school culture and be systemic and sustainable (Fullan, 2001a). Finally, limitations of the study are clarified, deriving the research context (Kazamias and Zambeta, 2000) and the nature of educational research (Pring, 2000).

1. INSIGHTS TO MANAGING CHANGE IN PRIMARY SCIENCE WITH GREEK EDUCATION

Responding to Environmental Challenges that Call for Change

Educational change as a field of study is multidisciplinary and methodologically diverse in nature. It is a worldwide study in the symbolic and substantive ways of investing in future. Studies of educational change are not new. Since the 1960s theories have explored change development, implementation and diffusion. For several decades the study of change addressing the call of school efficiency has become a subject of science that could be designed, implemented and managed. As information society takes a more mature shape, school effectiveness is complemented by school improvement drawing on varying traditions and comprising controversial forces, configurations and possibilities (Hargreaves, 2000).

Across the world, educational reform is itself a huge priority. Philosophically, it stands alongside chaos theory reflecting: multilevel patterns of action; interdependent policies; unpredictable widespread consequences and diverse flows of human emotions and responses to change. Current thinkers take for granted that the push towards future and development of coherent and inspiring visions for large-scale and deep reforms is an energizing, optimistic experience. In practice people often take contrasting positions in

relation to particular improvement processes addressing intractable dilemmas and considering the intricate barriers of real educational contexts. However, there is a growing general sense of urgency about the need for reform, and more appreciation of the complexity of achieving it. (Fullan, 2001; Hargreaves, 1997).

Today's global society is increasingly complex, requiring educated citizens who can learn continuously and who can work with diversity, in local and international contexts (Drucker, 1999). Educational systems are expected to produce citizens who can contribute to and benefit from a world, which offers them enormous opportunities, and equally complex difficulties of finding their way in it. Given a global environment characterized by radical and discontinuous change, educational organizations will need to redefine and adapt their goals, purposes and procedures, to question existing assumptions about control and consistency and to ensure that their standards of performance are aligned with the innovative social, cultural, pedagogical and economic trends. According to recent thinking, modern societies require organizational structures that assume existence of few rules, some specific information and a lot of freedom (Malhotra, 2001).

In the uncertain environments of the world, characterized by wide range of potential surprise, educational management is expected to take into consideration not only cognitive and rational dimensions but also emotional dimensions of human decision-making, which should be influenced by attention, motivation, commitment, creativity and innovation of individuals and groups. Knowledge is not conceived any more as a simple collection of information but as a construct derived from framed experience, values, contextual information and expert insights, providing a framework for evaluating and incorporating new experience and information (Bruner, 1990). In fact, a formidable challenge for designers and leaders of change is the contrast between information-processing capabilities of advanced technologies and sense-making capabilities of sensitive human minds. Above all, within changing environments the emerging culture of information sharing ensures the flow of true integration of information across various levels of organizations. This way it encourages experimentation, rethinking of existing premises and evokes creative responses to forces for change (Malhotra, 2001; Kelly, 1963; Drucker, 1994b).

Mastering new knowledge and experience at the leading edge of organizational change

During a time of rapid change, organizations are expected to abandon traditional patterns of straightforward managerial life and address initiatives that alter people perceptions and behaviour. Managers now have to face reforms that are more significant and broad than ever before. Information and Communications Technologies revolution makes work quicker and less labour intensive than before. New organizational structures are emerging emphasizing and enabling speed of response. Individuals have to learn new skills and adapt to uncertain environments. The social mission of organizations is consistently debated. Moreover, managers need to prepare themselves to provide satisfactory solutions to wide-ranging and fundamental problems having to do with economic, cultural and psychological challenging situations (Crainer, 1998).

Knowledge has been codified as part of organizational life. Traditional basics of scientific management, that is planning, organizing, directing, coordinating, reporting, remain central to many contexts. However, managers in the new world are expected to mobilize every ounce of intelligence to respond to multiple social challenges. Managerial skills need to be diverse and continuously expanding. New management has to take into consideration international facts, cultural diversity, various sources of authority, potentials of technology, significance and limitations of available information flows. Moreover, leaders of organizations have to: communicate with internal as well as with external environment; act strategically and responsibly; combine a variety of team roles; establish, reinforce and develop values; distil complex evidence derived from on-going research and; make plans for personal and professional development of people involved in the functions of the organization (Crainer, 1998).

All these interdependent activities and operational requirements of the so-called knowledge management consist the intellectual capital of the organization. Intellectual capital is knowledge-based as it represents the potential within an organization for generating value as being an asset in the traditional sense. In the field of education, intellectual capital represents the value that comes from effective human relationships within schools or from interactions between schools and their surrounding communities, from transferable personal experiences and competencies, from schools' infrastructure and from their ability to innovate and manage change effectively (Crainer, 1998, Kelly, 2004a). In fact, knowledge is acknowledged as the most important resource and a value of the organization in a sense that it reflects community's perception of how well knowledge management is integrated into organizations' life (Kelly, 2004a).

Responding quickly and effectively to change is an essential skill of intellectual management. What distinguishes intellectual management practices from the traditional ones is its transformational nature, which Senge (1990) calls 'metanoia', based on several fundamental activities such as designing the organization's policies, strategies and interactions, fitting them together as a coherent whole, developing shared vision, enforcing and sustaining a systemic understanding of the organization and linking tangible to intangible resources. In fact the essential task of intellectual capital management in change situations, is bringing people together in a deliberate manipulation to create capital from transfers of explicit and tacit knowledge. Unlike traditional managers who dislike uncertainty and change, knowledge leaders see change as a challenge and a chance to maximize organisational effectiveness by concentrating on new knowledge generation and utilization (Kelly, 2004a).

In the context of the growing knowledge society, there is a strong link between management and learning theory. Management involves not only information capture, retrieval and experience, but also the ways in which knowledge is created and shared. Few years ago, first generation of Knowledge Management, having its roots firmly in the use of technology and using ideas derived from systems analysis and management theories, attempted to apply econometric standards in order to categorize and disseminate information and to treat knowledge as if it were a commodity. In contrast, second generation of Knowledge Management recognizes that learning and doing are more important to organizational success than dissemination and imitation and gives priority to the way in which people construct and use knowledge. Deriving its ideas from complex systems and chaos theory managers tend to replace hierarchical models of organization with more organic models. These see effective organizations as capable of structural change in response to their environment. First generation of Knowledge Managing used models of organizations as integrated systems capable of making tacit knowledge explicit. Knowledge management creation assumes that organizations are complex interdependent entities, which according to Kelly (2004a) are capable of generating new knowledge by building on experience and by absorbing an existing body of know-how and adding to it. (Bernbom, 2001; Graham, 2001; Ward, 2001; Leibold, Probst, & Gibbert, 2001).

Establishing channels of understanding and meaning-sharing through the educational change environment

Changing economic, social and political situations in both developed and developing countries create needs for constant innovations and reforms in education. As Durkheim (1938, p. 167) argued:

> *"Educational transformations are always the result and the symptom of social transformations in terms of which they are to be explained. In order for people to feel at any particular moment in time the need to change its educational system, it is necessary that new ideas and needs have emerged in which the former system is no longer adequate"*

Changes in education usually come about when current practices are challenged and questions are being asked about the way things are done.

There are many models explaining educational change process. A broad category of theories sees change as an internal process originating from particular organizations. Other theories explain change as externally motivated, with a large input from social conditions. There are cases where the interplay between educational reform and social change cause wide scale educational transformations, which have broad, national structural proportions. In other situations, educational change has characteristics of relatively isolated technical or programmatic alterations, which reflect a low-level change effort. Anyway, as Paulston (1976) states, characteristics of any educational reform can be only partly explained by the theories of education and development in a given society, since social process leading to change initiation are complex, non linear chaotic procedures.

In the context of knowledge society, all learning is a continual process of making meaning. This model of understanding is in harmony with the new pedagogy of constructivism, which underpins modern aspects of learning. Educational change is seen as a set of patterns through which both organizations and individuals develop their capacity to learn. Attention moves away from the imposition of top down structural change towards the improvement in relationships between all people involved. These relationships are closely related to the culture of classrooms and schools and to values of the educational system as a whole.

As Fullan (2001a) argues, if schools are to play a major part in reinventing a fairer and more inclusive society and develop their intellectual capacity, principals and teachers need to be seen as 'moral change agents' who share and sustain ideas about innovation

and improvement. Change involves anxiety and struggle. Unless meaning is shared by all involved, change cannot be assimilated. Predictable solutions, which have been traditionally imposed, are ineffective if they ignore the culture of each individual school. As each school is unique one schools success cannot be simply transferred from one school to another. Innovative principals can develop learning-enriched schools that may be characterized as interactive communities of practice where all people involved feel a common stake in the future.

Cultural change is usually a three to five year process. As many forces tend to maintain the status quo, leadership for change requires a bias for action, a sense of urgency and a mix of pressure and support, until all members of the school community develop new and critical understanding in a climate of clarity and commitment. The developmental procedure applies as much to individuals or to organizations. In any case, it is a process of trying things out and keeping what is best, which requires sharing of meaning, coherence, connectedness, synergy, alignment and capacity for continual improvement (Fullan, 2001a).

Contrary to traditional emphasis on a simplistic linear model of change, these ideas are in line with the findings of complexity or chaos theory indicating that success depends on coping with unpredictability, conflict and inconsistency. Change is an uncertain balance between stability and excitement. In such an environment, where no one knows for sure what is best at every stage, organizations need security and a desire to grow and improve their intellectual output. Nevertheless, changing schools is a complex, self-organizing process through which leaders need to develop schools and individuals' capacity to reflect creatively and act on their own understandings (Hargreaves & Fullan, 1998).

Educational change primarily depends on what teachers do and think. In cases where teachers work in isolation and feel frustrated or burnt-out with imposed curriculum and accountability demands, collegial enforcement provides the best starting point in the process of school cultural regeneration. In schools that operate as professional learning communities, which build consistent standards through moral obligations and common vision, teaching is seen as a collective rather than an individual enterprise. Teachers in such schools neither conform uncritically to ideas that are imposed nor they resist unquestionably in change conditions. On the contrary, they are encouraged to improve their skills, classroom climate and their professional characteristics such as holding high expectations, achieving better learning outcomes and succeeding in organizing team work.

In the context of school organizations that act as learning communities, achieving change requires true reculturing of the teaching profession.

To develop a coherent professional community, school principals, as the gatekeepers of change, should lead the transformational improvement, fostering conditions required for school growth and install a commitment to a mutual purpose and a shared belief in ongoing common efforts. Leadership is a complex art creating harmony, forging consensus, setting standards and developing goals and future orientations. Developing school capacity in turn affects the quality of teaching and learning within school on the basis of a relationship-centred pattern in the framework of clear collegial value. Leadership based on relationships and trust is needed at all levels to encourage schools to pursue autonomy, support learning and maintain a strong interest in cultural transformations (Hargreaves & Fullan, 1998).

In general, the current state of art about educational change assumes that:

- In complex situations, change requires a radically new way of approaching learning, since learning cannot be transmitted or imposed but is mainly about meaning making. Thus, if people cannot find meaning in any reform, change cannot have an impact on organizations and systems.
- Existing conditions in each school must change so that all people involved can develop inspiring climate and common vision. A simple imitation of successful strategies will not be effective if school culture is not transformed with respect to local conditions.
- Teachers and principals should have the capacity to act effectively having in mind that change implementation is not a simple linear process consisting of predicable phases. It implies reconsideration at all levels of the system generating a constant interplay between tighter and looser forms of control or between external and internal commitment.
- Members of learning organizations conceive worthwhile learning, as the function of doing the right thing in the setting where educational discourses take place. Considering that no amount of outside motivation can specify best solutions for a particular situation, a learning community promotes knowledge creation in the context of a collaborative environment where people work together to solve problems and convert tacit knowledge into explicit shared ideas.

- School systems and democracy are closely connected. Education has strong moral components addressing purposes that should serve both individual and collective benefits. Schools have to share their ideas and experience for the benefit of all pupils and the surrounding community. Since everything is interconnected in the fields of education, being concerned with the success of the system as a whole is a new challenge for school management.
- All members of learning communities should learn to live with change. Teachers and principals have to work through change until shared meaning and improvement is achieved. Moreover, change must be taken both less and more seriously at the same time, because in some cases, new ideas are superficial and contradictory. Professional learning communities should sort out the worthwhile from the non worthwhile The ultimate goal is to make people see themselves as shareholders in a community that works for the success of the system as a whole built around values derived from shared meaning (Hargreaves & Fullan, 1998).

Re-Orienting Education for Sustainable Change through Patterns of Systemic Strategies

Systemic management for a sustainable reform leading to school improvement derives from a philosophy advocating widespread intellectual reflecting, deep rethinking and radical restructuring in reference to the educational system. It pervades every aspect of schooling, re-conceptualizing education from the ground up, beginning with the nature of teaching and learning, educational environment and school-community relationships. Typical dimensions of systemic reform refer to learner outcomes, curriculum, instruction, assessment, learning environment, technology, time management, school-government relationships, teacher leadership, personnel structures and collegiality. Moreover they address procedures of decision-making, fostering creativity, empowering professional responsibility and shifting roles among teachers, students, consultants, parents and administrators. Educational managers should strive to guide all their change efforts with systemic understanding of the context (Ellsworth, 2000; Fullan, 2001a)

A systemic approach is based on the assumption that policies and practices in one level of the system affect others. They focus on developing and strengthening of an infrastructure of pressure and support. At the same time, they are preoccupied with equity and accountability. Lasting and effective change should be institutionalised. It is expected

to lead to continuous improvements beyond initial investment. Sustainable change calls for upgrading of the system context, to provide opportunities for professional development, offering assistance and strengthening of institutions. In addition a systemic reform requires the units involved to make connections and to synchronize activities around common practices. This way, it is ensured that all aspects of innovation are coordinated and based on coherent plans and that organizational learning culture changes along with individual learning (Fullan 2000; King, & Newmann, 2001; Youngs, 1999).

In the process of upgrading the educational context, individuals find themselves in more that one structure and institutions find themselves interacting with other organizations as reform proceeds. Information dissemination and diffusion generate large number of implementers engaged in the reform effort focusing on similar priorities and goals. The system promotes commitment in educators and public. It also protects sustainability of the desired change. Substantial innovation needs also to be propelled with new teaching and training materials, new teaching practices, new assessment processes and deeper understanding. Pressure and support strategies should be integrated linking teaching practices with student performance.

Besides, as all learning communities are connected to the state policy, local educators should constantly address the question of what the reform priorities are, how do they relate to government decisions and what resources can be mobilized in the environment to serve change purposes (Fullan, 2000).

It is true that real systems are complex, non-linear entities that tend toward overload and fragmentation. They contain conflict, danger, and resistance that can disrupt the change process or distort intended innovations. Such systems however contain hidden opportunities and great potentials for innovativeness and creativity. Designers and implementers of change cannot control reactions of educational systems by predictable and logical procedures. However, they can mobilize interactive dynamics and capabilities of varying interdependent forces to establish substantial initiatives for systemic and sustainable reforms (Fullan, 2001a; 2002).

Towards Multi-Perspective Views of Science Learning and Instruction

The new direction for primary science education evidences a move away from studies focusing on individual student understandings of specific phenomena towards examination of ways in which understandings are developed in the social context of science classrooms. This trend assumes an emphasis in the role played by teachers, school

culture and interactions within educational community in the framework of which meanings are developed. The roots for such a direction can be traced to a number of pedagogical-philosophical sources, which include:

- Bruner's (1990) culturally oriented psychology, which ensures that the shape of human life is understandable through symbolic culture systems such as language and discourse modes, forms of logical and narrative interpretations and patterns of communal interactions.
- Wittgenstein's (1953) later writings cultural or discursive psychology.
- Mead's (1934) human studies about of symbolic interactions.
- Vygotsky's (1978) thought, referred to socio-cultural psychology claiming that higher mental functioning in individual derives from social life.
- Harre and Gillet's (1994) principles for a new cognitive psychology suggesting that many psychological phenomena are to be interpreted as features of public or private discourse, that is features of behaviour or thought and that symbolic systems are derived from interpersonal discursive processes characterizing human environment.
- Lemke's (1990) analysis of classroom discourse in terms of both patterns of social interactions and scientific contents of lessons, based on the central assumption that learning science means to communicate in the science language.
- Hewson's (1981), Gilbert, Osborn and Fenshman's (1982) and Driver *et al.* (2000) perspectives on the co-construction of knowledge through challenging active participation. This approach is based on the concept of conceptual change as it gives emphasis on learners' experiences and pre-instructional conceptions.

In respect of the understanding held by pupils of scientific concepts, intra-psychological approach that attempts to change their ideas through restructuring of their pre-instructional knowledge has recently expanded to examine pupils' conceptions of the nature of science and their interest in scientific ways of thinking. More emphasis is placed on the importance of affective factors of pupils' conceptual change that is: social aspects of learning; interactions that take place in real classroom situations; pupils' modelling ability, and; encouragement of pupils' engagement in learning activities.

Moreover, during the last decade, there have been intensive debates about scientific literacy inspired by concerns about educational demands of the knowledge

society and driven by public awareness about the urgent need to close existing gaps between theory and practice in the fields of primary science education (Vosniadou & Ioannides, 1998; Georghiades, 2000; Duit & Treagust, 2003).

Scientific literacy is seen as the capacity to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and changes made to it through human activity. Conceptions of scientific literacy refer to both to specific science process and cross-curricular competencies. They focus on recognition of investigable problems, on identification of evidence needed, on drawing conclusions and evaluations, on the communication of valid knowledge, and on demonstration of understanding scientific concepts. In addition conceptions of scientific literacy refer to specific educational acts and attitudes such as self-regulating learning, ability to solve problems, communication and cooperation (Duit & Treagust, 2003)

The need to improve scientific literacy is the profound impetus for change in primary science education. According to Driver and Osborne (1998) modern societies need scientifically and technologically literate work forces to maintain their competencies and individuals need some basic understanding of science and technology to function effectively as active citizens and consumers. Besides, educational planning has to take into consideration that science is a great human achievement and it is the major contributor to cultural development. In culturally developed and democratic societies, people need to reach an informed view on matters of science related public policies in order to participate in discussions and decision-making.

There are powerful developments towards admitting that teaching and learning science, as complex phenomena and processes, need pluralistic epistemological frameworks in order to address adequately the many facts emphasized by different views of knowledge acquisition. It has been widely recognized that only multi-perspective approaches are suited to meet the demands of the advanced levels of scientific literacy. Theoretical frameworks focused on student thinking and pedagogical attention can be used as tools in the context of both teacher pre-service and in-service training to explicate current practice and to raise awareness of the range of the classroom discursive approaches, which might be employed. Educational change in primary science education aims at refining and further development of these analytical tools, broadening of their scope and strengthening of their linkage to processes of meaning making.

Central to the focus of change in primary science is the way in which teachers can act upon science subject matter, their reconsideration of teaching activities, management

of their feelings associated with reform implementation and development of positive beliefs and conceptions underlying their role as moral agents of change (Fullan, 2001; Gilbert, 2004).

A reform in Greek primary science education as a challenge for reconsidering and restructuring the educational norms and patterns

According to Greek political and academic tradition, education is conceived as a public good offered through public provision. The idea that public education is a prerequisite for the inclusive democratic society has profound advocates and strong influence in the county's political culture. The Greek constitution provides for free education for all citizens at all educational levels. However, it is argued that public expenditures on education are not enough to respond to the needs of pupils and families since it does not ensure adequacy and quality of learning procedures. For the past years, the Greek educational system has been characterized as being highly centralized, deeply bureaucratic and as a result not flexible enough to adjust to a constantly changing knowledge environment. Besides, high private expenditures have been spent on education as a compensation for the systems' inadequacies, most of which refer to private supplementary courses, the so-called 'phrontistiria' (Zambeta, 2000a) or to the cost of university students studying abroad. Attempts for reform, have mainly focused on language reforms, the content of some courses and changes in the university entrance examinations totally dependent on the ministry of education. It is believed that in the framework of such a system, knowledge has been reproduced automatically and uncritically not allowing learners to construct meanings and understandings beyond the content of provided textbooks. By the end of the last decade, it has been widely recognized that there was a need -in the existing systems' framework- for a redefinition of what valuable knowledge is (Zambeta 2000a; Kazamias & Zambeta, 2000).

In the framework of the attempt to reform Greek education by the end of the 1990s it was declared that it focuses at

- Redefining educational objectives and school knowledge.
- Strengthening links between education and society, and between training and economic-labour market conditions.
- Acknowledging the increasingly multicultural character of Greek society.
- Introduction new culture in educational management.

- Introduction market mechanisms in educational assessment and accountability.
- Development of institutions responsible with implementing initiatives and programs providing financial aid for training and education, which are being promoted by the European Community aiming at decentralization of the system, professional development of educators, life-long learning and better utilization of new information technologies (Kazamias & Zambeta, 2000)

The scope and intentions of the attempt for reform are argued to be difficult to implement effectively. A retrospective look at the evolution of Greek education system from the nineteenth century to present demonstrates that there was a lagging of the kind of reforms that had already taken place in main European countries in the same period. As a result of this lagging, recent reformations embody both modernization elements as perceived in the early 20th century and post-modern positions as introduced by current literature and research about pedagogies, learning theories and education. These contradictory elements often create confusion and generate attitudes that rarely lead to successful outcomes. Besides, the one-dimensional nature of the educational system that is its strict vertical internal division to Primary School-Gymnasium-Lyceum-University, where each grade of the education scale essentially acts as a preparatory stage for the nest one, as well as the intense focus of the educational community as a whole on the university-entrance exams, prevents decentralization and discourages any initiatives for restructuring of school life at the district administrative level (Zambeta 2000; Kazamias & Zambeta, 2000).

The new primary science curriculum claims initiation of radical change in primary science education in Greece to respond to the demands of the growing knowledge society and meet the needs of the complex global environment. The reform introduces new curriculum and new text-books, it implements new teaching methods encouraging discovery teaching and active engagement of students in the learning process, and it establishes new programs that emphasize cross-curricular integrating activities, such as the flexible zone on innovative and creative studies. The philosophical framework of such an attempt refers to the new learning paradigm based on the pedagogical principles of constructivism, where young people participate creatively in the learning process through which they build actively their own understandings of the surrounding world. According to current ways of thinking this process needs to take place in the framework of a learning

community that provides the necessary intellectual and material resources for the development of valuable scientific knowledge (EURYDICE, 2000;YPEPTH, 2002).

It is believed that such an attempt can act as a challenge to traditional behaviours and attitudes at all educational levels. If it is to succeed, it requires: reconsideration of teaching strategies; assessment; organization of science classrooms and laboratories; time management; use of technological tools and materials; arrangement of group-work, and; designing of environmental activities and studies. Moreover, the new approach can challenge the existing school culture as demanding the establishment of collaborative patterns among principals and educators, strengthening of relationships between school and community members, broadening of investment in professional development programs, and encouragement of participation in decision-making procedures.

Searching for opportunities to master, develop and reflect on ideas, experiences and theories and participating in the attempt for on-going improvement, the members of the educational community can contribute to the promotion of scientific literacy among young people, the enhancement of public understanding of science among Greek society and reconsideration of the scope of the educational system acting not only an organization that reproduces traditional knowledge but as a moral agent of change and improvement (Kokkotas, 1998; Matsagouras, 1998; Karantzis, 2002).

Key issues raised by approaching reform implementation in Greek primary science education

In the light of theoretical developments in perspectives on managing an educational change that aims at science learning improvement in primary school, the empirical study of this study took place. It attempted to investigate the extent to which the primary science curriculum reform in Greece can really bring about change and limits any adverse effects of that change in subjective and objective terms.

The study aimed to examine whether the reform in Greek primary science addresses strategic and tactical issues involved in managing educational change in the context of currently evolving knowledge society and whether change implementation patterns in primary schools are associated with thought-out and followed-through programs of personal and institutional development.

Educational change is a highly complex and subtle social process involving interacting factors over time that form a system of variables determining the success or failure of the initiated reform. Above all, educational change is a learning experience for

the people involved, affecting the change implementation and continuation. Considering that, the study tented to investigate:

- The needs and reasons for change.
- The attitudes of the agents of change.
- The parameters and dimensions of change.
- The management of systemic change and its impact (Fullan, 2001a)

Through these points conclusions will be drawn and a practical thesis of meaning as well as attainments of change attempts will be constructed. It was suggested that an essential starting point should be the investigation of what reality is from the point of view of people within the role of change agent in the field of education. Thus, the study dealing with the subjective reality of coping with change has developed a pattern that could address the following set of research questions:

1) What are the forces that create the need for educational reform in primary science?
2) What are the attitudes of the members of the educational community – teachers, head teachers, students, and policy-makers – who are involved in the process of change implementation and need to share the meaning of change?
3) What are the dimensions of the reform and in which way the school management may design, organize, coordinate and control the implication of a reform in order to be systemic and sustainable?
4) To what extent the procedures regarding primary science learning, curriculum, assessment, professional development enhancing of the public understanding of science, are affected by the practical change?

Within the overall framework for thinking about the dynamics and meaning of educational change, the study attempted at covering the process of a curriculum reform identifying the reasons of the change initiation (**why**), the roles and attitudes of the agents of change (**who**), the management of the change implication (**how**), and the aspects of current practice that are to be affected by the new teaching approach, that is the dimensions or the objective reality of change (**what**).

The intellectual capital of educational organizations is of fundamental importance referred to schools' potentials to respond to change by nurturing systemic innovative patterns of thinking, learning to learn continuously and produce valuable knowledge

(Kelly, 2004a). Bearing that in mind, this studies' empirical work aimed at proving that regardless the positive attitudes of the members of educational community towards the change in primary science curriculum, the reform under investigation will not be sustainable since it has not been designed and organized in the framework of systemic management principles.

2. INSIGHTS IN THE METHODS AND TECHNIQUES OF RESEARCHING SUBJECTIVE MEANINGS OF PEOPLE INVOLVED IN A PROCESS OF EDUCATIONAL CHANGE

Being concerned with an educational situation, the study has essentially a qualitative grounding. Managing the reform that has been introduced in Greek primary science education in 1999-2000 is a topic under investigation that needs to be conceived and explored not as a causal linear relationship of variables. It should be examined as a multidimensional educational phenomenon within a specific cultural context reflecting all the complexities that exist in real social life.

Because of the complexity of educational change and the chaotic character of interacting processes that are associated with the change implementation, the empirical work of the study tended to explain the structure and essence of the subjective meanings of people involved in and affected by a particular reform and get insight into those people's attitudes, understandings and dispositions. The ultimate goal of the research was to investigate the potentials of the particular reform to be sustainable, to lead to the enhancement of primary education and to serve as an opportunity for the re-culturing of school management and the improvement of school life.

Focusing upon this goal, the study concentrated in a systematic examination of what the experience of being called to change traditional behaviours in the field of primary education is like.

Thinking about the appropriate method of conducting such an investigation it was primarily taken into consideration that an educational research is mainly concerned with processes of teaching and learning in practice. Educational practice as an object of research is necessarily seen differently by different people and by different traditions depending on the context of which the educational discourse takes place. An educational practice embodies a way of thinking about valuable learning, about what constitutes having learnt successfully and about what skills, knowledge and beliefs it is to incorporate. Thus, a situation of educational change, instead of being described in numerical and statistical terms as if it was a stable entity, it should better be examined:

- Through a naturalistic approach that usually seeks to understand phenomena on context-specific settings (Patton ,1990; Pring, 2000).

- By using a qualitative method of research, which is of an exploratory and descriptive character, uses predominantly words as data, is based on an emergent design and on inductive analysis, reports detailed views of informants and tends to build complex and holistic pictures of a situation (Denzin & Lincoln, 1994; Tesch, 1990).
- By being grounded in the principles of phenomenology which, as they refer to the way people experience their life-world, they can lead to intensive collection of descriptions from individuals, to discovering unique or common internal themes among various statements or pieces of data and to the challenging development of a deep understanding of the particular educational phenomenon (Tesch, 1990).

The underlying theory that informed the study has been grounded on arguments about the ability of learning organizations to manage their intellectual capital, to respond to change and to develop a collaborative culture that encourages the generation of knowledge, the individual sharing of meanings and the innovative ways of thinking in the field of primary science education (Senge, 1990; Garrat, 2000; Kelly, 2004a; Fullan, 2001a; Hargreaves, 2001) Thus, the empirical work has an interpretive character aiming at discovering the meaning of the particular change situation for the individuals who experience it and highlighting on a somewhat general level its essential constituents. The reports had to be descriptive, to incorporate expressive language and to utilize strategies that may provide a direction and a framework for developing specific designs and concrete data collection tactics (Patton, 1990; Lincoln & Guba, 1985).

The most appropriate techniques were found to be interview and questionnaires. The data coming from these techniques with were triangulated with few observations of teaching activities and documents about science teaching (Cohen, Manion & Morrison, 2000).

3. CONCLUSIONS DERIVING FROM EMPIRICAL WORK

Re-cognition of Necessity vs. Necessity of Re-Culturing

The fact that there was a wide recognition for change need does not guarantee its success. Initial vision is by no means considered helpful for the progress of the reform. The common vision should be built through a dynamic interaction, which takes place during the reform process (Fullan, 1993) and involves the personal visions of the members of the organisation (Senge, 1990). A prepared, strictly and detailed structured plan does not help the change succeed, as it does not allow space for improvement and for the actual use of comments feedback that might arise throughout the implementation and point out problems that need to be worked out (Fullan, 2001a). Misunderstandings in this common vision are rather frequent. Reforms that recently take place and aim to the transformation of schools into a learning community need to have their objectives clearly stated. Otherwise they are likely to be misperceived and the reform might end up being misapplied by the agents (Fullan, 1993; 2001a).

As the case of the new primary science curriculum in Greece shows, a single curriculum change that counts only on the agents' existent belief about its necessity and does not affect other dimensions of school function and the context in which this curriculum will work, cannot survive easily. Factors that affect the work of agents and were not taken into consideration by designers meddle and construct major barriers. Such factors could be: teachers' ideas about their role in the school life and educational structure; their perception of teaching and the curriculum as a code by which their mission is abided; the essential means they are provided with in order to apply and deal with reforms, in terms of material, equipment, information and guidance. All these are topics that need to be examined when a change is planned (Fullan, 2001a).

As a matter of fact, the existence of institutions that might provide opportunities for teachers to pass these barriers, get information about their role and how it is changing and gain instruction and guidance does not guarantee the desired outcome of the reform either. This applies in the case of the primary science curriculum reform in Greece, which is under examination (YPEPTH, 1985; 2000). Their potential and to act in favour of an effort for improvement and the satisfaction they provide to change agents should be examined before and during the effort for reform, otherwise they can be and remain ineffective without any provision for their improvement (Fullan, 2001a).

A reform that tends to assist the transformation of school to a learning organisation, no matter the form in which it arrives, it needs to focus its goals on the basic characteristics of the learning organisation and its teachers, as well as the traits of the current school that have to be replaced with them. If emphasis is only given in curricula and neglects other characteristics and the way they should be improved or updated, agents of the reform pay no attention to them either. Consequently, the change has limited benefit for the desired transformation (Drucker, 1999; Fullan, 2001a).

In order to achieve the desired re-culturing that Fullan (2001a) considers as a significant condition for effective, systemic and sustainable reform, the dimensions of the culture of the schools needs to be examined carefully, so that these parts of the school culture that do not allow the implementation of the reform should be diagnosed and treated suitably.

As Bush and Middlewood (2005) state, the culture of school, as learning organisation is generally dealt with, as kind of organisational culture. School culture, as the organisational culture does not limit itself to official elements that arrange its functions and mission. Instead, it expands and touches other issues and aspects of school life as values, beliefs and norms of each member of the organisation and the interaction of these aspects that leads to shared meanings and as well as the impact that they have on teachers and school work.

Insights to the culture of a school that is about to undergo an effort for reform and improvement can lead to precious information about series of barriers that the teachers will face as soon as the reform starts being implemented. These barriers might arrive from informal domains that dictate along with the formals the context in which the teachers work and are asked to carry out the desired reform. Culture is said to be unique for each different learning organisation, as it reflects characteristics of the individual members that work in it (Bush & Middlewood, 2005).

Researchers as Kazamias and Zambeta (2000), along with Ifanti (2000) on the other hand, when describing the Greek educational system, which, as they all emphasise is highly centralised, as the individual schools have limited autonomy, they point out traits that reflect culture and appear to be common in many public schools. In other words, they make reference to a common culture that applies generally in every Greek public school, arising mainly from the limited margin provided to the individual schools about decisions concerning the school programs and the teaching approaches that have to be followed (YPEPTH, 1985; EURYDICE, 2002; Kelly, 2004b).

As Pekmez, Johnson and Gott (2005) clarify, transmission from a particular way of teaching and working, that can be relevant to the desired shift in school culture that the change should achieve in order to be systemic and sustainable (Fullan, 2000) it is important for educators to appreciate the necessity of this new teaching approach and school culture. This applies particularly in the case of the reform examined, which refers to the involvement of practical work and the emphasis on the practical nature of science education (YPEPTH, 2002).

The case of the change in Greek primary science curriculum justifies Fullans' (2001a) sayings that unless effort is paid to update and improve the school culture, the possibilities of the reform to survive and be systemic and sustainable are being reduced. Such policy implies the thought that current school culture works in favour of the reform and will not reject it. It takes no account of the possibility that beliefs and attitudes of the agents of the reform can be incompatible with the principles of change and can prevent it for several reasons for being properly implemented. The falsity of this attitude is proved by the difficulty that reform agents claim they face concerning the lack of the necessary guidance, the inability to gather the equipment necessary, the pressure of time, cost and generally, the effort they have to do in order to apply the desired and accepted as necessary reform in the current educational context.

According to West, Ainscow and Stanford (2005, p.77), it is rather unwise to be after a "recipe", or common policy that can be applied in every school. It is up to individual learning communities, after identifying its real barriers in depth and investigating the impediments that prevent the reform, to decide which policy plan and which pathway it has to follow in order to overpass the barriers that accompany every effort for reform, to achieve the desired raise of standards and improvement. It is that point that Greek teachers do not seem to respect or be aware of. As a result, they conserve the belief that this policy should and can only arrive from central educational authorities. This attitude does not encourage them to use the intellectual capital of schools (Kelly, 2004a) in order to discover solutions to their problems and pathways that might assist the implementation not only of the reform in primary science curriculum but every effort for improvement that can be introduced to schools (Fullan, 2001a). Moreover, this attitude does not allow the individual learning organisations to take advantage of the reform in order to affect the totality of the educational system (Drucker, 1999).

The current structure of the Greek educational system, in the way that the agents of the reform perceive its hierarchy and structure of it, deprives them from some important aspects of school leadership functions as participation in decision-making, personnel development and school equipment organisation (Bush & Middlewood, 2005) and charges them to the consultants instead of the head-teachers. This opinion is not justified totally by the relevant law (YPEPTH, 1985), which gives authority to individual teachers and head-teachers to act as a leader, investigate, co-operate, communicate and contribute in any possible way to the improvement of schools. This attitude was not proved really helpful, as consultants claimed that it is impossible for them to carry out a mission as forming a policy to help each school respond positively to the effort for reform and resolve the problems that arise, as they don't feel entitled to do that either and due to time pressure. They feel obliged and willing to provide necessary information and advice to teachers on how to work and to offer the opportunities for teachers' professional development, which are actually dimensions of their role (YPEPTH, 1985; Ifanti, 2000).

As Bush and Middlewood (2005) emphasise, sustainable improvement in school performance depends highly on people, the way they work and the beliefs they have concerning their profession. In other words, unless people update their attitudes and start appreciating the need for such a continuous update no effort for improvement can lead to effective and successful results. The feeling of the role as a leader needs to be empowered so that the educators will feel "confidence and ownership of the change" (Bush & Middlewood, 2005, p. 28), understand that they are agents of the reform and they need to take active role in the change process, along with the designers (Fullan, 1993).

In order to assess a reforms' performance, success and actual impact on the educational system as a whole or in different parts of it individually, it is important, firstly to allow a certain period of time as reforms cannot always provide desired results immediately and secondly, to appreciate its complexity (Fullan, 2001a). It is also important to take into consideration the effort that has to be done in order to examine and manage the context in which the reform is implemented. The context meddles when forming questions about the kinds of documents or data that have to be used, people and sources that will provide these and the methods or means that will be used during their collection (Fullan, 2001a; Bush & Middlewood, 2005).

Any kind of reform that is due to be systemic and sustainable needs to improve basic foundations within the educational system, which are found to be unhealthy. This

means that the reform needs to have an impact on the context of the educational organisation, which is aimed to change and improve. Consequently, an effort to appraise this reform needs to examine the basic characteristics of the school culture before the reform is implemented, so that the evaluation that will be carried out after application, will show which parts of the context have actually been improved or unaffected (Fullan, 2001a; Bush & Middlewood, 2005).

In the reform of the Greek primary science education, the necessity of the new curriculum, according to the participants was realised mainly from low and unsatisfactory performances of pupils that the reforms' agents observed. In the absence of any other institution, method or mean that might provide access to any kind of qualitative or quantitative data that might reject and justify this the teachers' opinions remain the only source of information for this purpose of pupil performance comments and assessment (YPEPTH, 1985; Cohen, Manion & Morrison, 2000).

The feedback from teachers though does not seem to pay great attention to greater issues concerning the opportunity arriving from the reform to expand its impact on other dimensions of the school, as re-arrangement of time, space, equipment, updating of the teachers' belief around their work, not only in terms of effective teaching and learning methods, but also in terms of their new role as managers, classroom leaders and members of recent learning organisations, which is currently subject to reform and improvement (Fullan, 2001a).

In short, the necessary phase of successful evaluation of a reform needs to be planned carefully, taking into consideration, all basic characteristics of the learning organisation, which is submitted to change. If it emphasises in only some limited aspects of school life or teachers' work, it is not giving a full picture of its impact or a clear picture of the educational context, leaving gaps that might work against further efforts for reform (Fullan, 2001a).

Concluding Thoughts on Managing Change in the Greek School

Fayol and Gray (1987) proposed 14 principles as ingredients for effective management and managerial climate in an organisation. Based on the study of the reform in primary science curriculum, it is possible to point out which of those are not dealt as necessary, creating this problems to school management and to effort for improvement, in the context of the Greek educational system.

Division of work does not seem to be considered as an option in the case of Greek schools whenever a reform is implemented. It seems to be a rather common attitude among reforms' agents to tend to be conservative about their roles, not thinking whether they should undertake new ones in the light of a new curriculum or a change. The task of reform is fit into current school structure and not divided into sub-tasks, relevant to its numerous dimensions that each agent-person could undertake and accomplish contributing that way to successful result and re-culturing (Fullan, 2001a; Everard *et al*, 2004).

The topics of authority and responsibility are similar. Teachers, head-teachers, consultants tend to keep institutions and structures that existed prior to the reform in primary science education (YPEPTH, 1985; EURYDICE, 2002). The inabilities they express they feel to find solutions to problems that accompany reform implementation, do not seem to be a motivation for them to develop initiative to take responsibilities and take advantage of the schools' intellectual capital (Kelly, 2004a) to come up with plans that might deal with them. Lack of active assessment institutions along with extended bureaucracy seems to be increasing this phenomenon (Ifanti, 2000).

There seems to be much debate around the existence of discipline in schools where new primary science curriculum is due to be implemented. On the one hand, the highly centralised character of the Greek educational system, the existence of detailed and structured curriculum and lesson plans, provision of textbooks that have to be used (YPEPTH, 1985; 2000. EURYDICE, 2002), are factors that limit the initiative and freedom of the reforms', who feel that are forced in a highly disciplined working environment (Zambeta, 2000b). On the other hand, the fact that new primary science curriculum is not being applied as expected, the inability of school leadership to act and solve problems and difficulties, that agents face, puts into question the actual existence of the desired leadership in schools (Fayol & Gray, 1987; Fullan, 2001a).

Unity of command seems to exist only at a superficial level. Even though according to relevant legislative documents or organisations (YPEPTH, 1985; 2000) the teachers are working under the supervision of the head-teacher, both formers and the latter seems to be expecting advice from others as consultants, university tutors and policy makers. Moreover, teachers keep expressing the influence that parental involvement and the commitment to competitive general exams that pupils will sit in future has in their work (Kazamias & Zambeta, 2000; Zambeta, 2000b). These indicate that the forces that give commands to teachers are more than one. This way, they create problems to the

balance and order of organisational work and structure (Fayol & Gray, 1987; Crainer, 1998).

There is also superficial unity of direction. As it happens with the unity of command, detailed and highly structured curriculum, already designed lesson plans and pre-chosen text books as norm under which the Greek public and private schools that implement the examined reform, work (YPEPTH, 1985; 2000) are considered by the agents of the reform as means that orientate the direction of their work. However, lack of established institutions of communication and co-operation, teachers' inability to act as managers in an effort to gather or develop necessary qualities to solve difficulties that arise and the absence of suitable help from school leadership, appear as parameters that sabotage this desired unity of direction and the effectiveness of the reform (Fayol & Gray, 1987; Fullan, 2001a).

As for the subordination of interests, it is clear that the agents of the reform share its meaning and do not object to the necessity of the new primary science curriculum. This fact, by itself, essential though it is (Fullan, 2001a), does not seem sufficient for the establishment of an environment in schools that would be fertile for reform and improvement. Greek teachers do not seem to reconsider their role in the hierarchy of the educational system as an impact of the change in primary science curriculum. Consequently, they cannot assist in transformation of schools into learning organisations, as the current (YPEPTH, 2000) and usually every recent effort for reform aims at (Fullan, 2001a). It is, therefore, apparent that the interests and objectives of the new primary science curriculum designers are not clearly disseminated and are, as a result, misinterpreted (Senge, 1990; Fullan, 1993; Fullan, 2001a).

The efforts for remunerations of personnel are described to be either inexistent or unsatisfactory. Firstly, the already established mechanisms of assessment and evaluation of school, curriculum, reform and teachers' work (YPEPTH, 1985) are not active and there seems to be uncertainty around the development of the specific topic in near future, even though its necessity is being appreciated. This reality does not enhance the flexibility of the educational system in cases of reforms (Fullan, 2001a). The well described both in the literature and in the study, dissatisfaction of teachers towards their salary (Ifanti, 2000; Bush and Middlewood, 2005) and support they receive, also proves that remuneration is not offered sufficiently, reducing this way teachers' motivation to create and work towards a vision for effective education (Fullan, 2001a).

As far as centralisation is concerned, the highly centralised character of the Greek educational system (YPEPTH, 1985; EURYDICE, 2002) seems to bring on the establishment of a working climate for teachers and pupils, in which the characteristics of the individual school, learning community and environment seem to be neglected or considered as matters of minor importance (Ifanti, 2000; Bush & Middlwrood, 2005). As local authorities and head-teachers are not entitled to participate in personnel selection or transfer procedures (YPEPTH, 1985; EURYDICE, 2002), the difficulty of the work of the head teacher is increasing, along with the difficulty of reform implementation (Fayol & Gray, 1987; Fullan, 2001a).

There is evidence of the existence of a scalar chain and hierarchy in the structure of the Greek educational system (YPEPTH, 1985; EURYDICE, 2000), which is acknowledged and respected by reforms' agents. This is a phenomenon that could be helpful for normal and efficient school function, since it can reinforce the also important element of communication between the agents of the same or different groups (Fullan, 2001a). In spite of that encouraging fact, there seems to be a lack of awareness among teachers about the necessity of communication, dissatisfaction and ignorance observed generally on their behalf that concerns the existent or new methods and means for communication, co-operation and exchange of ideas between colleagues and limited efforts that aim to their improvement and updating. This situation leaves no space for this hierarchy to assist as expected the communication processes and, consequently in the normal function of the organisation (Fayol & Gray, 1987; Fullan, 2001a).

Order is tried to be established by the existent law and the hierarchy of the Greek educational system. There is specific and detailed legislation concerning aims of work, plans that should be followed, methods that have to be used, sources for materials and support that agents could call for. Moreover, careful selection mechanisms assure that teachers working in schools hold certain qualification, as university degrees that are considered adequate to justify their ability to carry out the specific profession (YPEPTH, 1985; EURYDICE, 2002). Teachers, though claim that, while trying to apply the new primary science curriculum, they come across problems of time pressure, inability to find the necessary equipment and improper provision of guidance and support, which are of course frequent problems in cases of educational reform (Fullan, 2001a; Everard *et al*, 2004), but provide evidence that management, order and planning of work, as well as qualification of the teachers are not sufficient to guarantee normal and effective action in missions of educational reform (Fullan, 2001a; Fayol & Gray, 1987).

Treatment appears to be generally equal towards all members of the learning organisation. No apparent points found in the relevant law (YPEPTH, 1985) or responses, given by participants, give any indications for discriminatory treatment towards agents of the reform, with probably a minor exception of few comments made by a small percentage of the sample of teachers who worked in rural areas and referred to problems that their area faces and prevent them from applying the new curriculum properly, which is rather common phenomenon (Fullan, 2001a). A point that seems to be a source of dissatisfaction is the feeling of teachers that there is not fair treatment towards them, as they are not provided with the relevant instruction, time, equipment, money and any kinds of means and qualification that they feel they need in order to work as they are expected to do and as they believe they should too. In other words they believe that there is huge pressure applied to them in their work, which is not a healthy phenomenon for the organisation or the reform (Fayol & Gray, 1987; Fullan, 2001a).

Stability and permanence of personnel is strongly tried to be established in the organisation, as according to the law of the civil services, by which the working conditions of the teachers are abided, each teacher is allocated a permanent post in a specific school, as the ministry of Education arranges this. However, this appointment is not done as soon as the teacher starts working, but only one or two years after, which makes many teachers moving from one school to another (YPEPTH, 1985; EURYDICE, 2000). This fact is included, by participants, in the causes that do not facilitate reform implementation. It is not the initial training of new personnel that seems to be consuming time against reform implementation though. The further training that both new and experienced teachers need in order to apply the reform in an effective way, is reported as problematic, insufficient and time consuming, as it is common in cases of educational reform (Fullan, 2001a; Everard *et al*, 2004).

Initiative in favour of school improvement is, at first impression, existent among the agents of the reform, as every participant underlined the need for a new, modern and improved primary science curriculum. Despite its significance, the appreciation for the reforms' necessity by itself cannot secure the successful progress and outcome of the change. The beliefs of the agents are sometimes not totally reflected in their working strategies, policies, values and lives, because the application of these beliefs is influenced by many external factors as the conditions and expectations, which are set to these agents and sometimes are considered to be pressing them (Fayol & Gray, 1987; Crainer, 1998; Fullan, 2001a; Foskett & Lumby, 2003). This is actually the case in the reform in the

primary science curriculum in Greece. Even though the agents agree to the reforms' necessity of and its potential to contribute to the improvement of science teaching and school work generally, the difficulties that emerged in relation to the school structure, support, guidance, time and cost cannot create the suitable environment that reinforces teachers in their task (Fullan, 2001a).

Lastly as far as the encouragement and enthusiasm of the personnel, the ingredient known as 'l' esprit de corps', is concerned, the situation in Greek primary schools seems to be very similar with the issue of initiative. The first positive comments are expressed by participants. These give evidence of a joyful reaction of pupils, more effective teaching of science not only as a sum of information but also as a process, as a task of negotiation of pupils' misconceptions, which accords with recent principles and findings of research around science education (Driver *et al*, 2000; Osborne *et al*, 2003; Pinto, 2005) could be promising (Fullan, 2001a). This enthusiasm though does not seem to conquer teachers, when they are asked to confront problems and difficulties that their working environment sets for reform implementation. The reform should affect many dimensions of the Greek educational system and of the teachers' work. If it is simply restricted to a curriculum with new content and essence but not different role than its previous, barriers will prevent the arrival of the desired improvement in school. This will make their transformation to learning organisations more difficult (Drucker, 1999; Fullan, 2001a).

4. PRACTICAL LIMITATIONS AND MORAL CONSIDERATIONS UNDERLYING THE STUDY AND RECOMMENDATIONS FOR FURTHER STUDIES

Limitations deriving from the nature of qualitative research

This study around the reform in primary science curriculum in Greece is of qualitative nature. It investigates subjective meanings and personal dispositions associated with a situation of the specific change. Such an educational research takes place within a framework of community values and there is rarely a clear-cut and context-free set of rules or principles that can be applied without deliberation and judgment. Moral judgments or decisions require a great deal of deliberation in the light of many factors that have to be taken into consideration. In fact there is a constant need to reflect on values, which inform the research and the ways in which those values might be made concrete in the research procedure (Glasser & Strauss, 1967; Pring, 2000).

Qualitative phenomenological research is not concerned with having straightforward positive or negative answers. In addition, change in a study is common because the researcher is not concerned with finding only one answer. Thus, to give a detailed description of the phenomenon under investigation, triangulation, or the use of many data gathering methods helps determine attitudes, conceptions and dispositions of the persons involved in the study, in a fair and accurate manner (Pring, 2000).

Since the field of qualitative research is still evolving, the criteria and terminology of its evaluation are not yet agreed upon. Connelly and Clandinin (1990) suggest that qualitative inquiry should be apparent, verisimilar and transferable. On the other hand, Lincoln and Guba (1985) emphasize the importance of the study being credible, transferable, dependable and confirmable. In any case, given the complexity of human interactions, the purpose of the study is to aim for objectivity, while it has to take into account the views of the participants, as well as their preconceptions and expectations. It has to be taken into consideration that sources or subjects may not all be equally credible and that some subjects may be previously influenced and skew the outcome of the study.

The holistic perspective, which characterizes the qualitative research, assumes that almost every action or communication must be taken as a part of the whole phenomenon under investigation. This approach can lead into taking every little action into consideration regardless of its relevance to the research topic. For instance, a particular

rhetorical strategy employed by the participants when asked about their attitude towards the implication of an educational reform, might not have anything to do with the reform itself. It might be linked to other experiences or personal habits deriving from specific cultures and traditions (Lincoln & Guba, 1985).

In conducting a qualitative educational research, complete neutrality is almost impossible. When compiling findings, it is difficult for the researcher to be completely non-judgmental, given the influences derived form being more or less aware of the recent philosophical tendencies and the current state of the art, in association to the central theme of the study. While absolute objectivity is impossible it is paramount that the phenomenon should be examined with an open a mind and a commitment to detach from biases and preconceptions (Pring, 2000).

Usually, it takes time to build trust with participants that facilitates full and honest self-representation. Time and space limits in conducting a qualitative educational research through semi-structured interviews and questionnaires, do not usually allow the formulation of a thoughtful and well-understood relationship between the researcher and the participants. Besides, the researcher trying to collect information within a short time period and in an uncomfortable space context cannot be fully aware of the possible presumptions that might influence the participants' responses and consequently the research findings. Focused information gathering might have overlooked important aspects of the theme of the study, which could have been revealed through more extensive conversations, or elements of other sources such as self-narratives, fiction, and performance texts (Alvermann *et al.*, 1996).

Limitations deriving from the context of Greek primary education

The goal of the particular study was to define specific research topics and answer specific research questions that refer to the management of change in the context of learning organizations in Greece.

The purpose, scope and focus of the study have been informed by theory referred to fields both of management and pedagogies. This complex approach was not easy to be clearly conceived by participants, who usually are called to comment on daily, routine and practical isolated educational subjects. Thus, background information referred to school hierarchies, group interrelationships, multifaceted personal interactions and patterns of behaviour that usually contribute to an in-depth study, may be missing.

Since no kind of relevant information about the impact of change implication upon school life has so far been published officially by Greek educational authorities, it was not possible to select interviewees or school communities in such a way as to gain a cross section of the people involved. For instance it was not possible to address simultaneously both high achievers and those having difficulty with the new science teaching approach or the new science class organization. Thus, the study interviewees can to a certain extent not be representative of the larger teachers' population. Besides, quantitative elements such as students' grades or teachers' evaluation points, have not been presented in the research because such information could not be provided officially by the system (YPEPTH, 1985; Ifanti, 2000; Zambeta, 2002).

Being affiliated by a university thesis, the study of a real educational situation, cannot be as professionally objective and theoretically concrete as it should be. It is difficult for researchers, who cannot avoid being influenced or learn mostly by participating in the investigation of a change implication in primary science education, to remain completely neutral. On the contrary, the particular research serves an intellectual challenge for the researcher shaping somehow the results of the investigation.

The sample of the population includes male and female participants from different Greek educational and geographical locations. However, it is not large enough to make the research findings able to serve as grounds for accurate generalizations or definite future predictions (Cohen, Manion & Morrison, 2000).

Finally it is important to mention that the study evaluates only one reform in a specific curriculum. However, it could be just enough to justify that a new curriculum is not always sufficient element for sustainable reform, as it does not neccesarily affect the context of the educational community (Pring, 2000; Fullan, 2001a).

These limitations could serve as guidelines for further studies with similar topics and interests. Theories, beliefs and statements are open to revision in the light of further experience. In a post modern intellectual context, what counts as knowledge and truth is influenced by major changes that occur in a pluralistic society and must always be open to criticism. If there is knowledge without certainty, then that knowledge must always be open to criticism (Pring, 2000).

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APPENDIX

APPENDIX

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INTERVIEW GUIDES:

Both the intreviews and the Questionnaires given were based on these guides

Interview Guide for teachers.

1. For how long have you been teaching?
2. What is/should be in their opinion the desired outcome of science teaching?
3. Do they believe that changes in primary science teaching were necessary? Why?
4. In short, what are the main differences that they can mention between the old and the new style of primary science teaching?
5. Do they know what the reasons leading to these changes are?
   OR
   What are, in their opinion, the reasons leading to these changes?
6. What training do the teachers receive to prepare themselves for the new changes? *How are they trained to apply the changes in the classroom and what are they advised to do? Are they being provided with the necessary experience?*
7. Is there going to be any kind of assessment of them? How?
8. Are you in any kind of co-operation with other teachers, head-teachers or policy-makers in an effort to get some help in any problems you face, while trying to apply the new measures of science teaching?
9. Do the new curriculum and textbooks help pupils understand the basic concepts and skills related to science better than the previous ones? Examples?
10. Do the pupils enjoy the science lesson more now?
11. Do the new curriculum and textbooks help pupils develop "higher-order thinking skills" to science better than the previous ones? Examples?
12. Do the curriculum and textbooks help pupils appreciate the contribution of science in everyday life better than the previous ones? Examples?
13. Do the curriculum and textbooks help children understand what exactly is science, the nature of scientific work better than the previous ones? Examples?
14. Do the new curriculum and textbooks help the negiotiation of pupils misconceptions better than the old one? Examples
15. Do the new curriculum and textbooks promote integrating activities better than the old one? Examples?
16. If there are groups of students (e.g. *students with disabilities or minority students*) that according to the teachers normally perform less good, in comparison to their classmates in science, do the new methods, help these children increase their performance in science subjects better than the previous ones? Examples?

17. Do they think that there is a sequel between science teaching in the primary and the secondary school?

    OR

    Do the new methods prepare children for secondary science teaching better than the previous ones? Examples?

18. Are there any other measures that accompany the reform other than the new curriculum and the textbooks?
19. Is the reform accompanied by any changes in the way schools are being managed and organised?
20. Is there any provision for school equipment (as science laboratories and computer rooms)?
21. Are ther any other changes in other subjects other than science?
22. Do you have any suggestions to propose that, in your opinion would help improvement in primary science education and school generally?

[This is the interview guide. As the interview was semi-structured, (Cohen, Manion & Morrison, 2000) there was room for re-arrangement of the questions and negotiation of other topics, as time, financial cost, within some of these questions depending on the participants' responses.]

2. Interview Guide for consultants, university tutors and policy-makers.

1. For how long have you been teaching?
2. What is/should be in their opinion the desired outcome of science teaching?
3. Do they believe that changes in primary science teaching were necessary? Why?
4. In short, what are the main differences that they can mention between the old and the new style of primary science teaching?
5. Do they know what the reasons leading to these changes are?

   OR

   What are, in their opinion, the reasons leading to these changes?
6. What training do the teachers receive to prepare themselves for the new changes? *How are they trained to apply the changes in the classroom and what are they advised to do? Are they being provided with the necessary experience?*
7. Is there going to be any kind of assessment of them? How?
8. Are you in any kind of co-operation with other teachers, head-teachers or policy-makers in an effort to get some help in any problems you face, while trying to apply the new measures of science teaching?
9. Do the new curriculum and textbooks help children understand the basic concepts and skills related to science better than the previous ones? Examples?
10. Do the new curriculum and textbooks help pupils develop "higher-order thinking skills" to science better than the previous ones? Examples?
11. Do the curriculum and textbooks help pupils appreciate the contribution of science in everyday life better than the previous ones? Examples?
12. Do the curriculum and textbooks help children understand what exactly is science, the nature of scientific work better than the previous ones? Examples?
13. Do the new curriculum and textbooks help the negiotiation of pupils misconceptions better than the old one? Examples
14. Do the new curriculum and textbooks promote integrating activities better than the old one? Examples?
15. If there are groups of students (e.g. *students with disabilities or minority students*) that according to the teachers normally perform less good, in comparison to their classmates in science, do the new methods, help these children increase their performance in science subjects better than the previous ones? Examples?
16. Do they think that there is a sequel between science teaching in the primary and the secondary school?

    OR

    Do the new curriculum and textbooks prepare children for secondary science teaching better than the previous ones? Examples?
17. Are there any other measures that accompany the reform other than the new curriculum and the textbooks?

18. Is the reform accompanied by any changes in the way schools are being managed and organised?
19. Is there any provision for school equipment (as science laboratories and computer rooms)?
20. Are ther any other changes in other subjects other than science?
21. Do you have any suggestions to propose that, in your opinion would help improvement in primary science education and school generally?

[This is the interview guide. As the interview was semi-structured, (Cohen, Manion & Morrison, 2000) there was room for re-arrangement of the questions and negotiation of other topics, within some of these questions depending on the participants' responses.]

3. Interview Guide for pupils.

1. Which school subjects do you like?
2. Do you like science? Why?
   OR
   Don't you like science? Why?
3. Can you describe the activities you do during science sessions?
   [From this question it is easy to see how the lesson is carried out, whether misconceptions are being negotiated]
4. Do you have science session in your usual classrrom or do you go to another room (laboratory?)
5. Are there any problems you have when doing science?

[This is the interview guide. As the interview was semi-structured, (Cohen, Manion & Morrison, 2000) there was room for re-arrangement of the questions and negotiation of other topics, as time, financial cost, within some of these questions depending on the participants' responses.]

4. Interview Guides for Parents

1. In what grade at school are your children going?
2. What do you expect your children to learn from science subject?
3. Are you satisfied with the way science is being taught at primary school?
4. Are your children satisfied with the way science is being taught at primary school?
5. Are there any activities carried out at home with the children that are relevant to science?
6. Can you rank the subject your children study at school starting from thre most important one?
7. What do you do when your children ask a question about a phenomenon or anything that has to do with science?
8. Do your children attend any afternoon activities that are relevant to science?
9. Is there any co-operation or communication between you and your childrens' teacher?
10. Do you receive any instructions from school in order to help your children with science subject?
11. Do you have any suggestion to make that in your opinion would help improve schools and science teaching?

[This is the interview guide. As the interview was semi-structured, (Cohen, Manion & Morrison, 2000) there was room for re-arrangement of the questions and negotiation of other topics, as time, financial cost, within some of these questions depending on the participants' responses.]

5. Interview Guides for Secondary Science Teachers

1. For how long have you been teaching?
2. In your opinion what is the desired outcome of science subjects?
3. Have you heard about the reform in primary science? IF YES, do you think that this pupils who studied science in the primary school with the new textbooks and curriculum are likely to perform better in secondary science (in comparison to the others who studied science in primary school with the previous curriculum)?
4. What kind of knowledge do you expect pupils to have when they enter high school?
5. When teaching science for the first time in your new pupils, do you take into consideration the fact that they have studied science in primary school or not?
6. What changes have taken place in secondary science so far?
7. Do you have any suggestion to make that in your opinion would help improve schools and science teaching?

[This is the interview guide. As the interview was semi-structured, (Cohen, Manion & Morrison, 2000) there was room for re-arrangement of the questions and negotiation of other topics, within some of these questions depending on the participants' responses.]

TABLES

Table 1: Teachers' information and responses. The fact that answers appear similar, in the last column is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
1	Female	South Aegean	Rhodes	17	Lifelong learning for science
2	Female	South Aegean	Rhodes	18	To meet the natural world, explain phenomena, experiments
3	Male	South Aegean	Rhodes	16	Meet the natural world, experiments, appreciate the contribution of science to learning
4	Male	South Aegean	Rhodes	6	Concepts, understanding the contribution of science
5	Male	South Aegean	Rhodes	4	Research, skills, construct new knowledge
6	Female	South Aegean	Rhodes	15	THE CURRICULUM aims (experiments, concepts, attitudes etc.)
7	Male	South Aegean	Rhodes	13	Understand concepts and phenomena, carry out experiments and RESEARCH that will open the students mind
8	Female	South Aegean	Rhodes	1	Learning concepts, analysis of phenomena, to carry out experiments and to understand the importance of science in everyday life
9	Female	South Aegean	Rhodes	3	Learning concepts, analysis of phenomena, to carry out experiments and to understand the importance of science in everyday life
10	Female	South Aegean	Rhodes	4	To come in touch with science
11	Male	South Aegean	Rhodes	11	Learn concepts, describe phenomena, carry out experiments and appreciate the contribution of science in every day life
12	Female	South Aegean	Kos	12	Learn phenomena, hypothesize, carry out experiment
13	Male	South Aegean	Simi	18	Learn phenomena and to get in touch with issues that concern humanity and future
14	Male	South Aegean	Rhodes	14	Learn concepts, the natural world, develop skills and abilities and positive attitudes towards science
15	Male	South Aegean	Rhodes	12	Child develops skills as reading, analyzing text, events, making comments. Learn about Phenomena, define and describe them link them to the outer world and get an idea of scientific work
16	Male	South Aegean	Rhodes	5	Development of "scientific thought", observe, hypothesize, experiment, state conclusion, explain and describe concepts and phenomena
17	Female	South Aegean	Athens Rhodes	3	Learn the basic phenomena, hypothesize, experiment & reject misconceptions

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
18	Male	South Aegean	Kos	6	Learning about concepts and developing abilities to construct knowledge
19	Male	South Aegean	Kos	5	Becoming able to construct knowledge
20	Female	North Aegean	In-service training	20	Learn concepts, phenomena, develop experimental & scientific skills and abilities
21	Male	North Aegean	In-service training	17	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
22	Female	North Aegean	In-service training	9	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
23	Female	North Aegean	In-service training	13	Learn concepts, phenomena, develop experimental & scientific skills and abilities
24	Male	North Aegean	In-service training	16	Learn concepts, phenomena, develop experimental & scientific skills and abilities
25	Male	North Aegean	In-service training	25	Learn concepts, phenomena, develop experimental & scientific skills and abilities
26	Female	North Aegean	In-service training	19	Learn concepts, phenomena, develop experimental & scientific skills and abilities, and appreciation of the contribution of science to life improvement
27	Male	Attica	In-service training	14	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
28	Female	Attica	In-service training	18	Learn concepts, phenomena, develop experimental & scientific skills and abilities
29	Female	Attica	In-service training	17	Learn concepts, phenomena, develop experimental & scientific skills and abilities, and appreciation of the contribution of science to life improvement
30	Male	Attica	In-service training	5	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
31	Female	Attica	In-service training	15	Learn concepts, phenomena, develop experimental & scientific skills and abilities and appreciate the contribution of science to the improvement of life conditions

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
32	Male	Attica	In-service training	8	Learn concepts, phenomena, develop experimental & scientific skills and abilities and appreciate the contribution of science to the improvement of life conditions
33	Female	Attica	In-service training	16	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
34	Male	Attica	In-service training	17	Learn concepts, phenomena, develop experimental & scientific skills and abilities
35	Female	Attica	In-service training	20	Learn concepts, phenomena, develop experimental & scientific skills and abilities
36	Male	Attica	In-service training	10	Learn concepts, phenomena, develop experimental & scientific skills and abilities
37	Female	Attica	In-service training	7	Learn concepts, phenomena, develop experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
38	Male	North Aegean	In-service training	11	Learn concepts, phenomena, develop experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
39	Male	North Aegean	In-service training	19	Learn concepts, phenomena, develop experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
40	Female	North Aegean	In-service training	12	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
41	Female	North Aegean	In-service training	15	Learn concepts, phenomena, develop experimental & scientific skills and abilities
42	Male	North Aegean	In-service training	18	Learn concepts, phenomena, develop experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
43	Female	North Aegean	In-service training	14	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
44	Female	North Aegean	In-service training	19	Development of appreciation of the contribution of science in the improvement of everyday life

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
45	Female	North Aegean	In-service training	16	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
46	Male	North Aegean	In-service training	20	Learning concepts and phenomena, development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
47	Female	North Aegean	In-service training	13	Learning concepts and phenomena, development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
48	Female	North Aegean	In-service training	19	Learn concepts, phenomena (until recently)
49	Female	Attica	In-service training	17	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
50	Female	Attica	In-service training	10	Learning concepts and phenomena, development of experimental & scientific skills and abilities
51	Male	Attica	In-service training	18	Learning concepts and phenomena, development of experimental & scientific skills and abilities
52	Male	Attica	In-service training	7	Learn concepts, phenomena
53	Male	Attica	In-service training	11	Development of experimental & scientific skills and abilities, appreciation of the contribution of science in the improvement of the society and life conditions
54	Male	Peloponnese	In-service training	20	Learn concepts, phenomena, develop experimental & scientific skills and abilities
55	Female	Peloponnese	In-service training	15	Learn concepts, phenomena, develop experimental & scientific skills and abilities and appreciate the contribution of science to the improvement of life conditions
56	Male	Macedonia	Thessaloniki	18	Learning concepts and phenomena, skill development, understanding the contribution of science in everyday life (understanding that phenomena happen everyday life and not only in labs), becoming able to construct knowledge and rejecting misconceptions
57	Female	Macedonia	Thessaloniki	19	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
58	Male	Macedonia	Thessaloniki	8	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
59	Female	Macedonia	Thessaloniki	10	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
60	Male	Epirus	Ioannina	21	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
61	Male	Epirus	Larissa	11	Development of skills, carrying out experiments, learning how to construct scientific knowledge and have a first meet with scientific concepts
62	Male	Peloponnese	Peloponnese	7	Learning concepts and phenomena, skill development, becoming able to construct knowledge
63	Female	Peloponnese	Peloponnese	19	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
64	Female	Peloponnese	Peloponnese	9	Development of skills, carrying out experiments, learning how to construct scientific knowledge and have a first meet with scientific concepts
65	Female	Peloponnese	Peloponnese	7	Learning concepts and phenomena, skill development, becoming able to construct knowledge
66	Male	Peloponnese	Peloponnese	8	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
67	Male	Crete	Crete	15	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
68	Female	Crete	Crete	12	Development of skills, experiments carrying out and becoming able to construct knowledge
69	Male	Crete	Crete	12	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
70	Male	Crete	Crete	8	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
71	Female	Crete	Crete	11	Learning concepts and phenomena, skill development, experiment carrying out
72	Female	Ionian islands	Corfu	17	Development of skills, experiments carrying out and becoming able to construct knowledge
73	Male	Ionian islands	Zante	14	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
74	Female	Ionian islands	Corfu	16	Development of skills, experiments carrying out and becoming able to construct knowledge

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
75	Female	Ionian islands	Lefkada	13	Learning concepts and phenomena, skill development, experiment carrying out, understanding and appreciating the contribution of science in everyday life, becoming able to construct knowledge
76	Female	Ionian islands	Lefkada	10	Learning concepts and phenomena, skill development, experiment carrying out, understanding and appreciating the contribution of science in everyday life, becoming able to construct knowledge
77	Male	Peloponnese	Patrai	2	Learning concepts and phenomena, skill development, experiment carrying out
78	Male	Peloponnese	Sparta	11	Learning concepts and phenomena, skill development, experiment carrying out
79	Male	Peloponnese	Sparta	14	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
80	Male	Peloponnese	Patrai	2	Learning concepts and phenomena, skill development, experiment carrying out
81	Female	Peloponnese	Patrai	3	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
82	Male	Peloponnese	Patrai	5	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
83	Male	Macedonia	Edessa	19	Learning concepts and phenomena, skill development, experiment carrying out
84	Female	Macedonia	Edessa	17	Learning concepts and phenomena, skill development, experiment carrying out, understanding and appreciating the contribution of science in everyday life, becoming able to construct knowledge
85	Male	Macedonia	Kilkis	20	Learning concepts and phenomena, skill development, experiment carrying out, understanding and appreciating the contribution of science in everyday life, becoming able to construct knowledge
86	Female	Thrace	Alexandroupoli	21	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
87	Female	Thrace	Alexandroupoli	19	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
88	Male	Thrace	Alexandroupoli	20	Learning concepts and phenomena, becoming able to construct knowledge
89	Female	Thrace	Alexandroupoli	18	Learning concepts and phenomena, becoming able to construct knowledge

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
90	Female	South Aegean	Rhodes	1	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
91	Male	Attica	Athens	9	Learning concepts and phenomena, skill development, experiment carrying out, appreciation of the contribution of science in everyday life condition improvement and development
92	Female	South Aegean	Rhodes	2	Learning concepts and phenomena, skill development, experiment carrying out, becoming able to construct knowledge
93	Female	Attica	Piraeus	5	Becoming able to construct knowledge
94	Female	Attica	Piraeus	6	Becoming able to construct knowledge
95	Male	Thessaly	Larisa	2	Becoming able to construct knowledge
96	Male	Thessaly	Larisa	10	Development of skills, experiments carrying out and becoming able to construct knowledge
97	Female	Thessaly	Larisa	9	Learning concepts and phenomena, skill development, experiment carrying out, appreciation of the contribution of science in everyday life condition improvement and development
98	Male	Thessaly	Volos	6	Becoming able to construct knowledge
99	Male	Thessaly	Volos	10	Development of skills, experiments carrying out and becoming able to construct knowledge
100	Female	Central Greece	In-service training	2	Becoming able to construct knowledge
101	Male	Central Greece	In-service training	18	Development of skills, experiments carrying out and becoming able to construct knowledge
102	Male	Central Greece	In-service training	18	Development of skills, experiments carrying out and becoming able to construct knowledge
103	Male	Central Greece	In-service training	10	Learning concepts and phenomena
104	Female	Central Greece	In-service training	22	Development of skills, experiments carrying out and becoming able to construct knowledge
105	Female	Central Greece	In-service training	10	Learning about concepts and phenomena, experiment carrying out and skill development
106	Male	Central Greece	In-service training	16	Development of skills, experiments carrying out and becoming able to construct knowledge
107	Female	Central Greece	In-service training	10	Appreciation of the contribution of science in the improvement of life & the society

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
108	Male	Central Greece	In-service training	19	Learning about concepts and the phenomena, development of skills, experiments carrying out and becoming able to construct knowledge
109	Male	Central Greece	In-service training	14	Learning about concepts and the phenomena, development of skills, experiments carrying out, appreciation of the contribution of science in everdaylife and becoming able to construct knowledge
110	Female	Central Greece	In-service training	14	Development of skills, experiments carrying out and becoming able to construct knowledge
111	Male	Central Greece	In-service training	7	Learning concepts and phenomena, development of skills, experiments carrying out, appreciation of science contribution and becoming able to construct knowledge
112	Male	Central Greece	In-service training	17	Becoming able to construct knowledge
113	Female	Central Greece	In-service training	8	Learning about concepts and the phenomena, development of skills, experiments carrying out and becoming able to construct knowledge
114	Male	Central Greece	In-service training	17	Learning about concepts and the phenomena, development of skills, experiments carrying out and becoming able to construct knowledge
115	Female	Central Greece	In-service training	10	Development of skills, experiments carrying out and becoming able to construct knowledge
116	Female	South Aegean	Rhodes	4	The development of skills, experiments carrying out, appreciation of the contribution of science in the society and the improvement of life conditions
117	Female	South Aegean	Rhodes	23	Appreciation of the contribution of science in the improvement of life & the society
118	Male	South Aegean	Rhodes	2	Learning about concepts and phenomena, experiment carrying out and skill development, appreciation of the contribution of science in the society, development by the students of the ability to construct knowledge by themselves
119	Male	South Aegean	Rhodes	10	Development of skills, experiments carrying out and appreciating the contribution of science in the society
120	Female	South Aegean	Rhodes	14	Development of skills, experiments carrying out and becoming able to construct knowledge
121	Female	South Aegean	Rhodes	8	Development of skills, experiments carrying out
122	Female	Thessaly	Trikala	20	Development of skills, experiments carrying out and becoming able to construct knowledge

Teacher No	Gender	Region	Place	Years of teaching experience	What is the aim of science subjects?
123	Female	Thessaly	Trikala	11	Development of skills, experiments carrying out
124	Male	Thessaly	Trikala	6	Development of skills, experiments carrying out
125	Female	Peloponnese	Patrai	16	Development of skills, experiments carrying out
126	Female	Peloponnese	Patrai	9	Development of skills, experiments carrying out
127	Male	Peloponnese	Githion	7	Development of skills, experiments carrying out and becoming able to construct knowledge
128	Male	Peloponnese	Githion	13	Development of skills, experiments carrying out and becoming able to construct knowledge
129	Female	Ionian islands	Corfu	12	Development of skills, experiments carrying out and becoming able to construct knowledge
130	Male	Crete	Iraklion	19	Development of skills, experiments carrying out

Table 2: Teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	Was the change necessary	What were the reasons for the change
1	YES	The need for new books practical & integrating activities, familiar to students
2	YES	The lesson was boring and not practical and the books were old
3	YES	The previous book was too old, not exciting, low results of Greece in international assessment
4	YES	The need for new books practical lesson with experiments
5	YES	The previous book was old, boring and only theory
6	YES	The previous book was too old, made the lesson boring, low results of Greece in international assessment
7	YES	The previous book was too old just providing information
8	YES	There was need for change, low results of Greece in international assessment
9	YES	There was need for change, and new books
10	YES	The old book was in use for about 20 years, no emphasis on pupil misconceptions
11	YES	The old book was in use for about 20 years
12	YES	The new book serves better the aims of scientific literacy (phenomena, hypothesis, experiments), and has group activities.
13	YES	Life changes so does the curriculum, political reasons
14	YES	Research has shown the necessity for a more updated and modern approach to scientific knowledge through pupil misconceptions
15	YES	The current pedagogical tendencies want the child to learn science by working as a scientist individually or in groups
16	YES	To make the lesson more interesting and more prosperous with group activities, the old book contained wrong information
17	YES	The previous book was too old, had difficult text and not many practical activities that could be applied in the classroom
18	YES	The previous book was old unattractive and difficult, low results of Greece in international assessment, political reasons
19	YES	The previous book was old and not in accordance to current Science Education theories and pupil misconceptions
20	YES	The need for new books, active student learning, emphasis on experiment, pupil misconceptions and the development of criticality
21	YES	The need for new books, active student learning, emphasis on experiment, pupil misconceptions and the development of criticality
22	YES	The need for new books, active student learning, emphasis on experiment, pupil misconceptions and the development of criticality
23	YES	The need for new books, active student learning, emphasis on experiment, pupil misconceptions and the development of criticality
24	YES	Changes in the society, the improvement of modern technologies, and the changes in the philosophy about learning
25	YES	The need for learning through research, pupil misconceptions and experience, low results of Greece in international assessment

Teacher No	Was the change necessary	What were the reasons for the change
26	YES	The need for a more recent books and teaching system, low results of Greece in international assessment
27	YES	The need for more effective science teaching, based on active student learning, low results of Greece in international assessment
28	YES	The need for new books active student learning, emphasis on experiment and the development of criticality
29	YES	The need for more recent books and effective science teaching, based on active student learning, political reasons
30	YES	The need for more effective science teaching, based on active student learning, low results of Greece in international assessment
31	YES	The need for more recent books and effective science teaching, based on active student learning and pupil misconceptions
32	YES	The need for more recent books and effective science teaching, based on active student learning and pupil misconceptions
33	YES	The need for more recent and effective science teaching, based on active student co-operative learning and analysing of experiments
34	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning and pupil misconceptions
35	YES	Scientific progress changes in the society, the improvement of modern technologies, and the changes in the philosophy about learning
36	YES	The need for more recent and effective science teaching, based on active student co-operative learning and analysing of experiments
37	YES	The need for new books active student learning, emphasis on experiment and the development of criticality, political reasons
38	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning
39	YES	Too old textbooks, changes in the society, the improvement of modern technologies, and the changes in the philosophy about learning
40	YES	The need for more recent and effective science teaching, based on active student co-operative learning and analysing of experiments
41	YES	The need for new books and need to introduce the experiment in the lesson, low results of Greece in international assessment
42	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning and pupil misconceptions
43	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning and pupil misconceptions
44	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning and pupil misconceptions
45	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning and pupil misconceptions
46	YES	The need for a more recent text-book with nice visual material that reinforces the active group learning and pupil misconceptions
47	YES	The need for new books learning through observation, critical thinking and experiments linked with everyday life experience
48	YES	The need to introduce the experiment and pupil misconceptions in the lesson, low results of Greece in international assessment
49	YES	The need to introduce the experiment and pupil misconceptions in the lesson, low results of Greece in international assessment
50	YES	The need to introduce the experiment and pupil misconceptions in the lesson, low results of Greece in international assessment
51	YES	The need to introduce the experiment and pupil misconceptions in the lesson, low results of Greece in international assessment
52	YES	The need for more attractive textbooks that contain experiments for the lesson and learning through experiments

Teacher No	Was the change necessary	What were the reasons for the change
53	YES	The need to introduce the experience of the children even if wrong (misconceptions), too old textbooks
54	YES	Scientific progress changes in the society, the improvement of modern technologies, and the changes in the philosophy about learning
55	YES	The need for more recent textbooks and effective science teaching, based on active student learning and concern about misconceptions
56	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no integration and no concern about misconceptions, low results of Greece in international assessment
57	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no links with everyday experience, no integration
58	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no integration and no concern about misconceptions, low results of Greece in international assessment
59	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no integration and no concern about misconceptions, low results of Greece in international assessment
60	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no links with everyday experience, no integration, low results of Greece in international assessment
61	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no integration, no concern about misconceptions and no emphasis on development of critical thinking
62	YES	The increase of the learning level of students, inadequate information, not attractive (not nice images), no concern about misconceptions and not many opportunities for integration, low results of Greece in international assessment, old textbooks
63	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no links with everyday experience, no integration
64	YES	The old book had too much theory, no emphasis on experiment, not attractive, difficult text, no integration and no emphasis on development of critical thinking, political reasons
65	YES	The increase of the learning level of students, inadequate information, not attractive (not nice images), no concern about misconceptions and not many opportunities for integration, too old textbooks
66	YES	Inadequate information, outdated information, no emphasis on experiment, unattractive book, difficult language, no opportunities for integration, low results of Greece in international assessment, too old textbooks
67	YES	Outdated knowledge, too old textbooks no emphasis on misconceptions, no emphasis on experiment, not good link with everyday life, unattractive book, no opportunities for integration and for lesson through "project"
68	YES	No emphasis on experiment, too old textbooks, not good link with everyday life, unattractive book, no opportunities for integrating activities, no opportunities for students to construct knowledge
69	YES	No emphasis on misconceptions, no emphasis on experiment, not good link with everyday life, unattractive book, old textbooks no opportunities for integration and for lesson through "project"
70	YES	Inadequate and outdated information, no emphasis on experiment, unattractive & old book, difficult language, no opportunities for integration, too old textbooks

Teacher No	Was the change necessary	What were the reasons for the change
71	YES	Inadequate information, no active involvement of students in the lesson, no emphasis on experiments, unattractive book, no opportunities for integrating activities no concern about misconceptions, low results of Greece in international assessment
72	YES	Outdated knowledge old textbooks, too much emphasis on theory, unattractive book, difficult vocabulary no concern about misconceptions
73	YES	Outdated knowledge old textbooks, too much emphasis on theory, unattractive book, difficult vocabulary
74	YES	Inadequate knowledge, old textbooks no emphasis on experiments, no opportunities for integration, unattractive and tiring teaching techniques and learning approaches no concern about misconceptions
75	YES	Outdated knowledge old textbooks, no emphasis in experiments, not good links with everyday life, no opportunities for integration,
76	YES	No emphasis in experiments, not good links with everyday life, no opportunities for integration, no concern about misconceptions
77	YES	No emphasis in experiments, unattractive book, not good links with everyday life, low results of Greece in international assessment
78	YES	Inadequate information, old textbooks, no active involvement of students in the lesson, no emphasis on experiments, unattractive book, no opportunities for integrating activities
79	YES	Inadequate knowledge, old textbooks, no emphasis on experiments, no opportunities for integration, unattractive and tiring teaching techniques and learning approaches, low results of Greece in international assessment
80	YES	No emphasis in experiments, unattractive and old book, not good links with everyday life, no concern about misconceptions
81	YES	Outdated knowledge, old textbooks, no emphasis in experiments, not good links with everyday life, no opportunities for integration,
82	YES	Outdated knowledge, old textbooks, no emphasis in experiments, not good links with everyday life, no opportunities for integration,
83	YES	Ineffective teaching and learning old textbooks, Inadequate information, no emphasis on the experiment, not good link with everyday life, unattractive books, no opportunity for integration no concern about misconceptions
84	YES	Extreme emphasis on theory, old textbooks, no emphasis on experiments, not good links with everyday life, unattractive book, no opportunities for integration no concern about misconceptions
85	YES	Extreme emphasis on theory, old textbooks, no emphasis on experiments, not good links with everyday life, unattractive book, no opportunities for integration no concern about misconceptions, political reasons
86	YES	Outdated knowledge, old textbooks, extreme emphasis on theory, no emphasis in experiments, unattractive books, not good links with everyday life, no opportunities for integration, no concern about misconceptions
87	YES	Outdated knowledge, old textbooks, extreme emphasis on theory, no emphasis in experiments, unattractive books, not good links with everyday life, no opportunities for integration, low results of Greece in international assessment
88	YES	No emphasis on experiments, old textbooks, extreme emphasis on theory, not good links with everyday life experience, unattractive book, not many opportunities for integrating activities no concern about misconceptions, low results of Greece in international assessment
89	YES	No emphasis on experiments, old textbooks, extreme emphasis on theory, not good links with everyday life experience, unattractive book, not many opportunities for integrating activities, low results of Greece in international assessment

Teacher No	Was the change necessary	What were the reasons for the change
90	YES	No emphasis on experiments, old textbooks, extreme emphasis on theory, not good links with everyday life experience, unattractive book, not many opportunities for integrating activities, low results of Greece in international assessment
91	YES	Outdated knowledge, old textbooks, no emphasis on experiments, too much emphasis on theory, no good links with everyday life
92	YES	No emphasis on experiments, extreme emphasis on theory, not good links with everyday life experience, unattractive book, not many opportunities for integrating activities no concern about misconceptions, low results of Greece in international assessment
93	YES	Limited opportunities for integrating activities no concern about misconceptions, low results of Greece in international assessment
94	YES	Inadequate knowledge, old textbooks, no emphasis on experiments and observation, unattractive books,
95	YES	No links with everyday life experience, unattractive and old books, difficult vocabulary and chapters for children to learn
96	YES	No emphasis on experiments and observation, old textbooks, too much emphasis on theory, insufficient links with everyday life experience, unattractive books, difficult vocabulary and units, limited integration no concern about misconceptions
97	YES	Outdated knowledge, old textbooks, no emphasis on experiments, too much emphasis on theory, no good links with everyday life
98	YES	Inadequate knowledge, no emphasis on experiments and observation, unattractive books no concern about misconceptions
99	YES	No emphasis on experiments and observation, too much emphasis on theory, insufficient links with everyday life experience, unattractive and books, difficult vocabulary and units, limited integration no concern about misconceptions
100	YES	No links with everyday life experience, unattractive and old books, difficult vocabulary and chapters for children to learn
101	YES	Outdated knowledge, no emphasis on experiments, not good links with everyday life misconceptions, old books, not enough opportunities for integrating activities, scientific progress
102	YES	Too much emphasis on theory, too old textbooks no emphasis on experiments & skills, no opportunities for integration, the need for students to learn how to construct knowledge, low results of Greece in international assessment
103	YES	Outdated knowledge low results of Greece in international assessment, political reasons, old textbooks
104	YES	No emphasis on experiments and skills, the development of new teaching approaches (constructivism), old textbooks
105	YES	No emphasis on experiments and skills development, old unattractive and inefficient textbooks
106	YES	Too much emphasis on theory, unattractive and old books, no opportunities for integration, the need for new teaching approaches
107	YES	No emphasis on experiments and skill development, unattractive and old books, low results of Greece in international assessment
108	YES	Inadequate knowledge, old textbooks too much emphasis on theory, low results of Greece in international assessment
109	YES	No emphasis on experiments and skill development, no opportunities for integration no concern about misconceptions, old textbooks
110	YES	Inadequate knowledge, no emphasis on experiments etc, too much theory, unattractive and old books, no links with everyday, difficult texts, no integration
111	YES	Inadequate knowledge, no emphasis on experiments etc, too much theory, unattractive and old books, no links with everyday, difficult texts, no integration no concern about misconceptions

Teacher No	Was the change necessary	What were the reasons for the change
112	YES	No integration, low results of Greece in international assessment, old books
113	YES	Outdated knowledge, too old textbooks no emphasis on experiments and skills, no opportunities for integration
114	YES	No emphasis on experiments and skills, unattractive and old books, no opportunities for integration
115	YES	Unattractive and old text-books, low results of Greece in international assessment
116	YES	Unattractive and old textbook, difficult text, ministry no concern about misconceptions
117	YES	Not much links with everyday life, ministry, old textbooks, low results of Greece in international assessment
118	YES	No emphasis on the experiments, old textbooks, no opportunities for integration and for active learning by the students
119	YES	No emphasis on experiments and activities, old textbooks too much emphasis on theory, difficult vocabulary for students, the ministry
120	YES	Outdated knowledge, old textbooks, too much theory, no links with everyday life, too easy text, the society
121	YES	Old textbooks
122	YES	Outdated knowledge, too much theory, no links with everyday life, too easy text, the society no concern about misconceptions
123	YES	Outdated knowledge, too much theory, no links with everyday life, old textbooks, too easy text, the society
124	YES	Too much emphasis on theory, old textbooks, no emphasis on experiments & skills, no opportunities for integration, the need for students to learn how to construct knowledge, low results of Greece in international assessment
125	YES	Outdated knowledge, no emphasis on experiments, not good links with everyday life misconceptions, unattractive and books, not enough opportunities for integrating activities, scientific progress
126	YES	No links with everyday life experience, unattractive and books, difficult vocabulary and chapters for children to learn
127	YES	Outdated knowledge, no emphasis on experiments, not good links with everyday life misconceptions, unattractive and books, not enough opportunities for integrating activities, scientific progress no concern about misconceptions
128	YES	Outdated knowledge, no emphasis on experiments, not good links with everyday life misconceptions, unattractive and books, not enough opportunities for integrating activities, scientific progress
129	YES	Too much emphasis on theory, no emphasis on experiments & skills, no opportunities for integration, the need for students to learn how to construct knowledge, low results of Greece in international assessment, old textbooks
130	YES	Outdated knowledge, no emphasis on experiments, not good links with everyday life misconceptions, unattractive and old books, not enough opportunities for integrating activities, scientific progress, low results of Greece in international assessment

Table 3: Teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	What are the differences between old and new curriculum	Is further education provided? What kind?
1	Experiments, skill development (by children), researched type lesson	Limited, only at the level of the consultant
2	Experiments, skill development (by children), researched based lesson	SUFFICIENT, by the consultant,
3	Experiments, skill development (by children)	Improper in terms of time, and kind (WORKSHOP, would be more helpful)
4	Experiments, skill development (by children) with simple materials, less text to memorise (observation, experiment, conclusion)	Improper, only teachers book
5	Experiments, skill development (by students), more liked by students	Nothing only teachers' book and personal experience
6	Experiments, skill development (by students) with simple materials	Seminars, sufficient generally & teachers' themselves professional development
7	Experiments, skill development (by students)	Limited, only through seminars in the University
8	They learn LANGUAGE and not science	Nothing, few seminars that don't help a lot
9	Supposed to be more practical with Experiments, skill development done by children	Nothing, few seminars that don't help a lot
10	Experiments, misconceptions, skill development (done by children)	Nothing, few seminars that don't help a lot
11	Experiments, skill development (done by students), the lesson has the type of researched activity	Nothing, few seminars that don't help a lot
12	Experiments, skill development and group activities, (done by students)	Seminars that offer theoretical and NOT PRACTICAL GUIDANCE
13	Experiments, skill development, practical activities (done by students)	Seminars that offer theoretical and NOT PRACTICAL GUIDANCE
14	Active learning, misconceptions, attractive materials, Experiments, skill development	Lack of further training
15	Experiments, skill development, group activities, (done by students)	S that offer theoretical and NOT PRACTICAL GUIDANCE
16	Group activities with simple materials and worksheets, in simple language	Seminars that offer theoretical and NOT PRACTICAL GUIDANCE
17	The previous book had difficult text and not many practical activities that could be applied in class	Seminars that offer theoretical and NOT PRACTICAL GUIDANCE
18	Experiments, skill development, every day life links	Seminars by the consultant
19	Experiments, skill development, effort to involve misconceptions (which, is unsuccessful due to time pressure)	Only the consultant
20	Emphasis on Experiments, misconceptions and development of critical and scientific skills	Limited to inexistent
21	Emphasis on Experiments, misconceptions and development of critical and scientific skills	Not enough

Teacher No	What are the differences between old and new curriculum	Is further education provided? What kind?
22	Emphasis on Experiments, skill development and learning through misconceptions and experience	Not enough
23	Emphasis on Experiments, misconceptions and development of critical and scientific skills	Insufficient
24	Emphasis on Experiments, skill development and everyday experience links	Very limited
25	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Not enough
26	Emphasis on scientific concepts	Not enough
27	Emphasis on Experiments, skill development and development of critical and scientific skills	Insufficient
28	Emphasis on every day life links and experience	Limited
29	Emphasis on Experiments, skill development and everyday experience links	Limited
30	Emphasis on Experiments, skill development and everyday experience links	Limited
31	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Adequate
32	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Just sufficient
33	Emphasis on Experiments, skill development and everyday experience links	Very limited
34	Emphasis on Experiments, skills, group activities misconceptions, everyday experience links	Insufficient
35	Emphasis on Experiments, skill development and development of critical and scientific skills	Insufficient
36	Emphasis on Experiments, skill development and development of critical and scientific skills	Insufficient
37	Emphasis on Experiments, skill development and everyday experience links	Not enough
38	Emphasis on Experiments, skills, group activities misconceptions, everyday experience links	Very limited
39	Emphasis on Experiments, skill development and everyday experience links	Only through the consultant
40	Emphasis on Experiments, skill development and everyday experience links	Limited
41	Emphasis on Experiments, skill development and development of critical and scientific skills	Just adequate
42	Emphasis on misconceptions group activities, every day life links and experience	Almost inexistent
43	Emphasis on Experiments, skill development, group activities misconceptions	Almost inexistent
44	Emphasis on Experiments, skills development group activities misconceptions	Almost inexistent
45	Emphasis on Experiments, skills, group activities misconceptions, everyday experience links	Limited to the level of the consultant
46	Emphasis on Experiments, skills, group activities misconceptions, everyday experience links	Limited
47	Emphasis on Experiments, skill development and everyday experience links	Limited
48	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited
49	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited

Teacher No	What are the differences between old and new curriculum	Is further education provided? What kind?
50	Emphasis on misconceptions and every day life links and experience	Limited
51	Emphasis on Experiments, misconceptions and development of critical and scientific skills	Limited
52	Emphasis on every day life links and experience	Limited
53	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited
54	Emphasis on Experiments, skill development and development of critical and scientific skills	Insufficient
55	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Adequate
56	Emphasis on Experiments, skill development and everyday experience links	YES but not through the Ministry or the Ped. Institute. Through ICT in Science lesson
57	Emphasis on Experiments, skill development and everyday experience links	No
58	Emphasis on Experiments, skill development, misconceptions and everyday experience links	YES but through Universities
59	Emphasis on Experiments, skill development, misconceptions and everyday experience links	No barely existent
60	Emphasis on Experiments, skill development and everyday experience links	NOTHING, just through the Universities some concern from the side of the consultant, in both cases INSUFFICIENT
61	Emphasis on Experiments, skill development, misconceptions and everyday experience links . The child is free to observe, hypothesize, experiment, make mistakes and draw conclusions	YES within in-service training (exomoiosh)
62	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Only at the level of the consultant
63	Emphasis on Experiments, skill development and everyday experience links	NOTHING, just through the Universities some concern from the side of the consultant, in both cases INSUFFICIENT
64	Emphasis on Experiments, skill development and everyday experience links . The child is free to observe, hypothesise, experiment, make mistakes and draw conclusions	YES within in-service training (exomoiosh)
65	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Only at the level of the consultant
66	Emphasis on Experiments, skill development, and everyday experience links	YES seminars
67	Emphasis on Experiments, skill development, misconceptions and everyday experience links	NO
68	Emphasis on Experiments, skill development, misconceptions and everyday experience links	YES, seminars, documents
69	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Insufficient
70	Emphasis on Experiments, skill development and everyday experience links	YES seminars
71	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Nothing
72	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Nothing
73	Emphasis on Experiments, skill development and everyday experience links	Nothing
74	Emphasis on Experiments, skill development, misconceptions and everyday experience links	YES, seminars

Teacher No	What are the differences between old and new curriculum	Is further education provided? What kind?
75	Emphasis on Experiments, skill development and everyday experience links	NO, just seminars for children with special needs
76	Emphasis on Experiments, skill development, misconceptions and everyday experience links	NO, just seminars for children with special needs
77	Emphasis on Experiments, skill development and everyday experience links	NO
78	Emphasis on Experiments, skill development and everyday experience links	Nothing
79	Emphasis on Experiments, skill development and everyday experience links	YES, seminars
80	Emphasis on Experiments, skill development, misconceptions and everyday experience links	NO
81	Emphasis on concepts, emphasis on Experiments, skill development and everyday experience links	Limited
82	Emphasis on concepts, emphasis on Experiments, skill development and everyday experience links	Limited
83	Emphasis on Experiments, skill development, misconceptions and everyday experience links	YES, seminars, documents
84	Emphasis on Experiments, skill development, misconceptions and everyday experience links	NO, simply a one day seminar that does not help at all
85	Emphasis on Experiments, skill development, misconceptions and everyday experience links	NO, simply a one day seminar that does not help at all
86	Emphasis on Experiments, skill development, misconceptions and everyday experience links	YES but limited, only through seminars and documents
87	Emphasis on Experiments, skill development and everyday experience links	YES but limited, only through seminars and documents
88	Emphasis on Experiments, skill development, misconceptions and everyday experience links	NO
89	Emphasis on Experiments, skill development and everyday experience links	Very limited
90	Emphasis on Experiments, skill development and everyday experience links	YES, documents
91	Emphasis on concepts and phenomena, emphasis on Experiments, skill development and everyday experience links	Limited
92	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited
93	Emphasis on the everyday experience links , misconceptions	Limited
94	Emphasis on the everyday experience links	Optional seminars
95	Emphasis on the everyday experience links	Obligatory seminars
96	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited
97	Emphasis on concepts and phenomena, emphasis on Experiments, skill development and everyday experience links	Limited
98	Emphasis on the everyday experience links and pupil misconceptions	Optional seminars
99	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited
100	Emphasis on the everyday experience links	Obligatory seminars

Teacher No	What are the differences between old and new curriculum	Is further education provided? What kind?
101	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Limited
102	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Seminars, which are not helpful enough
103	Emphasis on everyday experience links	Nothing
104	Emphasis on Experiments, skill development and misconceptions	YES, documents
105	Emphasis on Experiments, skill development and everyday experience links	Limited
106	Emphasis on Experiments, skill development and everyday experience links	NO, only teachers books
107	Emphasis on Experiments, skill development and everyday experience links	Seminars, programs
108	Emphasis on Experiments, skill development, skill development	Mandatory seminars and programs
109	Emphasis on Experiments, skill development, misconceptions and everyday experience links	Mandatory seminars and programs
110	Emphasis on Experiments, skill development and everyday experience links	Nothing
111	Emphasis on concepts, Emphasis on Experiments carrying out, skill development, pupil misconceptions and everyday experience links	Nothing
112	Emphasis on links with every-day life experience	Nothing
113	Emphasis on links with every-day life experience	Optional seminars and programs
114	Emphasis on learning and phenomena, experiment carrying out and skill development and every day life links experiment	Nothing
115	Emphasis on the everyday experience links	Nothing
116	Emphasis on the everyday experience links and pupil misconceptions	Limited to documents
117	Emphasis on the everyday experience links	Limited to documents
118	Emphasis on Experiments, skill development,	Nothing
119	Emphasis on Experiments, skill development	YES, documents
120	Emphasis on Experiments, skill development	YES, mandatory seminars and programs
121	Emphasis on Experiments, skill development carrying out and development of skills	Limited
122	Emphasis on Experiments carrying out, skill development and pupil misconceptions	Limited
123	Emphasis on Experiments carrying out, and development of skills	Limited
124	Emphasis on Experiments carrying out, skill development and pupil misconceptions	Limited
125	Emphasis on Experiments carrying out, skill development and pupil misconceptions	Limited
126	Emphasis on Experiments carrying out, skill development	Limited
127	Emphasis on Experiments, skill development carrying out and pupil misconceptions	Nothing

Teacher No	What are the differences between old and new curriculum	Is further education provided? What kind?
128	Emphasis on Experiments, skill development carrying out and pupil misconceptions	Seminars, programs
129	Emphasis on Experiments, skill development carrying out and pupil misconceptions	Nothing
130	Emphasis on Experiments, skill development carrying out and pupil misconceptions	Seminars, programs

Table 4: Teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	Is there Assessment	Is there Co-operation & communication	Do children enjoy more science subjects now?	Are scientific concepts taught better now?
1	Only the consultant, probably at National level in Future	Limited, only the consultant	YES	YES
2	The consultant	SUFFICIENT, by the consultant,	YES	YES
3	Only the consultant, probably at National level in future	Insufficient again, workshop type seminars would	YES	YES
4	Consultant, nothing more	Teachers' council, consultant and INFORMAL between teachers	YES	YES
5	Consultant	INFORMAL between teachers	YES	YES
6	Consultant	Consultant mainly and INFORMAL with teachers	YES	YES
7	University tutors	INFORMAL with other teachers	YES	YES
8	The consultant but nothing more	Very limited, only the consultant, only INFORMAL with other teachers	YES	NO
9	The consultant	Very limited, only the consultant, only INFORMAL with other teachers	YES	NO
10	The consultant	Very limited, only the consultant, only INFORMAL with other teachers	YES	YES
11	The consultant	Very limited, only the consultant, only INFORMAL with other teachers	YES	YES
12	The consultant	FORMAL with the consultant INFRORMAL with teachers and through the internet	YES	YES
13	The consultant	FORMAL with the consultant INFRORMAL with teachers and through the internet	YES	YES
14	The consultant,	FORMAL with the consultant INFRORMAL with teachers and through the internet	YES	YES
15	Nothing specific	INFRORMAL with teachers, head-teachers, parents etc	YES	YES
16	Nothing specific	FORMAL with the consultant INFRORMAL with teachers and through the internet	YES	YES

Teacher No	Is there Assessment	Is there Co-operation & communication	Do children enjoy more science subjects now?	Are scientific concepts taught better now?
17	Nothing specific	Only the consultant	YES	YES
18	Only the consultant	Only the consultant	YES	YES
19	Nothing specific, the consultant can assess the teacher and the students probably with WRITTEN EXAMINATIONS at the end of the school year	FORMAL with the consultant INFRORMAL with teachers and through the internet	YES	YES
20	Nothing specific. Assessment has no reason as it is unlikely to be valid, as with no further education, low salaries & poor school equipment	YES but mainly unofficial and between schools	YES	YES
21	Nothing specific	Informal	YES	YES
22	Nothing specific	Informal only between schools	YES	YES
23	Assessment for feedback is necessary.	Informal	YES	YES
24	Nothing specific	Yes but informal and only through schools	YES	YES
25	Nothing specific	YES	YES	YES
26	Nothing specific	No	YES	YES
27	Noting specific	YES, to the level that this is possible	YES	YES
28	Probably	Yes with the head-teacher	YES	YES
29	Nothing specific	Sometimes	YES	YES
30	Nothing specific	Only through internet	YES	YES
31	YES, assessment of teachers and students	Yes but informal	YES	YES
32	Nothing specific	Yes but informal	YES	YES
33	Nothing specific	Yes but informal	YES	YES
34	Nothing specific	Yes with the head-teacher	YES	YES
35	It is under discussion and it is required	Yes but only with teachers and informally	YES	YES
36	Nothing specific	Yes but only with teachers and informally	YES	YES
37	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
38	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES

Teacher No	Is there Assessment	Is there Co-operation & communication	Do children enjoy more science subjects now?	Are scientific concepts taught better now?
39	Only through the consultant	Only through the consultant	YES	YES
40	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
41	Nothing specific	Internet	YES	YES
42	Noting specific	No	YES	YES
43	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
44	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
45	Nothing clear, just information about teacher assessment generally	Yes but only with teachers and informally and through internet	YES	YES
46	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
47	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
48	Nothing specific	Internet	YES	YES
49	Nothing specific	Yes but only with teachers and informally and through internet	YES	NO
50	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
51	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
52	Nothing specific	Yes but only with teachers and informally and through internet	YES	YES
53	Nothing specific	Yes but only with consultant	YES	YES
54	It is under discussion and it is required	Yes but only with teachers and informally	YES	YES
55	YES, assessment of teachers and students	Yes but informal	YES	YES
56	Nothing specific	The school consultant, university tutors, internet	YES	YES
57	No	The school consultant, university tutors, internet	YES	YES
58	Nothing specific	The school consultant, university tutors, internet	YES	YES
59	No	The school consultant, university tutors, internet	YES	YES

Teacher No	Is there Assessment	Is there Co-operation & communication	Do children enjoy more science subjects now?	Are scientific concepts taught better now?
60	NOTHING	The school consultant, university tutors, internet	YES	YES
61	Assessment of teachers	The school consultant and colleagues	YES	YES
62	Nothing	Only with the school consultant	YES	YES
63	NOTHING	The school consultant, internet	YES	YES
64	Assessment of teachers (noting specific)	The school consultant mainly and colleagues	YES	YES
65	Nothing	Only through the school consultant	YES	YES
66	Nothing	Only through the school consultant	YES	YES
67	NO	Only through the school consultant	YES	YES
68	NO	Limited, mainly as responsibility of the school consultant or the educators	YES	YES
69	Just for students	Only through the school consultant	YES	YES
70	Nothing	Only through the school consultant	YES	YES
71	Nothing	Only through the school consultant	YES	YES
72	Nothing	Nothing	YES	YES
73	Nothing	Nothing	YES	YES
74	Assessment of educators	Inadequate	YES	YES
75	Assessment of students (written exams)	Only with the consultant	YES	YES
76	Assessment of students (written exams)	Only with the consultant	YES	YES
77	NO	NO	YES	YES
78	Nothing	Only through the school consultant	YES	YES
79	Assessment of educators	Inadequate	YES	YES
80	NO	NO	YES	YES
81	YES, educators and students (written exams)	NO	YES	YES
82	YES, educators and students (written exams)	NO	YES	YES
83	YES, with student exams	Insufficient, mainly thanks to internet	YES	YES
84	No	No, just the consultant	YES	YES
85	No	No, just the consultant	YES	YES

Teacher No	Is there Assessment	Is there Co-operation & communication	Do children enjoy more science subjects now?	Are scientific concepts taught better now?
86	No	No, just the consultant	YES	YES
87	No	No, just the consultant	YES	YES
88	NO	NO	YES	YES
89	Various information for educators assessment	Limited, just the consultant	YES	YES
90	No	Pedagogical Institute	YES	YES
91	Noting specific	The consultant	YES	YES
92	Consultant	Internet	YES	YES
93	Performance of students	Informal	YES	YES
94	Assessment of teachers	Informal	YES	YES
95	Assessment of teachers	Informal	YES	YES
96	Nothing specific	Informal	YES	YES
97	Noting specific	The consultant	YES	YES
98	Assessment of teachers	Informal	YES	YES
99	Nothing specific	Informal	YES	YES
100	Assessment of teachers	Informal	YES	YES
101	Nothing specific	Nothing	YES	YES
102	Nothing specific	Internet	YES	YES
103	Nothing specific	Nothing	YES	YES
104	Assessment of students performance	YES	YES	YES
105	Nothing specific	NO	YES	YES
106	Assessment of students performance	YES	YES	YES
107	Assessment of students performance	Nothing	YES	YES
108	Nothing	Nothing	YES	YES
109	Nothing	Nothing	YES	YES
110	Nothing	Nothing	YES	YES
111	Assessment of teachers and student performance	Nothing	YES	YES
112	Nothing	Nothing	YES	YES

Teacher No	Is there Assessment	Is there Co-operation & communication	Do children enjoy more science subjects now?	Are scientific concepts taught better now?
113	Assessment of teachers and student performance	Nothing	YES	YES
114	Nothing	Nothing	YES	YES
115	Nothing	Nothing	YES	YES
116	Nothing	Nothing	YES	YES
117	Assessment of students performance	Informal	YES	YES
118	Nothing	Nothing	YES	YES
119	Assessment of teachers and student performance	Nothing	YES	YES
120	Assessment of students performance	Internet	YES	YES
121	Assessment of teachers	Informal	YES	YES
122	Nothing	Internet	YES	YES
123	Nothing	Internet	YES	YES
124	Nothing	Nothing	YES	YES
125	Assessment of teachers, but nothing specific	Informal	YES	YES
126	Assessment of teachers, but nothing specific	Informal	YES	YES
127	Assessment of teachers	Informal	YES	YES
128	Assessment of teachers, but nothing specific	Only with the consultant	YES	YES
129	Assessment of teachers	Only with the consultant	YES	YES
130	Assessment of teachers, but nothing specific	Informal	YES	YES

Table 5: Teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
1	YES	YES	YES	YES, but no reference in other	YES but depends on teacher
2	YES	YES	YES	YES but not reference generally	YES but depend on the teacher
3	YES	YES, MAYBE, they are not assessed on that	YES	YES but not reference generally	YES (optics, etc)
4	YES	YES	YES	YES but not reference generally	YES (Electric circuit and everyday life)
5	YES	YES	YES	YES but not referenced generally	YES with every day life
6	YES	YES	YES	YES but not referenced generally	YES
7	YES	YES BUT with some work outside the classroom	YES	YES but not referenced generally	YES
8	NO they learn language	NO they learn language	NO they learn language	The other book (Kokkotas) was better	NO they learn language
9	Supposed to but in reality no	Supposed to but in reality no	Supposed to but in reality no	Supposed to but in reality no	Haven't though about it, since they have problems with FLEXIBLE ZONE
10	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could
11	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could

Teacher No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
12	YES	YES	YES	YES	YES
13	YES	YES	YES	YES	YES
14	YES but it depends on the teacher	YES but it depends on the teacher	YES but it depends on the teacher	YES they are negotiated	YES but it depends on the teacher
15	YES	YES	YES	YES, it is more practical and the book does not reinforce misconceptions as the previous one	YES, NOT because the book contains more opportunities but because NOW they are promoted
16	YES	YES	YES	YES they are negotiated	YES, in co-ordination with FLEXIBLE ZONE
17	YES to the level that this is possible, bearing in mind the barriers	YES to the level that this is possible, bearing in mind the barriers	YES to the level that this is possible, bearing in mind the barriers	YES to the level that this is possible, bearing in mind the barriers. Misconceptions are known now	YES to the level that this is possible, bearing in mind the barriers
18	YES to the level that this is possible, bearing in mind the barriers	YES to the level that this is possible, bearing in mind the barriers	No difference	No difference	YES
19	YES	YES	YES	No, Even though it is being tried time pressure does not allow it	YES
20	YES	YES	YES	No difference	YES
21	YES	YES	YES	No difference	YES
22	YES	YES	YES	No difference	YES
23	YES	YES	YES	No difference	YES
24	YES	YES	YES	No difference	YES
25	YES	YES	YES	No difference	YES
26	YES	YES	YES	No difference	YES
27	YES	YES	YES	No difference	YES
28	YES	YES	YES	No difference	YES
29	YES	YES	YES	YES	YES
30	YES	YES	YES	No difference	YES

Teacher No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
31	YES	YES	YES	YES	YES
32	YES but Depends on the teacher	YES but Depends on the teacher	YES but Depends on the teacher	YES but Depends on the teacher	YES but Depends on the teacher
33	YES	YES	YES	YES	YES
34	YES	YES	YES	No difference	YES
35	YES	YES	YES	No difference	YES
36	YES	YES	YES	No difference	YES
37	YES	YES	YES	No difference	YES
38	YES	YES	Depends on the teacher	NO	YES
39	YES	YES	YES	YES	More than before
40	YES	YES	NO	NO	NO
41	YES	YES	YES	YES	YES
42	Probably	Probably	Probably	Probably	Probably
43	YES	YES	YES	NO	YES
44	YES	YES	YES	NO	YES
45	YES	YES	YES	YES	YES
46	YES	YES	NO	NO	YES
47	YES	YES	NO	NO	YES
48	YES	YES	YES	Depends on the teacher	YES
49	YES	YES	YES	NO	YES
50	YES	YES	YES	No difference	YES
51	YES	YES	YES	YES	YES
52	YES	YES	YES	No difference	YES
53	YES	YES	YES	No difference	YES
54	YES	YES	YES	No difference	YES
55	YES	YES	YES	No difference	YES
56	YES	YES	YES	YES	YES

Teacher No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
57	YES	No	No	YES	YES
58	YES	YES	YES	YES	YES
59	YES	NO	NO	YES	YES
60	YES, depending on the teacher	YES, depending on the teacher	YES, depending on the teacher	YES, depending on the teacher	YES, depending on the teacher
61	YES	YES	YES	YES	YES
62	YES	YES	YES	No difference	YES
63	YES	YES	YES	YES	YES
64	YES	YES	YES	YES	YES
65	YES	YES	No difference	YES	YES
66	YES	YES	YES	NO	YES
67	YES	YES	YES	NO	YES
68	YES	YES	YES	YES	YES
69	YES	YES	YES	YES	YES
70	YES	YES	YES	NO	YES
71	YES	YES	YES	YES	YES
72	YES	YES	YES	YES	YES
73	YES	YES	YES	YES	YES
74	YES	YES	YES	YES	YES
75	YES	YES	YES	YES	YES
76	YES	YES	YES	NO	YES
77	NO	NO	NO	NO	NO
78	YES	YES	YES	YES	YES
79	YES	YES	YES	YES	YES
80	NO	NO	NO	NO	NO
81	YES	YES	YES	YES	YES
82	YES	YES	No	YES	YES
83	YES	YES	YES	NO	YES

Teacher No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
84	YES	YES	YES	YES	YES
85	YES	YES	YES	NO	YES
86	YES	NO	YES	NO	YES
87	YES	YES	YES	NO	YES
88	YES	NO	NO	YES	YES
89	YES	YES	NO	NO	YES
90	YES	No	Yes	No	NO
91	YES	YES	YES	YES	YES
92	YES	NO	NO	No	NO
93	YES	YES	YES	YES	YES
94	YES	YES	YES	No difference	YES
95	YES	YES	YES	YES	YES
96	YES	YES	YES	YES	YES
97	YES	YES	YES	YES	YES
98	YES	YES	YES	No difference	YES
99	YES	YES	YES	YES	YES
100	YES	YES	YES	YES	YES
101	YES	YES	YES	YES	YES
102	YES	YES	YES	YES	YES
103	NO	NO	NO	NO	NO
104	YES	YES	YES	YES	YES
105	YES	YES	YES	YES	NO
106	YES	YES	YES	YES	YES
107	YES	YES	NO	NO	NO
108	YES	YES	YES	YES	YES
109	YES	YES	YES	YES	No
110	YES	YES	YES	YES	YES
111	YES	YES	NO	YES	YES

Teacher No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
112	YES	YES	YES	YES	YES
113	YES	YES	YES	YES	YES
114	YES	YES	YES	NO	YES
115	YES	YES	YES	NO	YES
116	YES	No difference	YES	No difference	No difference
117	YES	No difference	No difference	No difference	No difference
118	YES	YES	YES	YES	YES
119	YES	YES	YES	YES	YES
120	YES	No difference	YES	No difference	YES
121	YES	No difference	No difference	No difference	No difference
122	YES, but not as good as possible	YES, but not as good as possible	YES, but not as good as possible	YES, but not as good as possible	YES, but not as good as possible
123	YES	YES	YES	YES	YES
124	YES	YES	YES	Up to a point	YES
125	YES	No difference	No difference	No difference	No difference
126	YES	YES	YES	YES	YES
127	YES	YES	YES	YES	YES
128	YES	YES	YES	YES	YES
129	YES	YES	YES	YES	YES
130	YES	YES	YES	YES	YES

Table 6: Teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
1	YES more practical, images, less difficult text	Better than before but still not very good
2	YES it promotes group activities and team learning	YES
3	YES nice images, not difficult text, experiments	Don't know (WORKSHOP with high-school teachers needed)
4	YES, not difficult text, group activities	No answer
5	YES	No answer
6	Probably	Probably
7	No experience with such students	Probably
8	No experience with such students	Not answer
9	No difference at all	Not answer
10	NO learning problems (his opinion special needs should not join the classroom), bilingual students YES	MAYBE if the schools in high school change as well,
11	YES but not as much as it could	Not answer
12	YES it is more practical	Probably
13	YES, less text, easy language, nice images, group activities, experiments	Uncertain
14	Should be but no experience	Uncertain, possibly
15	YES UP TO A POINT because now they can be involved in the lesson-experiment	YES IN A WAY
16	Probably	Uncertain
17	YES it is more practical to the level that this is possible, bearing in mind the barriers	Doubtful
18	YES, it is more attractive and promotes group tasks	Probably
19	YES	YES
20	YES it is more practical	Doubtful
21	YES it is more practical	YES better learning now

Teacher No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
22	YES it is more practical	YES it is more practical
23	YES it is more practical	No difference
24	YES it is more practical	NO, because the high school system is more similar to the previous one
25	YES it is more practical	YES it is more practical
26	YES it is more practical	YES it is more practical
27	YES it is more practical	YES it is more practical
28	YES it is more practical	Doubtful
29	YES it is more practical	YES it is more practical
30	YES it is more practical	YES it is more practical
31	YES it is more practical	Possibly but not definitely
32	YES but Depends on the teacher	YES but Depends on the teacher
33	YES it is more practical	YES it is more practical
34	YES it is more practical	YES it is more practical
35	YES it is more practical	YES it is more practical
36	YES it is more practical	YES it is more practical
37	YES it is more practical	Can't answer
38	YES it is more practical	YES it is more practical
39	YES it is more practical	Don't think so
40	Depends on the teacher and the student	NO
41	YES it is more practical	YES it is more practical
42	Probably	Probably
43	Probably	NO
44	YES it is more practical	Can't know
45	YES it is more practical	Can't know
46	NO	NO
47	YES it is more practical	NO
48	YES it is more practical	YES it is more practical
49	YES it is more practical	Unlikely

Teacher No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
50	YES it is more practical	YES it is more practical
51	YES it is more practical	YES it is more practical
52	YES it is more practical	NO
53	YES it is more practical	YES it is more practical
54	YES it is more practical	YES it is more practical
55	YES it is more practical	Possibly but not definitely
56	YES, there is no barrier of difficult language	YES it is more practical
57	YES, there is no barrier of difficult language	No
58	YES it is more practical	YES it is more practical
59	YES, there is no barrier of difficult language	NO
60	YES, it promotes group learning	YES
61	YES, it has nice visual image, and practical activities	YES, as they develop better attitudes towards science
62	YES, thanks to the practical activities and the nice images	YES
63	YES, it promotes group learning and nice visual material	YES
64	YES, it has nice visual image and not difficult text	YES
65	YES, thanks to the experiment and the images	YES
66	YES, thanks to the experiment	YES
67	YES, thanks to the group activities, the construction of knowledge through experiments and the lack of difficult vocabulary	YES
68	YES, nice images and suitable teaching approach	YES
69	YES, it promotes group learning and nice visual material	NO
70	YES, thanks to the experiments	YES
71	NO	YES
72	NO	YES
73	NO	YES

Teacher No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
74	YES, it is based on previously obtained knowledge, emphasizes on experiments and practical learning, and has nice images	YES
75	YES, it is more practical	Unable to say
76	YES, it is more practical	Doubtful
77	NO	NO
78	NO	YES
79	YES, it is based on previously obtained knowledge, emphasises on experiments and practical learning, and has nice images	YES
80	YES, up to a point	YES
81	YES, thanks to the experiments	YES
82	YES, nice visual material, analysis of experiments	Doubtful
83	YES, thanks to the experiments	NO
84	YES, thanks to group activities, and the experiments that help them construct knowledge without memorizing	NO, as there is no link between primary and secondary education
85	YES, thanks to group activities, and the experiments that help them construct knowledge without memorising	NO, as there is no link between primary and secondary education
86	YES thanks to the visual material and the lack of difficult language	NO
87	YES thanks to the visual material and the lack of difficult language	NO
88	YES, as children like questioning, carrying out experiments, discovering, which is the approach of the new book	NO
89	YES, as children like questioning, carrying out experiments, discovering, which is the approach of the new book	NO
90	YES, as children like questioning, carrying out experiments, discovering, which is the approach of the new book	NO

Teacher No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
91	NO	YES
92	Depends on the teacher	Unlikely
93	NO	YES
94	Probably	YES
95	No experience	YES
96	No experience	Don't know
97	No experience	Don't know
98	Probably	Don't know
99	No experience	YES
100	No experience	YES
101	No answer	Don't know
102	YES, thanks to group work, practical activities that motivate critical thinking	YES
103	NO	NO
104	YES	NO
105	YES, thanks to the experiments with simple materials, the nice visual materials and the clear and simple text	YES
106	YES thanks to the learning through experience	NO
107	YES	No difference
108	YES	YES
109	No	Don't know
110	No experience	Don't know
111	YES, because they participate in the lesson and carry out experiments, investigate and construct knowledge themselves	Don't know
112	Nothing	Don't know
113	YES, thanks to group work	Don't know
114	YES, nice visual materials and experiments	YES
115	YES	NO
116	NO	No difference

Teacher No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
117	No difference	NO
118	YES, because of the experiments with simple materials	YES
119	NO	YES
120	NO	No difference
121	No difference	No difference
122	YES	YES, but not as good as possible
123	YES	YES
124	YES	YES
125	No difference	No difference
126	YES, thanks to the easy-to-read-text	No difference
127	YES, thanks to group work	YES
128	YES	NO
129	YES	NO
130	YES	NO

Table 7: Teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Teacher No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
1	Only in science lesson	Nothing	Only to science lesson, teacher leader
2	Only in science lesson	Not necessary, simple materials needed	Only to the lesson level
3	Only in science lesson	Nothing	Only to the lesson level
4	Only in science lesson	Nothing but not necessary that much	Only to the lesson level
5	Only in science lesson	Nothing and it is important	Only to the lesson level
6	Only in science lesson	Nothing but not necessary that much	Only to the lesson level
7	Only in science lesson	Nothing	Only to the science lesson level
8	Only in science lesson	Nothing	Only to the science lesson level
9	Only in science lesson	Nothing	Only to the science lesson level
10	Only in science lesson	Nothing	Only to the science lesson level
11	Only in science lesson	Nothing	Only to the science lesson level
12	Only in science lesson	Improper	Only to the science lesson level
13	Only in science lesson	Improper	Only to the science lesson level
14	Only in science lesson	Improper	Only to the science lesson level
15	Only in science lesson	Improper	Only to the science lesson level
16	Only in science lesson	The private school of this teacher is equipped	Only to the science lesson level
17	Only in science lesson	Nothing and lack of concern about school building structure	Only to the science lesson level
18	Only science lesson and curriculum	Unsatisfactory	Only to the science lesson level
19	Only science lesson and curriculum	Yes but inadequate	Only to the science lesson level
20	Only in science lesson	Nothing	Only to the science lesson level
21	Only in science lesson	Nothing	Only to the science lesson level

Teacher No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
22	Only in science lesson	Nothing	Only to the science lesson level
23	Only in science lesson	Nothing	Only to the science lesson level
24	Only in science lesson	Unsatisfactory	Only at the level of school science
25	Only in science lesson	Unsatisfactory	Only at the level of school science
26	Only in science lesson	Unsatisfactory	Only at the level of school science
27	Only science lesson and curriculum	Insufficient and limited	Only at the level of school science
28	Only science lesson and curriculum	Insufficient and limited	Only at the level of school science
29	Only science lesson and curriculum	Insufficient and limited	Only at the level of school science
30	Only science lesson and curriculum	Insufficient and limited	Only at the level of school science
31	Only science lesson and curriculum	Insufficient and limited	Only at the level of science lesson
32	Only in science lesson	Insufficient and limited	Only at the level of science lesson
33	Only in science lesson	Nothing	Only at the level of science lesson
34	Only in science lesson	Nothing	Only at the level of science lesson
35	Only in science lesson	Insufficient and limited	Only at the level of science lesson
36	Only in science lesson	Insufficient and limited	Only at the level of science lesson
37	Only in science lesson	Insufficient and limited	Only at the level of science lesson
38	Only in science lesson	Nothing	Only at the level of science lesson
39	Only in science lesson	Nothing	Only at the level of science lesson
40	Only in science lesson	Nothing	Only at the level of science lesson
41	Only curriculum change and textbooks	Nothing	Only at the level of science lesson
42	Only in science lesson	Nothing	Only at the level of science lesson
43	Only in science lesson	Nothing	Only at the level of science lesson
44	Only in science lesson	Nothing	Only at the level of science lesson
45	Only curriculum change and textbooks	Nothing	Only at the level of science lesson
46	Only in science lesson	Insufficient and limited	Only at the level of science lesson
47	Only in science lesson	Insufficient and limited	Only at the level of science lesson
48	Only in science lesson	Insufficient and limited	Only at the level of science lesson
49	Only curriculum change and textbooks	Insufficient and limited	Only at the level of science lesson

Teacher No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
50	Only in science lesson	Insufficient and limited	Only at the level of science lesson
51	Only in science lesson	Insufficient and limited	Only at the level of science lesson
52	Only curriculum change and textbooks	Insufficient and limited	Only at the level of science lesson
53	Only curriculum change and textbooks	Insufficient and limited	Only at the level of science lesson
54	Only curriculum change and textbooks	Nothing	Only at the level of science lesson
55	Only curriculum change and textbooks	Nothing	Only at the level of science lesson
56	Only at the lesson of school science lesson and maybe some equipment	Limited and not appropriate	Only at the level of school science
57	Only at the lesson of school science lesson and maybe some equipment	Nothing	Only at the level of school science
58	Only at the lesson of school science lesson and maybe some equipment	Limited and inappropriate	Only at the level of school science
59	Only at the lesson of school science lesson and maybe some equipment	Nothing	Only at the level of school science lesson
60	Maybe some computing equipment	Insufficient and limited	Only at the level of school science lesson but SCHOOL STRUCTURE MUST CHANGE
61	Curriculum change, new textbooks and the flexible zone	Nothing	Only at the level of school science lesson
62	Computing equipment and establishment or relevant centers for Science Education (Primary and Secondary)	Improper	Only at the level of school science lesson
63	Maybe some computing equipment	Insufficient and limited	Only at the level of school science lesson but SCHOOL STRUCTURE MUST CHANGE
64	Only curriculum change and textbooks	Nothing	Only at the level of school science lesson
65	CD-ROMS, establishment of Centers of Science Education, composed by primary educators too	Theoretical, but in action we still waited 2 months for the books	Only at the level of school science lesson

Teacher No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
66	Only curriculum change and textbooks	Insufficient in reality, focusing on computers and visual material	Only at the level of school science lesson
67	Only curriculum change and textbooks	Nothing	Only at the level of lesson
68	Only curriculum change and textbooks and introduction of computing materials	Computers and training in computers	Only at the level of lesson
69	Only curriculum change and textbooks	Insufficient as claimed to be unnecessary	Only at the level of lesson
70	Only curriculum change and textbooks	Insufficient, focusing on computers and visual material	Only at the level of school science lesson
71	Only curriculum change and textbooks	Nothing special	Only at the level of school science lesson
72	Only curriculum change and textbooks	Nothing	Only at lesson level, and gradually for every subject
73	Only curriculum change and textbooks	Nothing	Only at lesson level, and gradually for every subject
74	Equipment, laboratories, computers	Equipment, laboratories, computers	Nothing
75	Only curriculum change and textbooks	Nothing	Only at lesson level
76	Only curriculum change and textbooks	Nothing	Only at lesson level
77	Only curriculum change and textbooks	Nothing	Only at lesson level
78	Only curriculum change and textbooks	Nothing special	Only at the level of school science lesson
79	Equipment, laboratories, computers	Equipment, laboratories, computers	Nothing
80	Only curriculum change and textbooks	No	Nothing
81	Only curriculum change and textbooks	Nothing	Nothing
82	Only curriculum change and textbooks	Nothing	Nothing
83	Only curriculum change and textbooks	Nothing	Nothing
84	Only curriculum change and textbooks	Nothing at the moment	Nothing
85	Only in science lesson	Nothing at the moment	Nothing
86	Only curriculum change and textbooks	Nothing	Nothing
87	Only curriculum change and textbooks	Nothing	Nothing
88	Only curriculum change and textbooks	Nothing	Nothing
89	Only curriculum change and textbooks	Nothing	Nothing
90	Only curriculum change and textbooks	Nothing	Nothing

Teacher No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
91	Only curriculum change and textbooks	Nothing	Nothing
92	Only curriculum change and textbooks	Nothing	Nothing
93	Only curriculum change and textbooks	Nothing	Nothing
94	Only curriculum change and textbooks	Nothing	Nothing
95	Only curriculum change and textbooks	Nothing	Nothing
96	Nothing	Nothing	Nothing
97	Only curriculum change and textbooks	Nothing	Nothing
98	Only curriculum change and textbooks	Nothing	Nothing
99	Nothing	Nothing	Nothing
100	Only curriculum change and textbooks	Nothing	Nothing
101	Only in science lesson	Nothing	Nothing
102	Only in science lesson	NO	Vague
103	Introduction of laboratories in primary schools, (insufficient)	NO	NO
104	Nothing	Audio and visual materials	YES
105	Only in science lesson	Nothing	Nothing
106	Only in science lesson	Provision for science classroom with audio-visual material	Nothing
107	Only in science lesson	Nothing	Nothing
108	Only in science lesson	Nothing	Nothing
109	Only in science lesson	Nothing	Nothing
110	Only in science lesson	Nothing	Nothing
111	Only in science lesson	Nothing	Not always
112	Only in science lesson	Nothing	Nothing
113	YES	YES	YES (EPEAEK)
114	Only in science lesson	Nothing	Nothing
115	Only in science lesson	Nothing	Nothing
116	Only in science lesson	Nothing	Nothing
117	Only in science lesson	Nothing	Nothing

Teacher No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
118	Only in science lesson	Nothing and that is the problem	Nothing
119	Only in science lesson	Nothing	Nothing
120	Only in science lesson	Nothing	Nothing
121	Only in science lesson	Nothing	Nothing
122	Only in science lesson	Nothing	Nothing
123	Only in science lesson	Nothing	Limited
124	Only in science lesson	Nothing	It is about to happen
125	Only in science lesson	Nothing	Nothing
126	Only in science lesson	Nothing	Nothing
127	Only in science lesson	Nothing	Nothing
128	Only in science lesson	Nothing	Nothing
129	Only in science lesson	Nothing	Nothing
130	Only in science lesson	Nothing	Nothing

Table 8: Teachers' information and responses. The fact that some answers seem identical, though they are not, is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis with the N-VIVO program.

Teacher No	Other changes	Suggestions
1	Other subjects gradually	Assessment, training, equipment, time
2	Other subjects gradually	Better classroom construction and time
3	Gradually other subjects	Further education (workshops seminars) and more time
4	Geography, mathematics	Further education, more time to choose between books
5	Gradually all subjects	Further education, not just teachers book, Equipment provision, more time
6	Gradually all subjects	Problems: time, students forget to bringing the required materials AND more text for the students to study at home
7	Gradually all subjects	Further education, more equipment and more time
8	Gradually all subjects, flexible zone	Further education, more equipment and more time
9	Gradually all subjects, flexible zone	Further education, more equipment and more time
10	Gradually all subjects, flexible zone	Further education, more equipment and more time
11	Gradually all subjects, flexible zone	Further education, more equipment and more time
12	Gradually all subjects	Further education, more equipment and more time
13	Gradually all subjects	Further education, more equipment and more time and the changes to be applied AT PILOT LEVEL FIRST
14	Gradually all subjects	Further education, more equipment and more time
15	Gradually all subjects	Further education, more equipment and more time
16	Gradually all subjects	Further education, more time more equipment & the development of the sense of professional development FROM THE SIDE OF THE TEACHERS
17	Gradually all subjects, flexible zone, day-long school	Further education, more time more equipment, concern about school building structure and change at the level of school routine & culture
18	Gradually all subjects,	Further education, more time, more equipment
19	Gradually all subjects	More time, more equipment & training, better communication with policy-makers
20	Gradually all subjects	Further education, more equipment, concern about school building structure

Teacher No	Other changes	Suggestions
21	Gradually all subjects	Further education, more equipment, more time
22	Gradually all subjects	Further education, more equipment, more time
23	Gradually all subjects	Further education, more equipment, more time
24	Gradually all subjects flexible zone	Further education, more equipment, more time
25	Gradually all subjects flexible zone	Further education, more equipment, more time
26	Gradually all subjects flexible zone	Further education, more equipment, more time
27	Gradually all subjects flexible zone	Further education, more equipment, more time and CO-OPERATION with the Ministry and Pedagogical Institute
28	Other subjects	Further education, more equipment, more time
29	Other subjects	Further education, more equipment and MORE TEXT in the book, so that students can study it, more time
30	Other subjects	More effective co-operation with the ministry and the educational organizations further education, more equipment
31	Through curriculum for integration	Further education, more equipment, more time
32	Geography, mathematics	Further education, more equipment, more time
33	Geography, mathematics	More effective co-operation with the ministry and the educational organizations further education, more equipment, more time
34	Through curriculum for integration	Arrangement of the book, which requires huge time fro preparation, further education, more equipment
35	Gradually all subjects	Assessment, more co-operation with the educational organizational and the policy-makers, further education, more equipment, more time
36	Gradually all subjects	More text for students to study at home, more active participation of the teachers in decision-making, more time
37	Gradually all subjects	Further education, more equipment, more time
38	Integration	Further education, more equipment
39	Gradually all subjects	Further education, more equipment (we cannot be sure that students will bring the materials from home), more time
40	Through curriculum for integration	Further education, more equipment (we cannot be sure that students will bring the materials from home)
41	Gradually all subjects	Further education, more equipment, more time
42	So far science gradually all,	Further education, more equipment, more time

Teacher No	Other changes	Suggestions
43	Nothing	Further education, more equipment, the need for teachers to know how to accept change, more time
44	So far science gradually all,	Further education, more equipment, more time
45	So far science gradually all,	Further education, more equipment, more time
46	So far science gradually all,	Further education, more equipment, more time
47	Nothing	Further education, more equipment, more time
48	So far science gradually all,	Further education, more equipment
49	So far science gradually all,	Further education, more equipment, another way of communication between teachers & ministry, policy-makers
50	Through curriculum for integration	Further education, more equipment, more time
51	So far science gradually all,	Further education, more equipment, more time
52	So far science gradually all,	Further education, more equipment, more time
53	So far science gradually all,	Rationalization of the units that have to be taught (too many things to teach), further education, more equipment, more time
54	Noting specific	Assessment, more co-operation with the educational organizational and the policy-makers, further education, more equipment, more time
55	So far science gradually all,	Further education, more equipment, more time
56	So far science gradually all,	Modern technological equipment and further instruction opportunities
57	Through curriculum for integration	Further education, more equipment, more time
58	Gradually all subjects	Further education, more equipment, more time
59	Through curriculum for integration	Further education, more equipment, more time
60	Gradually all subjects	Equipment, Instruction (in ICT as well) and permission for fieldwork visits (in centers, museums, etc), more time
61	Gradually all subjects	Further education, more equipment, more time
62	Gradually all subjects	Equipment provision, instruction and introduction of ICT in schools, more time
63	Gradually all subjects	Equipment, Instruction (in ICT as well) and permission for fieldwork visits (in centers, museums, etc), more time
64	Gradually all subjects	Further education, more equipment, more time
65	NO	Equipment provision, MANDATORY instruction and introduction of ICT in schools
66	Gradually all subjects	Further education, more equipment, more time

Teacher No	Other changes	Suggestions
67	Gradually all subjects	Equipment, further improvement of the books and for the books of every subject, re-arrangements of the school and classroom structure (no arrangements of desks in as they are currently), more freedom/initiative for teachers to act
68	Gradually all subjects	The use of simulators for students for experiments that cannot be carried out in a classroom environment
69	Gradually in all	Equipment, further improvement of the books and for the books of every subject, re-arrangements of the school and classroom structure, more freedom/initiative for teachers to act, more time
70	Gradually all subjects	Further education, more equipment, more time
71	So far science gradually all,	Equipment, instruction and assessment of change implementation and results
72	Gradually all subjects	Equipment, Instruction and expansion of the session duration as 45 minutes is not enough
73	Gradually all subjects	Equipment, Instruction and expansion of the session duration as 45 minutes is not enough
74	Gradually all subjects	More instruction, more equipment, provision of motivation (salaries), more time
75	Gradually all subjects	Equipment, instruction to laboratorial and practical learning, more time
76	Gradually all subjects	Equipment, instruction to laboratorial and practical learning, more time
77	Gradually all subjects	Further education, more equipment, more time
78	Gradually all subjects	Equipment, instruction and assessment of change implementation and results
79	Gradually all subjects	More instruction, more equipment, provision of motivation (salaries), time
80	Gradually all subjects	Further education, more equipment, more time
81	Gradually all subjects	Further education, more equipment, more time
82	Gradually all subjects	Further education, more equipment, more time
83	Nothing	Further education, more equipment, more time
84	Just science the others will come later	Further education, more equipment
85	Just science the others will come later	Further education, more equipment, more time
86	Only the flexible zone	Equipment & instruction (through workshops) and analysis of an exemplary teaching session, more time
87	Only the flexible zone	Equipment, instruction more time and removal of some chapters (e.g. it is not necessary for primary school students to learn about the ions)
88	Nothing	Further education, more equipment, more time

Teacher No	Other changes	Suggestions
89	Not yet but in future	Further education, more equipment, more time
90	Only the flexible zone	More equipment & more instruction and more text in the books, as students need to study text at home, more time
91	Nothing	Further education, more equipment, more time
92	Gradually all subjects	Equipment & instruction and more text in the books, as students need to study text at home, more time
93	Gradually all subjects	Limitation of the materials that are to be taught to some important topics that can be taught at greater depths (unwise to teach ions in the primary school), more time
94	Gradually all subjects	Fewer units, more time
95	Gradually all subjects	Limitation of the materials that are to be taught to some important topics that can be taught at greater depths (unwise to teach ions in the primary school)
96	Nothing	Further education, more equipment, more time
97	Nothing	Further education, more equipment, more time
98	Gradually all subjects	Fewer units, more time
99	Nothing	More time
100	Gradually all subjects	Limitation of the materials that are to be taught to some important topics that can be taught at greater depths (unwise to teach ions in the primary school)
101	Nothing	Further education, more time
102	Flexible zone	Limitation of classrooms to 20 students maximum, school equipment, more time
103	NO	Better textbooks, more time
104	NO	Better school structure, more time
105	Gradually all subjects	More time
106	Gradually all subjects	Further education, more equipment, more time
107	Nothing	Nothing
108	Nothing	More time
109	Nothing	More time
110	Nothing	More equipment, out school visits, more time
111	Gradually all subjects	More teacher training, more time
112	Nothing	Nothing
113	Integration	More time

Teacher No	Other changes	Suggestions
114	Nothing	More time
115	Nothing	More time
116	Nothing	Further education, more equipment, more time
117	Nothing	Further education, more equipment, more time
118	Nothing	More equipment because now the teachers have to carry out the experiment instead of the students, more time (extra hours-laboratorial sessions)
119	Just language	More equipment, more time
120	Nothing	More equipment, more training, more time
121	Nothing	More equipment, more training, more time
122	Nothing	Further education, more equipment, more time
123	Geography	Further education, more equipment, more time
124	Nothing	More equipment, more training, more time
125	Changes are on the way	More equipment, more training, more time and better communication
126	Geography	More equipment, more training, more time
127	Nothing	More equipment, more training, more time
128	Nothing	Further education, more equipment, more time
129	Nothing	Further education, more equipment, more time
130	Integration, health and environmental education	Further education, more equipment, more time

Table 9: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	Gender	Region	Place	Years of work	What is the aim of science subjects?
1	Male	Attica	Athens	40	To learn concepts, explain and co-operate to approach knowledge of the natural world
2	Male	South Aegean	Rhodes	38	Learn concepts, develop skills, think critically
3	Female	Crete	Iraklion	29	Learn concepts, develop skills
4	Male	Peloponnese	Patra	32	Learn concepts, develop skills
5	Female	Macedonia	Thessaloniki	30	Learn concepts, develop skills
6	Male	Epirus	Ioannina	35	Learn concepts, develop skills
7	Female	Ionian Islands	Corfu	28	Learn concepts, develop skills
8	Female	Thrace	Alexandroupoli	31	Learn concepts, develop skills
9	Female	Thessaly	Larisa	30	Learn concepts, develop skills
10	Male	South Aegean	Rhodes-Kos	33	Learn concepts, develop skills

Table 10: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	Was the change necessary	What were the reasons for the change
1	YES	The need to promote group work and a more attractive book
2	YES	The lesson was boring and not practical
3	YES	The previous book was too old outdated knowledge, not exciting, focusing only on theory
4	YES	The need for practical lesson with experiments and that the previous book was too old outdated knowledge, not exciting, focusing only on theory
5	YES	The recent findings on research
6	YES	The need for practical lesson with experiments and that the previous book was too old outdated knowledge, not exciting, focusing only on theory
7	YES	The need for practical lesson with experiments and that the previous book was too old outdated knowledge, not exciting, focusing only on theory
8	YES	The previous book was too old, not exciting, focusing only on theory
9	YES	There was need for change, but the schools were not ready
10	YES	The need for practical lesson with experiments and that the previous book was too old outdated knowledge, not exciting, focusing only on theory

Table 11: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	What are the differences between old and new curriculum	Is further education provided? What kind?
1	Experiments (by children), more group activities	It is part of their job but it is limited
2	Experiments (by children), more group activities	It is part of their job but it is limited, due to time pressure
3	Experiments (by children) more group activities	It is part of their job but it is limited, due to time pressure
4	Experiments (by children) with simple materials more group activities	It is part of their job but it is limited, due to time pressure
5	Experiments (by students), more liked by students	It is part of their job but it is limited, due to time pressure
6	Experiments (by students) with simple materials more group activities	It is part of their job but it is limited, due to time pressure
7	Experiments (by students)	It is part of their job but it is limited, due to time pressure
8	Experiments (by students) with simple materials more group activities	It is part of their job but it is limited, due to time pressure
9	Supposed to be more practical with experiments done by children	It is part of their job but it is limited, due to time pressure
10	Experiments (done by children)	It is part of their job but it is limited, due to time pressure

Table 12: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	Is there Assessment	Is there Co-operation & communication	Are concepts taught better now
1	Nothing specific	Limited, only the consultant	YES
2	Nothing specific	SUFFICIENT, by the consultant,	YES
3	Nothing specific	Insufficient again, workshop type seminars would	YES
4	Nothing specific	Teachers' council, consultant and INFORMAL between teachers	YES
5	Nothing specific	INFORMAL between teachers	YES
6	Nothing specific	Consultant mainly and INFORMAL with teachers	YES
7	Nothing specific	INFORMAL with other teachers	YES
8	Nothing specific	Very limited, only the consultant, only INFORMAL with other teachers	YES
9	Nothing specific	Very limited, only the consultant, only INFORMAL with other teachers	YES
10	Nothing specific	Very limited, only the consultant, only INFORMAL with other teachers	YES

Table 13: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
1	YES it is more practical	YES it is more practical	YES it is more practical	YES it is more practical, but no reference in other	YES (water cycle), Flexible zone
2	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better
3	YES it is more practical	YES, MAYBE, they are not assessed on that	YES it is more practical	YES but not reference generally	TE Flexible zone
4	YES it is more practical	YES	YES it is more practical	YES but not reference generally	YES (Electric circuit and everyday life)
5	YES it is more practical	YES it is more practical	YES it is more practical	YES but not referenced generally	YES Flexible zone
6	YES it is more practical	YES it is more practical	YES it is more practical	YES but not referenced generally	YES Flexible zone
7	YES it is more practical	YES BUT with some work outside the classroom	YES it is more practical	YES but not referenced generally	YES Flexible zone
8	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better, Flexible zone
9	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better, Flexible zone
10	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could	YES but not as much as it could Flexible zone

Table 14: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
1	YES more practical, images, less difficult text	And for the rest of their lives
2	YES it promotes group activities and team learning	YES
3	YES nice images, not difficult text, experiments	Probably
4	YES, not difficult text, group activities	Probably, expecting to see
5	YES	YES
6	Probably	YES
7	YES	YES
8	YES nice images, not difficult text, experiments	YES
9	YES nice images, not difficult text, experiments	YES
10	YES nice images, not difficult text, experiments	YES

Table 15: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultant No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
1	Only in science lesson Flexible zone	Nothing, but there is problem with room at school buildings	Only to science lesson, teacher leader
2	Computer equipment, nothing specific, daylong schools	Not necessary, simple materials needed	Only to the lesson level
3	Only in science lesson	Nothing	Only to the lesson level
4	Only in science lesson Flexible zone	Nothing but not necessary that much	Only to the lesson level
5	Only in science lesson Flexible zone	Nothing and it is important	Only to the lesson level
6	Only in science lesson Flexible zone	Nothing but not necessary that much	Only to the lesson level
7	Only in science lesson Flexible zone	Nothing	Only to the science lesson level
8	Only in science lesson Flexible zone	Nothing	Only to the science lesson level
9	Only in science lesson Flexible zone	Nothing	Only to the science lesson level
10	Only in science lesson Flexible zone	Nothing	Only to the science lesson level

Table 16: Consultants information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Consultants No	Other changes	Suggestions
1	Gradually other subjects	Assessment, training, equipment
2	Gradually other subjects	Deeper reforms, not just curriculum and text books further education and equipment
3	Gradually other subjects	Further education and equipment
4	Gradually other subjects	Further education, more time to choose between books
5	Gradually other subjects	Further education, not just teachers book, EQUIPMENT
6	Gradually other subjects	Deeper reforms, not just curriculum and text books further education and equipment
7	Gradually other subjects	Further education, more equipment
8	Gradually other subjects	Further education, more equipment
9	Gradually other subjects	Further education, more equipment
10	Gradually other subjects	Further education, more equipment

Table 17: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	Gender	Years of work	What is the aim of science subjects?
1	Male	15	To learn concepts, explain and co-operate to approach knowledge of the natural world
2	Female	19	Learn concepts, develop skills, think critically
3	Female	12	Learn concepts, develop skills

Table 18: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	Was the change necessary	What were the reasons for the change
1	YES	the need to promote group work and a more attractive book
2	YES	the lesson was boring and not practical
3	YES	the previous book was too old outdated knowledge, not exciting, focusing only on theory

Table 19: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	What are the differences between old and new curriculum	Is further education provided? What kind?
1	experiments (by children), constructivist approach, research type lesson, more group activities	It is part of their job but it is limited
2	experiments (by children), constructivist approach, research based lesson	It is part of their job but it is limited, due to time pressure
3	experiments (by children) constructivist approach, more group activities	It is part of their job but it is limited, due to time pressure

Table 20: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	Is there Assessment	Is there Co-operation & communication	Are concepts taught better now?
1	Nothing specific	NO	YES
2	Nothing specific	NO	YES
3	Nothing specific	NO	YES

Table 21: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
1	YES it is more practical	YES it is more practical	YES it is more practical	To an extent	YES (water cycle), Flexible zone
2	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better
3	YES it is more practical	YES, MAYBE, they are not assessed on that	YES it is more practical	YES but could be better	YES Flexible zone

Table 22: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
1	YES more practical, images, less difficult text	NO
2	Probably	NO
3	This was a reason for the reform	NO

Table 23: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy maker No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
1	only in science lesson	Nothing	only to science lesson, teacher leader
2	Computer equipment, nothing specific, daylong schools	Nothing	only to the lesson level
3	only in science lesson	Nothing	only to the lesson level

Table 24: Policy makers information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Policy makers No	Other changes	Suggestions
1	Gradually all subjects	Reforms should be applied in the "appropriate plan": reasons for reform → pilot implementation → evaluation →complete implementation →evaluation →new reform
2	Gradually all subjects	More training to teachers
3	Gradually all subjects	More training to teachers

Table 25: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	Gender	Area of work	Years of work	What is the aim of science subjects?
1	Male	Science Education	8	To learn concepts, explain the natural world and to construct knowledge
2	Female	Science Education, Educational Research	13	Learn concepts, develop skills, and to become able to construct knowledge
3	Male	Science Education, Curriculum	16	To learn to construct knowledge to explain phenomena
4	Female	Science Education, ICT	9	To learn concepts, develop skills and construct knowledge
5	Male	Science Education and School Policy	14	To learn to construct knowledge
6	Female	School Policy	5	Learn concepts, develop skills
7	Male	School Management	6	Learn concepts, develop skills
8	Male	School Management	8	Learn concepts, develop skills
9	Female	School management and pedagogy	11	Learn concepts, develop skills

Table 26: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	Was the change necessary	What were the reasons for the change
1	YES	To introduce constructivism and integration,
2	YES	To introduce constructivism and integration, the low results of Greek students in the OECD
3	YES	To introduce constructivism and integration
4	YES	To introduce constructivism and integration
5	YES	To introduce constructivism and integration, the need to modernize curricula, political reasons
6	YES	To introduce constructivism and integration
7	YES	To introduce constructivism and integration, the need to modernize curricula
8	YES	To introduce constructivism and integration, the need to modernize curricula, political reasons
9	YES	To introduce constructivism and integration

Table 27: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	What are the differences between old and new curriculum	Is further education provided? What kind?
1	Experiments (by children), research type lesson, more group activities, constructivist approach	There is but it is superficial
2	Experiments (by children), research based lesson, constructivist approach	There is but it is vestigial and but does not address to teachers actual needs
3	Experiments (by children) more group activities, constructivist approach	There is
4	Experiments (by children) with simple materials more group activities, constructivist approach	There is, but does not address to teachers actual needs
5	Experiments (by students),constructivist approach	There is
6	Experiments (by students) with simple materials more group activities	There is but teachers do not respond properly
7	Experiments (by students)	There is, but does not address to teachers actual needs
8	Experiments (by students) with simple materials more group activities	There is but does not address to teachers actual needs
9	Supposed to be more practical with experiments done by children	There is but does not address to teachers actual needs

Table 28: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	Is there Assessment	Is there Co-operation & communication	Are concepts taught better now?
1	Nothing specific	Only in seminars	YES
2	It starts now by recording the basic information about school units and their structure	Only in seminars, limited	YES
3	Nothing specific	Only in seminars	YES
4	It starts now by recording the basic information about school units and their structure	Only in seminars, limited	YES
5	It starts now by recording the basic information about school units and their structure	Only in seminars	N/a
6	Nothing specific	Only in seminars	N/a
7	Nothing specific	Only in seminars, limited	N/a
8	Nothing specific	Only in seminars, limited	N/a
9	Nothing specific	Only in seminars, limited	N/a

Table 29: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	Are skills taught better with the new curriculum?	Is the link with everyday life done better now	Is nature of Science taught better now	Are misconceptions negotiated more/better now	Is Integration with other subjects promoted more now?
1	YES	YES	YES	YES	YES
2	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better
3	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better
4	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better
5	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better	YES but it could be better
6	N/a	N/a	N/a	N/a	N/a
7	N/a	N/a	N/a	N/a	N/a
8	N/a	N/a	N/a	N/a	N/a
9	N/a	N/a	N/a	N/a	N/a

Table 30: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	Are culturally diverse learners and students with special needs helped more now	Are pupils prepared better for high school now?
1	No research done about that	NO, in high school science is not taught through constructivism
2	No research done about that	YES, they will have learnt to construct knowledge by themselves
3	No research done about that	NO, there is a great gap between primary and secondary school
4	No research done about that	Possibly
5	No research done about that	NO, we need unified curriculum for primary and secondary
6	No research done about that	NO, there is a great gap between primary and secondary school
7	No research done about that	NO, there is a great gap between primary and secondary school
8	No research done about that	NO, there is a great gap between primary and secondary school
9	No research done about that	NO, there is a great gap between primary and secondary school

Table 31: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutor No	Other dimensions of the reform apart from curriculum and books	Is there provision for any kind of equipment	Is there reform on the school management and hierarchy
1	Only in science lesson and Integration	Nothing	Only to the science lesson level
2	Computer equipment, nothing specific, daylong schools	Yes, but more in secondary schools	Only to the science lesson level
3	Integration	Nothing	Only to the science lesson level
4	Integration	Nothing	Only to the science lesson level
5	Integration	Nothing	Only to the science lesson level, but teachers should consider it an opportunity for further changes in their work
6	Integration	Nothing	Only to the science lesson level
7	Integration	Nothing	Only to the science lesson level, but teachers should consider it an opportunity for further changes in their work
8	Integration	Nothing	Only to the science lesson level, but teachers should consider it an opportunity for further changes in their work
9	Integration	Nothing	Only to the science lesson level

Table 32: University tutors information and responses- The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

University tutors No	Other changes	Suggestions
1	Gradually other subjects	Training, equipment
2	Gradually other subjects	Assessment, new methods for training
3	Gradually other subjects	Assessment
4	Gradually other subjects	Deeper changes more carefully planned
5	Gradually other subjects	Deeper changes more focused on school management
6	Gradually other subjects	Deeper changes more carefully planned
7	Gradually other subjects	Deeper changes more carefully planned
8	Gradually other subjects	Deeper changes more carefully planned
9	Gradually other subjects	Deeper changes more carefully planned
10	Gradually other subjects	Deeper changes more carefully planned

Table 33: Parents' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

number	Gender	area	Their opinion of the aim of science subjects	Are they satisfied with the science curriculum and text books	Are their children satisfied
1	Male	city	learn concepts, develop interests, success in general exams	YES	YES
2	Female	village	explain phenomena and not to have a lot of questions and inquiries	YES	YES
3	Female	village	learn concepts, success in general exams	YES	YES
4	Female	village	explain phenomena	YES	YES
5	Male	village	learn concepts, success in general exams	YES	YES
6	Male	village	learn concepts, success in general exams	YES	YES
7	Female	village	explain phenomena	YES	YES
8	Male	village	learn concepts, success in general exams	not much	YES
9	Female	village	learn concepts, success in general exams	YES	YES
10	Female	village	learn concepts, success in general exams	YES	YES
11	Male	city	explain phenomena scientifically	YES	YES
12	Female	city	to develop interests	YES	YES
13	Male	city	explain phenomena and not to have a lot of questions and inquiries	YES	YES
14	Male	city	scientific knowledge	YES	YES
15	Male	city	explain phenomena	YES	YES
16	Female	city	learn concepts	YES	YES
17	Female	city	learn concepts, success in general exams	YES	YES
18	Male	city	explain phenomena	YES	YES
19	Female	city	learn concepts, success in general exams	YES	YES
20	Male	city	learn concepts, success in general exams	YES	YES
21	Female	city	to develop interests	YES	YES
22	Male	village	explain phenomena and not to have a lot of questions and inquiries	YES	YES
23	Female	city	learn concepts, success in general exams	YES	YES

number	gender	area	Their opinion of the aim of science subjects	Are they satisfied with the science curriculum and text books	Are their children satisfied
24	Male	village	explain phenomena	NO	YES
25	Male	village	learn concepts, success in general exams	YES	YES
26	Female	city	learn concepts, success in general exams	YES	YES
27	Male	village	explain phenomena	YES	YES
28	Female	city	learn concepts, success in general exams	YES	YES
29	Female	city	learn concepts, success in general exams	YES	YES
30	Female	village	learn concepts, success in general exams	NO	YES
31	Male	city	explain phenomena scientifically	YES	YES
32	Female	city	learn concepts, develop interests, success in general exams	YES	YES
33	Male	city	learn concepts, success in general exams	YES	YES
34	Female	city	scientific knowledge	YES	YES
35	Female	city	explain phenomena, success in general exams	NO	YES
36	Male	city	learn concepts, success in general exams	YES	YES
37	Female	city	learn concepts, success in general exams	YES	YES
38	Male	village	explain phenomena, success in general exams	YES	YES
39	Male	city	learn concepts, success in general exams	YES	YES
40	Female	city	learn concepts, success in general exams	YES	YES
41	Female	city	to develop interests	YES	YES
42	Male	village	learn concepts, success in general exams	YES	YES
43	Female	village	scientific knowledge	YES	YES
44	Male	village	explain phenomena	NO	YES
45	Female	city	learn concepts, success in general exams	YES	YES
46	Male	city	learn concepts, success in general exams	YES	YES
47	Male	city	explain phenomena, success in general exams	YES	YES
48	Female	village	learn concepts, success in general exams	YES	YES
49	Male	village	learn concepts, success in general exams	YES	YES
50	Male	village	learn concepts, success in general exams	YES	YES
51	Female	city	explain phenomena scientifically	YES	YES

number	gender	area	Their opinion of the aim of science subjects	Are they satisfied with the science curriculum and text books	Are their children satisfied
52	Male	city	learn concepts, develop interests, success in general exams	YES	YES
53	Female	village	learn concepts, success in general exams	YES	YES
54	Female	city	scientific knowledge	YES	YES
55	Male	city	explain phenomena	YES	YES
56	Female	city	learn concepts, success in general exams	YES	YES
57	Male	village	learn concepts, success in general exams	YES	YES
58	Female	village	explain phenomena	YES	YES
59	Male	city	learn science	YES	YES
60	Male	village	learn concepts, success in general exams	YES	YES
61	Female	city	to develop interests	YES	YES
62	Female	village	learn concepts, success in general exams	not much	YES
63	Male	village	scientific knowledge	YES	YES
64	Male	village	explain phenomena	YES	YES
65	Female	city	learn concepts, success in general exams	YES	YES
66	Female	city	learn concepts, success in general exams	YES	YES
67	Male	city	explain phenomena, success in general exams	YES	YES
68	Female	village	learn science	YES	YES
69	Male	village	learn concepts	YES	YES
70	Male	city	explain phenomena, success in general exams	YES	YES
71	Female	city	explain phenomena scientifically	not much	YES
72	Male	city	to develop interests	YES	YES
73	Male	city	explain phenomena and not to have a lot of questions and inquiries	YES	YES
74	Female	village	scientific knowledge	YES	YES
75	Male	village	explain phenomena, success in general exams	YES	YES
76	Female	village	learn concepts, success in general exams	YES	YES
77	Male	city	learn concepts, success in general exams	YES	YES
78	Female	city	explain phenomena	YES	YES

Table 34: Parents' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Number	Area	Are any activities carried out at home linked to science	Prioritization of science as subject	What do they do when the child asks something lined to science?	Any out-school activities of the child, linked to science?
1	City	only when the child asks, as then he shows interest	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
2	City	No	4 after language, mathematics religion	Ask the teacher	YES no links with science
3	Village	No	1	Ask the teacher	NO
4	Village	Yes	4 after language, mathematics religion	Ask the teacher	NO
5	Village	No	2 after religion	Ask the teacher, or the book	YES no links with science
6	Village	No	8 (only MUSIC & ARTS after science)	Ask the teacher,	NO
7	Village	No	5 after language, mathematics, physical education, political education	Ask the teacher,	YES no links with science
8	Village	No	3 after language and mathematics	Ask the teacher,	YES no links with science
9	Village	No	4 after language, mathematics religion	Ask the teacher,	NO
10	Village	No	4 after language, mathematics religion	Ask the teacher,	NO
11	City	No	3 after language and mathematics	search encyclopedias	YES and it is linked with science
12	City	No	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
13	Village	No	4 after language, mathematics religion	Ask the teacher	YES no links with science
14	City	No	3 after language and mathematics	Ask the teacher	NO
15	City	Yes	3 after mathematics and language	Ask the teacher	NO
16	City	No	3 after language and mathematics	Ask the teacher, or the book	YES no links with science
17	City	No	3 after mathematics and language	Ask the teacher,	NO
18	City	No	5 after language, mathematics, religion, history	Ask the teacher,	YES no links with science
19	City	No	3 after language and mathematics	Ask the teacher,	YES no links with science
20	City	No	3 after language and mathematics	Ask the teacher,	NO

Number	Area	Are any activities carried out at home linked to science	Prioritization of science as subject	What do they do when the child asks something lined to science?	Any out-school activities of the child, linked to science?
21	City	No	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
22	Village	No	4 after language, mathematics religion	Ask the teacher	YES no links with science
23	City	No	3 after mathematics and language	Ask the teacher	NO
24	Village	Yes	3 after mathematics and language	Ask the teacher	NO
25	Village	No	2 after religion	Ask the teacher, or the book	YES no links with science
26	City	No	3 after language and mathematics	Ask the teacher,	NO
27	Village	No	5 after language, mathematics, religion, political education	Ask the teacher,	YES no links with science
28	City	No	3 after language and mathematics	Ask the teacher,	YES no links with science
29	Village	No	6 after language, mathematics, religion, geography arts	Ask the teacher,	NO
30	Village	No	4 after language, mathematics religion	Ask the teacher,	NO
31	City	No	3 after language and mathematics	search encyclopedias	YES and it is linked with science
32	City	No	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
33	City	Sometimes	4 after language, mathematics religion	Ask the teacher	YES no links with science
34	City	No	3 after mathematics and language	Ask the teacher	YES no links with science
35	City	No	3 after mathematics and language	Ask the teacher	NO
36	City	No	4 after language, mathematics history	Ask the teacher, or the book	YES no links with science
37	City	No	3 after mathematics and language	Ask the teacher,	NO
38	Village	Yes	5 after language, mathematics, religion, physical education	Ask the teacher,	YES no links with science
39	City	No	3 after language and mathematics	Ask the teacher,	YES no links with science
40	Village	No	6 after language, mathematics, history, geography arts	Ask the teacher,	NO
41	Village	No	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
42	Village	No	4 after language, mathematics religion	Ask the teacher	YES no links with science

Number	Area	Are any activities carried out at home linked to science	Prioritization of science as subject	What do they do when the child asks something lined to science?	Any out-school activities of the child, linked to science?
43	Village	No	1	Ask the teacher	NO
44	City	Yes	3 after mathematics and language	Ask the teacher	NO
45	City	No	3 after mathematics and language	Ask the teacher, or the book	YES no links with science
46	City	No	3 after mathematics and language	Ask the teacher,	NO
47	Village	No	5 after language, mathematics, religion, political education	Ask the teacher,	YES no links with science
48	Village	No	3 after language and mathematics	Ask the teacher,	YES no links with science
49	Village	No	4 after language, mathematics religion	Ask the teacher,	NO
50	Village	No	4 after language, mathematics religion	Ask the teacher,	NO
51	City	No	3 after language and mathematics	Ask the teacher	YES and it is linked with science
52	City	No	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
53	Village	No	4 after language, mathematics religion	Ask the teacher	YES no links with science
54	City	No	1	Ask the teacher	NO
55	City	No	3 after mathematics and language	Ask the teacher	NO
56	City	No	3 after mathematics and language	Ask the teacher, or the book	YES no links with science
57	Village	No	3 after mathematics and language	Ask the teacher,	NO
58	Village	No	5 after language, mathematics, religion, political education	Ask the teacher,	YES no links with science
59	City	No	3 after language and mathematics	Ask the teacher,	YES no links with science
60	Village	No	6 after language, mathematics, religion, history arts	Ask the teacher,	NO
61	City	No	3 after language and mathematics	ASK THE TEACHER, or sometimes relative	YES no links with science
62	Village	No	4 after language, mathematics religion	Ask the teacher	YES no links with science
63	Village	No	4 after language, mathematics religion	Ask the teacher	NO
64	City	Yes	3 after mathematics and language	Ask the teacher	NO
65	City	No	3 after mathematics and language	Ask the teacher, or the book	YES no links with science
66	City	No	3 after mathematics and language	Ask the teacher,	NO

Number	Area	Are any activities carried out at home linked to science	Prioritization of science as subject	What do they do when the child asks something lined to science?	Any out-school activities of the child, linked to science?
67	City	No	3 after mathematics and language	Ask the teacher,	YES no links with science
68	City	No	3 after language and mathematics	Ask the teacher,	YES no links with science
69	Village	No	6 after language, mathematics, religion, geography arts	Ask the teacher,	NO
70	Village	No	4 after language, mathematics religion	Ask the teacher,	NO
71	City	No	3 after language and mathematics	Ask the teacher	YES and it is linked with science
72	Village	No	4 after language, mathematics religion	ASK THE TEACHER, or sometimes relative	YES no links with science
73	Village	No	4 after language, mathematics religion	Ask the teacher	YES no links with science
74	Village	No	1	Ask the teacher	NO
75	Village	No	4 after language, mathematics religion	Ask the teacher	NO
76	Village	No	4 after language, mathematics religion	Ask the teacher, or the book	YES no links with science
77	City	No	3 after mathematics and language	Ask the teacher,	NO
78	Village	No	4 after language, mathematics religion	Ask the teacher,	YES no links with science

Table 35: Parents' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Number	How do they communicate and co-operate with the school	Do they receive instruction from school to help/educate pupils at home	Suggestions
1	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
2	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
3	visits to school as before	YES	No, everything OK
4	visits to school as before	NO	Nothing
5	NO	NO	more information and communication with schools
6	NO	NO	more information and communication with schools
7	visits to school as before	NO	NO
8	visits to school as before	NO	NO
9	visits to school as before	NO	NO
10	visits to school as before	NO	more instructions for help at home
11	visits to school as before	YES	NO
12	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
13	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
14	visits to school as before	YES	No, everything OK
15	visits to school as before	NO	Nothing
16	NO	NO	more information and communication with schools
17	NO	NO	more information and communication with schools
18	visits to school as before	NO	NO
19	visits to school as before	NO	NO
20	visits to school as before	NO	NO
21	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
22	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
23	visits to school as before	YES	No, everything OK
24	visits to school as before	NO	Nothing
25	NO	NO	more information and communication with schools

Number	How do they communicate and co-operate with the school	Do they receive instruction from school to help/educate pupils at home	Suggestions
26	NO	NO	more information and communication with schools
27	visits to school as before	NO	NO
28	visits to school as before	NO	NO
29	visits to school as before	NO	NO
30	visits to school as before	NO	more instructions for help at home
31	visits to school as before	YES	NO
32	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
33	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
34	visits to school as before	YES	No, everything OK
35	visits to school as before	NO	Nothing
36	NO	NO	more information and communication with schools
37	NO	NO	more information and communication with schools
38	visits to school as before	NO	NO
39	visits to school as before	NO	NO
40	visits to school as before	NO	NO
41	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
42	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
43	visits to school as before	YES	No, everything OK
44	visits to school as before	NO	Nothing
45	NO	NO	more information and communication with schools
46	NO	NO	more information and communication with schools
47	visits to school as before	NO	NO
48	visits to school as before	NO	NO
49	visits to school as before	NO	NO
50	visits to school as before	NO	more instructions for help at home
51	visits to school as before	YES	NO
52	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
53	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
54	visits to school as before	YES	No, everything OK

Number	How do they communicate and co-operate with the school	Do they receive instruction from school to help/educate pupils at home	Suggestions
55	visits to school as before	NO	Nothing
56	NO	NO	more information and communication with schools
57	NO	NO	more information and communication with schools
58	visits to school as before	NO	NO
59	visits to school as before	NO	NO
60	visits to school as before	NO	NO
61	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
62	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
63	visits to school as before	YES	No, everything OK
64	visits to school as before	NO	Nothing
65	NO	NO	more information and communication with schools
66	NO	NO	more information and communication with schools
67	visits to school as before	NO	NO
68	visits to school as before	NO	NO
69	visits to school as before	NO	NO
70	visits to school as before	NO	more instructions for help at home
71	visits to school as before	YES	NO
72	visits to school as before	NO, and that is right as this is school job	referring to the general school functions
73	visits to school as before	NO	more equipment as the child can't keep bringing materials from home
74	visits to school as before	YES	No, everything OK
75	visits to school as before	NO	Nothing
76	NO	NO	more information and communication with schools
77	NO	NO	more information and communication with schools
78	visits to school as before	NO	NO

Table 36: Pupils' information and responses. The fact that answers appear similar, in the last column is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
1	Male	YES	Language, mathematics, geography history, gymnastics,
2	Male	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
3	Male	YES, favourite subject	Language, mathematics, geography, history, politics, arts, gymnastics,
4	Male	YES	Language, mathematics, arts, gymnastics,
5	Male	YES	Language, mathematics, geography, history, politics, arts, gymnastics, religion, English
6	Female	YES, favourite subject	Mathematics, geography, history, politics, arts, gymnastics, English
7	Female	YES, favourite subject	Language, mathematics, history, arts, gymnastics, religion, English
8	Female	YES	Language, geography, history, politics, religion, English
9	Female	YES	Language, mathematics, geography, history, politics, gymnastics English
10	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
11	Male	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics, English
12	Male	YES, favourite subject	Mathematics geography, history, politics, arts, gymnastics, religion, English
13	Male	YES, favourite subject	Language, mathematics, geography, politics, religion, English
14	Female	YES	Language, mathematics, geography, history, arts, gymnastics religion, English,
15	Female	YES, favourite subject	Mathematics, geography, politics arts, gymnastics, religion, English
16	Female	YES, favourite subject	Mathematics, geography, history, arts, English
17	Female	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
18	Female	YES, favourite subject	Language, mathematics, geography, history, politics arts, gymnastics, religion, English
19	Female	YES	Mathematics, geography, history, arts, gymnastics, religion, English
20	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
21	Female	YES	Language, geography, history, arts, gymnastics, English
22	Male	YES, favourite subject	Mathematics, geography, politics, arts, gymnastics, religion, English
23	Male	YES	Language, mathematics, history, arts, gymnastics, religion, English
24	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
25	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
26	Male	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
27	Female	YES	Language, mathematics, history, arts, gymnastics, English
28	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
29	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
30	Female	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, English
31	Male	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics,
32	Male	YES, favourite subject	Language, mathematics, geography, history, politics, arts, gymnastics, English
33	Male	YES	Mathematics, geography, history, politics, arts, gymnastics,
34	Male	YES	Language, mathematics, geography, arts, religion, English
35	Male	YES, favourite subject	Language, mathematics, geography, religion, English
36	Female	YES	Mathematics, geography, history, arts, gymnastics, religion, English
37	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
38	Female	YES	Mathematics, geography, arts, gymnastics, religion, English
39	Female	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics, religion, English
40	Male	YES	Language, geography, geography, history, arts, gymnastics, religion, English
41	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion,
42	Male	YES, favourite subject	Language, mathematics, history, arts, gymnastics, religion
43	Male	YES, favourite subject	Mathematics, geography, politics, arts, gymnastics, English
44	Male	YES, favourite subject	Geography, history, gymnastics, religion, English
45	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
46	Female	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
47	Female	YES	Language, mathematics, history, religion, English
48	Female	YES	Mathematics, geography, history, arts, gymnastics, religion, English
49	Female	YES	Mathematics, geography, history, arts, religion, English
50	Female	YES	Language, geography, history, politics, arts, gymnastics,
51	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
52	Male	YES, favourite subject	Mathematics, geography, history, arts, gymnastics, religion, English
53	Female	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
54	Female	YES, favourite subject	Language, mathematics, geography, gymnastics, religion, English
55	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
56	Female	YES	Language, mathematics, history, arts, gymnastics, English
57	Male	YES	Language, geography, politics, gymnastics, religion, English
58	Male	YES, favourite subject	Language, mathematics, geography, history, gymnastics, English
59	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
60	Female	YES	Mathematics, geography, history, politics, arts, gymnastics,
61	Male	YES	Mathematics, history, politics, arts, gymnastics, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
62	Male	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion, English
63	Male	YES, favourite subject	Language, mathematics, geography, history, arts, religion, English
64	Male	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics, religion, English
65	Female	YES, favourite subject	Language, mathematics, geography, history, politics, arts, religion, English
66	Female	YES, favourite subject	Language, mathematics, history, gymnastics,
67	Male	YES	Language, mathematics, geography, arts, religion, English
68	Male	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
69	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
70	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion,
71	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
72	Female	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics,
73	Female	YES	Language, mathematics, politics, arts, gymnastics, religion, English
74	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
75	Female	YES	Mathematics, geography, politics, arts, gymnastics, religion, English
76	Female	YES	Geography, politics, arts, gymnastics, religion, English
77	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
78	Female	YES	Geography, history, politics, arts, gymnastics, religion, English
79	Female	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion,
80	Female	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, English
81	Male	YES	Language, mathematics, geography, arts, gymnastics, English
82	Male	YES	Mathematics, geography, history, politics, arts, gymnastics, English
83	Male	YES, favourite subject	Language, mathematics, history, gymnastics,
84	Male	YES	Language, mathematics, geography, politics, arts, gymnastics religion, English,
85	Female	YES	Language, geography, politics, arts, gymnastics, English
86	Female	YES	Mathematics, geography, politics, arts, gymnastics, religion, English
87	Female	YES	Language, geography, history, politics, arts, gymnastics, English
88	Female	YES	Language, mathematics, history, politics, arts, gymnastics, English
89	Male	YES, favourite subject	Language, mathematics, history, arts, gymnastics, English
90	Male	YES	Language, mathematics, politics, arts, gymnastics, English
91	Male	YES	Language, geography, history, arts, gymnastics, religion
92	Male	YES	Mathematics, geography, politics, arts, gymnastics, religion, English
93	Female	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
94	Female	YES, favourite subject	Mathematics, geography, politics, arts, gymnastics, religion, English
95	Female	YES	Language, mathematics, geography, gymnastics, religion, English
96	Female	YES	Language, geography, politics, arts, gymnastics,
97	Male	YES	Language, mathematics, history, religion, English
98	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
99	Male	YES, favourite subject	Language, geography, history, arts, religion, English
100	Male	YES	Mathematics, history, politics, arts, gymnastics religion,
101	Female	YES	Language, mathematics, geography, religion, English
102	Female	YES	Geography, arts, gymnastics, religion, English
103	Female	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
104	Female	YES	Language, mathematics, geography, arts, gymnastics, religion, English
105	Male	YES, favourite subject	Mathematics, geography, politics, arts, gymnastics,
106	Male	YES	Language, mathematics, arts, gymnastics, religion, English
107	Male	YES	Language, history, politics, arts, gymnastics, religion, English
108	Male	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English,
109	Female	YES, favourite subject	Language, mathematics, geography, gymnastics, religion, English
110	Female	YES, favourite subject	History, politics, arts, gymnastics, religion, English
111	Male	YES	Language, mathematics, geography, politics, arts, gymnastics, religion,
112	Male	YES	Language, geography, history, arts, gymnastics,
113	Female	YES, favourite subject	Language, mathematics, politics, arts, gymnastics, religion, English
114	Female	YES	Language, mathematics, geography, arts, gymnastics, religion
115	Female	YES	Mathematics, geography, arts, gymnastics, religion, English
116	Female	YES	Language, geography, history, arts, gymnastics, English
117	Male	YES	Language, mathematics, geography, politics, arts, English
118	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics,
119	Male	YES, favourite subject	Language, geography, history, politics, arts, gymnastics, religion, English
120	Male	YES, favourite subject	Language, mathematics, history, arts, gymnastics,
121	Female	YES	Language, geography, history, arts, gymnastics, religion, English
122	Female	YES	Language, mathematics, politics, arts, gymnastics, religion, English
123	Male	YES	Mathematics, history, politics, arts, gymnastics, religion, English
124	Male	YES	History, politics, arts, gymnastics, religion, English
125	Male	YES	Mathematics, geography, history, arts, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
126	Male	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
127	Male	YES	Language, mathematics, history, religion, English
128	Male	YES	Language, geography, history, arts, gymnastics, religion, English
129	Female	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
130	Female	YES, favourite subject	Geography, history, politics, gymnastics, religion, English
131	Female	YES, favourite subject	Language, mathematics, geography, history, arts, religion,
132	Female	YES	Language, mathematics, history, arts, gymnastics, English
133	Female	YES	History, gymnastics, religion, English
134	Female	YES	Language, mathematics, geography, history, politics, arts, gymnastics, religion, English
135	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
136	Male	YES	Language, history, politics, arts, gymnastics, English
137	Male	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics religion, English,
138	Male	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
139	Female	YES	Language, geography, history, arts, gymnastics, English
140	Female	YES	Language, mathematics, geography, history, politics,
141	Female	YES, favourite subject	Geography, history, arts, gymnastics, religion, English
142	Female	YES, favourite subject	Mathematics, geography, history, politics, gymnastics,
143	Male	YES	Language, mathematics, geography, history, politics, arts, English
144	Female	YES	History, arts, gymnastics,
145	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
146	Female	YES	Language, mathematics, geography, history, religion
147	Male	YES	Language, mathematics, geography, history, arts, gymnastics religion, English,
148	Male	YES	Language, mathematics, history, arts, gymnastics, religion, English
149	Male	YES, favourite subject	Mathematics, geography, history, politics, arts, gymnastics, religion, English
150	Male	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics, religion, English
151	Female	YES, favourite subject	Geography, history, arts, gymnastics, English
152	Female	YES, favourite subject	History, arts, gymnastics, religion
153	Male	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics, religion, English
154	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
155	Male	YES, favourite subject	Language, geography, history, politics, gymnastics, religion, English
156	Male	YES, favourite subject	History, arts, gymnastics, religion,
157	Female	YES, favourite subject	Language, mathematics, geography, history, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
158	Female	YES, favourite subject	Language, geography, history, arts, English
159	Female	YES	Language, mathematics, geography, arts, gymnastics, religion, English
160	Female	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics, religion, English
161	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
162	Male	YES	Language, geography, history, politics, arts, gymnastics, religion, English
163	Male	YES	Language, geography, history, arts, gymnastics,
164	Male	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
165	Male	YES	Language, mathematics, history, gymnastics, religion, English
166	Male	YES	Geography, history, politics, arts, gymnastics,
167	Female	YES	Language, geography, history, arts, gymnastics, religion, English
168	Female	YES	Language, mathematics, geography, politics, gymnastics, religion, English
169	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
170	Female	YES	History, arts, gymnastics, English
171	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
172	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
173	Male	YES	Language, geography, history, arts, gymnastics, English
174	Male	YES	Language, geography, history, politics, arts, gymnastics, religion, English
175	Female	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
176	Female	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics, religion, English
177	Female	YES	Language, mathematics, geography, arts, gymnastics, religion,
178	Female	YES	Geography, history, politics
179	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
180	Male	YES	Language, geography, history, politics, arts, gymnastics, English
181	Male	YES	Language, mathematics, geography, politics, arts, religion
182	Male	YES	History, politics, arts, gymnastics, English
183	Female	YES, favourite subject	Language, mathematics, history, gymnastics, religion, English
184	Female	YES	Mathematics, geography, history, arts, gymnastics, religion, English
185	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
186	Female	YES	Language, geography, history, arts, gymnastics, religion, English
187	Male	YES	Language, mathematics, history, gymnastics, religion, English
188	Male	YES	Language, geography, history, politics, arts, gymnastics, religion, English
189	Male	YES	Language, mathematics, geography, history, politics, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
190	Male	YES, favourite subject	Mathematics, geography, history, arts, gymnastics, religion
191	Male	YES	Language, mathematics, history, arts, gymnastics, English
192	Male	YES, favourite subject	Language, geography, history, politics, arts, gymnastics, religion, English
193	Female	YES	Language, mathematics, geography, politics, arts, gymnastics,
194	Female	YES, favourite subject	Language, mathematics, history, politics, arts, gymnastics, English
195	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
196	Male	YES	Mathematics, geography, politics, arts, gymnastics, religion, English
197	Male	YES, favourite subject	Language, mathematics, geography, arts, gymnastics, religion, English
198	Male	YES	Language, geography, history, arts, gymnastics,
199	Male	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics, religion, English
200	Female	YES	Mathematics, geography, history, politics, arts,
201	Female	YES, favourite subject	Language, mathematics, history, arts, gymnastics, English
202	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
203	Female	YES	Language, geography, politics,
204	Female	YES	Language, history, politics, arts, gymnastics, religion, English
205	Female	YES	Language, mathematics, geography, arts, gymnastics, religion, English
206	Male	YES	Language, geography, politics, arts, gymnastics, religion, English
207	Male	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion, English
208	Male	YES	Language, geography, history, politics, arts, religion, English
209	Male	YES	Language, mathematics, politics, gymnastics,
210	Female	YES, favourite subject	Geography, history, arts, gymnastics, religion, English
211	Female	YES, favourite subject	Mathematics, geography, history, politics, arts, gymnastics, religion, English
212	Female	YES	Mathematics, geography, politics, arts, gymnastics, religion,
213	Female	YES	History, arts, gymnastics, English
214	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, English
215	Male	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
216	Male	YES	Mathematics, geography, politics, arts, gymnastics, religion, English
217	Male	YES	Language, mathematics, geography, history, arts, religion, English
218	Male	YES	Language, mathematics, geography, arts, gymnastics, religion, English
219	Female	YES, favourite subject	Language, geography, history, politics, arts, gymnastics, English
220	Female	YES, favourite subject	Language, mathematics, geography, history, politics, gymnastics,
221	Female	YES, favourite subject	Language, geography, history, politics, arts, gymnastics, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
222	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
223	Female	YES	Language, mathematics, geography, history, politics, religion, English
224	Female	YES	Language, mathematics, geography, politics, religion, English
225	Male	YES	Geography, history, politics, arts, gymnastics, religion
226	Male	YES, favourite subject	Mathematics, geography, history, politics, arts, gymnastics, religion, English
227	Male	YES	History, politics, arts, gymnastics, religion, English
228	Male	YES	Language, mathematics, geography, history, arts, gymnastics,
229	Male	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion, English
230	Female	YES	Geography, history, politics, arts, gymnastics, English
231	Female	YES	Language, mathematics, geography, history, arts, gymnastics, English
232	Female	YES	Language, geography, politics, arts, gymnastics,
233	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
234	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
235	Male	YES	Language, geography, history, politics,
236	Male	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion, English
237	Female	YES, favourite subject	Language, mathematics, geography, politics, arts, English
238	Female	YES, favourite subject	Mathematics, geography, history, gymnastics, religion, English
239	Female	YES, favourite subject	Language, geography, history, politics, arts, gymnastics, English
240	Female	YES, favourite subject	Language, mathematics, history, arts, gymnastics, religion, English
241	Male	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion,
242	Male	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
243	Male	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
244	Male	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
245	Male	YES	Language, geography, history, politics, arts, gymnastics, religion, English
246	Male	YES	Language, mathematics, history, arts, English
247	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
248	Female	YES	Language, mathematics, history, arts, gymnastics, religion, English
249	Female	YES	Geography, history, politics, politics, arts, gymnastics, religion, English
250	Female	YES, favourite subject	Language, mathematics, history, arts, gymnastics, religion
251	Male	YES, favourite subject	Language, mathematics, geography, history, politics, arts, gymnastics, religion, English
252	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
253	Male	YES, favourite subject	Language, mathematics, geography, history, gymnastics, religion, English

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
254	Male	YES	History, politics, arts, gymnastics, religion, English
255	Male	YES	Mathematics, geography, history, arts, gymnastics, English
256	Male	YES	Language, mathematics, geography, arts, gymnastics, religion
257	Female	YES, favourite subject	Language, geography, history, arts, gymnastics,
258	Female	YES	Language, mathematics, geography, politics,
259	Female	YES	Language, mathematics, geography, politics, arts, gymnastics, religion, English
260	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
261	Female	YES	Language, mathematics, geography, arts, gymnastics, religion, English
262	Male	YES, favourite subject	Mathematics history, politics, gymnastics,
263	Male	YES, favourite subject	Language, geography, history, arts, religion, English
264	Male	YES, favourite subject	Language, mathematics, geography, history, politics, arts, gymnastics, religion, English
265	Male	YES, favourite subject	Language, mathematics, geography, religion, English
266	Female	YES, favourite subject	Language, mathematics, geography, history, politics, arts, gymnastics, English
267	Female	YES, favourite subject	Geography, history, arts, gymnastics, religion, English
268	Female	YES, favourite subject	Language, mathematics, geography, politics, arts, gymnastics, religion, English
269	Female	YES, favourite subject	Language, geography, history, politics, arts, gymnastics, English
270	Female	YES, favourite subject	History, arts, gymnastics,
271	Male	YES, favourite subject	Mathematics, geography, history, politics, arts, gymnastics, religion, English
272	Male	YES, favourite subject	Language, mathematics, history, arts, gymnastics, religion, English
273	Male	YES	Language, geography, history, politics, arts, gymnastics, religion, English
274	Male	YES	Language, mathematics, history, gymnastics, religion, English
275	Female	YES	Mathematics, geography, history, arts, religion, English
276	Female	YES, favourite subject	Language, mathematics, geography, history, politics, arts, English
277	Female	YES	Language, geography, history, arts, religion, English
278	Female	YES	Politics, arts, gymnastics, religion, English
279	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
280	Female	YES	Geography, history, politics, arts, gymnastics, religion, English
281	Male	YES	Language, mathematics, geography, history, gymnastics,
282	Male	YES	Language, mathematics, history, politics, arts, gymnastics, English
283	Male	YES, favourite subject	Language, geography, history, gymnastics, religion, English
284	Male	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
285	Female	YES	Mathematics, geography, history, arts, gymnastics,

Pupil No	Gender	Does the pupil like science?	Other subjects the pupil likes
286	Female	YES	Language, geography, history, politics, arts, gymnastics, religion, English
287	Female	YES	Language, mathematics, history, arts, gymnastics, religion
288	Male	YES	Language, geography, history, arts, gymnastics,
289	Male	YES	Language, mathematics, geography, politics, arts, religion, English
290	Female	YES	Language, mathematics, geography, history, politics, arts, gymnastics, religion, English
291	Female	YES	Mathematics, geography, history, arts, gymnastics,
292	Female	YES	Language, geography, history, politics, arts, gymnastics, English
293	Female	YES	Language, mathematics, history, arts, gymnastics, religion, English
294	Male	YES	History, politics, arts, gymnastics, religion, English
295	Male	YES	Mathematics, geography, history, arts,
296	Male	YES, favourite subject	Language, mathematics, geography, history, politics, arts, gymnastics, religion, English
297	Male	YES	Gymnastics,
298	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
299	Female	YES, favourite subject	Language, mathematics, geography, history, arts, gymnastics, religion, English
300	Female	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
301	Female	YES	Language, history, politics, arts, gymnastics
302	Male	YES	Language, mathematics, geography, history, religion, English
303	Male	YES	Mathematics, geography, history, politics, arts, gymnastics, religion, English
304	Male	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
305	Male	YES	Language, mathematics, geography, history, arts, gymnastics, religion, English
306	Male	YES	Language, geography, history, politics, arts, religion, English
307	Male	YES, favourite subject	Language, mathematics, history, gymnastics, English
308	Male	YES	History, politics, arts, gymnastics, religion, English
309	Female	YES	Language, mathematics, geography, history, arts, gymnastics, English
310	Female	YES	Language, mathematics, history, politics, arts, gymnastics, religion, English
311	Female	YES	Language, mathematics, history, arts, gymnastics, religion, English
312	Female	YES	Language, mathematics, geography, history, politics, arts, gymnastics, English

Table 37: Pupils' information and responses. The fact that answers appear similar, in the last column is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Pupil No	What does the pupil enjoy most from science lesson
1	Experiments, easy to learn
2	Experiments, group activities
3	Experiments, easy to learn, group activities, nice book
4	Experiments, easy to learn, group activities, nice book
5	Experiments, easy to learn, group activities,
6	Experiments, easy to learn, nice book
7	Experiments, easy to learn, group activities, nice book
8	Experiments, group activities, nice book
9	Experiments,
10	Experiments, easy to learn, group activities, nice book
11	Experiments, easy to learn, group activities, nice book
12	Experiments, nice book
13	Experiments, group activities, nice book
14	Experiments, easy to learn, group activities, nice book
15	Experiments, easy to learn,
16	Experiments, easy to learn, nice book
17	Experiments, easy to learn, group activities, nice book
18	Experiments, easy to learn, group activities, nice book
19	Experiments, easy to learn, group activities, nice book
20	Experiments, group activities, nice book
21	Experiments, easy to learn, group activities, nice book
22	Experiments, easy to learn, group activities, nice book
23	Experiments, group activities, nice book
24	Experiments, easy to learn, nice book
25	Experiments, easy to learn, group activities, nice book
26	Experiments, easy to learn, group activities, nice book
27	Experiments
28	Experiments, easy to learn
29	Experiments, easy to learn, group activities, nice book

Pupil No	What does the pupil enjoy most from science lesson
30	Experiments, easy to learn, group activities, nice book
31	Experiments, easy to learn, group activities, nice book
32	Experiments, easy to learn, group activities, nice book
33	Experiments, group activities, nice book
34	Experiments, nice book
35	Experiments, easy to learn
36	Experiments, easy to learn, group activities, nice book
37	Experiments, easy to learn, nice book
38	Experiments, easy to learn, group activities, nice book
39	Experiments, easy to learn, group activities, nice book
40	Experiments
41	Experiments
42	Experiments, nice book
43	Experiments, group activities, nice book
44	Experiments, easy to learn,
45	Experiments, easy to learn, nice book
46	Experiments, easy to learn, nice book
47	Experiments, nice book
48	Experiments, nice book
49	Experiments, easy to learn, group activities, nice book
50	Experiments, easy to learn, group activities, nice book
51	Experiments, group activities, nice book
52	Experiments, easy to learn, nice book
53	Experiments, easy to learn, group activities, nice book
54	Experiments
55	Experiments, easy to learn, group activities, nice book
56	Experiments, group activities, nice book
57	Experiments, nice book
58	Experiments, easy to learn, group activities, nice book
59	Experiments, easy to learn, group activities, nice book
60	Experiments, group activities, nice book
61	Experiments, easy to learn, group activities, nice book

Pupil No	What does the pupil enjoy most from science lesson
62	Experiments, easy to learn, group activities, nice book
63	Experiments, easy to learn, group activities, nice book
64	Experiments, easy to learn, group activities, nice book
65	Experiments, easy to learn, group activities, nice book
66	Experiments, easy to learn, group activities, nice book
67	Experiments
68	Experiments, nice book
69	Experiments, group activities
70	Experiments, easy to learn, group activities, nice book
71	Experiments
72	Experiments, easy to learn, group activities, nice book
73	Experiments, easy to learn
74	Experiments, group activities, nice book
75	Experiments, group activities, nice book
76	Experiments, group activities, nice book
77	Experiments, easy to learn
78	Experiments, easy to learn, group activities, nice book
79	Experiments, easy to learn
80	Experiments, easy to learn, group activities
81	Experiments, easy to learn, group activities, nice book
82	Experiments
83	Experiments, easy to learn, group activities, nice book
84	Experiments, nice book
85	Experiments, easy to learn, group activities, nice book
86	Experiments, group activities
87	Experiments, easy to learn, group activities
88	Experiments, nice book
89	Experiments, easy to learn, group activities, nice book
90	Experiments
91	Experiments
92	Experiments
93	Experiments, easy to learn, group activities, nice book

Pupil No	What does the pupil enjoy most from science lesson
94	Experiments, nice book
95	Experiments, easy to learn, group activities, nice book
96	Experiments, group activities
97	Experiments, easy to learn
98	Experiments, nice book
99	Experiments
100	Experiments, group activities, nice book
101	Experiments, easy to learn, group activities, nice book
102	Experiments, group activities, nice book
103	Experiments, nice book
104	Experiments, group activities, nice book
105	Experiments, easy to learn, group activities, nice book
106	Experiments, easy to learn, nice book
107	Experiments, easy to learn, group activities, nice book
108	Experiments, easy to learn
109	Experiments, easy to learn
110	Experiments, group activities, nice book
111	Experiments, easy to learn, group activities, nice book
112	Experiments, group activities, nice book
113	Experiments, easy to learn, group activities
114	Experiments, easy to learn, group activities, nice book
115	Experiments
116	Experiments, group activities, nice book
117	Experiments, easy to learn, nice book
118	Experiments, group activities, nice book
119	Experiments, group activities
120	Experiments, nice book
121	Experiments, easy to learn
122	Experiments, easy to learn
123	Experiments, easy to learn
124	Experiments, easy to learn
125	Experiments, easy to learn

Pupil No	What does the pupil enjoy most from science lesson
126	Experiments, easy to learn
127	Experiments, easy to learn
128	Experiments, easy to learn, group activities, nice book
129	Experiments, easy to learn, group activities, nice book
130	Experiments, nice book
131	Experiments, easy to learn, group activities, nice book
132	Experiments, easy to learn,
133	Experiments, easy to learn, group activities, nice book
134	Experiments
135	Experiments, nice book
136	Experiments, easy to learn, group activities, nice book
137	Experiments
138	Experiments, easy to learn, group activities, nice book
139	Experiments, easy to learn, group activities, nice book
140	Experiments, group activities, nice book
141	Experiments, group activities
142	Experiments, easy to learn, group activities
143	Experiments
144	Experiments, nice book
145	Experiments
146	Experiments
147	Experiments, easy to learn, group activities, nice book
148	Experiments, group activities, nice book
149	Experiments, easy to learn, group activities, nice book
150	Experiments, easy to learn, group activities, nice book
151	Experiments, easy to learn, group activities
152	Experiments, easy to learn, nice book
153	Experiments, group activities, nice book
154	Experiments, easy to learn, nice book
155	Experiments, nice book
156	Experiments, easy to learn, group activities, nice book
157	Experiments

Pupil No	What does the pupil enjoy most from science lesson
158	Experiments, nice book
159	Experiments, easy to learn, group activities, nice book
160	Experiments, easy to learn, group activities, nice book
161	Experiments, group activities
162	Experiments, easy to learn
163	Experiments, easy to learn
164	Experiments, easy to learn
165	Experiments, easy to learn
166	Experiments, easy to learn, group activities, nice book
167	Experiments, easy to learn, group activities, nice book
168	Experiments, easy to learn, group activities, nice book
169	Experiments, nice book
170	Experiments, easy to learn, group activities, nice book
171	Experiments, easy to learn, group activities, nice book
172	Experiments, easy to learn, group activities, nice book
173	Experiments
174	Experiments, easy to learn, group activities, nice book
175	Experiments, easy to learn, group activities, nice book
176	Experiments, easy to learn, group activities, nice book
177	Experiments, nice book
178	Experiments, easy to learn, group activities, nice book
179	Experiments, group activities, nice book
180	Experiments, easy to learn, nice book
181	Experiments, easy to learn, group activities, nice book
182	Experiments, easy to learn, group activities, nice book
183	Experiments, easy to learn
184	Experiments, easy to learn, group activities, nice book
185	Experiments
186	Experiments, easy to learn, group activities
187	Experiments, nice book
188	Experiments, group activities, nice book
189	Experiments, easy to learn, group activities, nice book

Pupil No	What does the pupil enjoy most from science lesson
190	Experiments, easy to learn, group activities, nice book
191	Experiments, nice book
192	Experiments, nice book
193	Experiments, group activities, nice book
194	Experiments, nice book
195	Experiments, easy to learn, nice book
196	Experiments, easy to learn, group activities, nice book
197	Experiments, nice book
198	Experiments, easy to learn
199	Experiments, group activities, nice book
200	Experiments, easy to learn, group activities, nice book
201	Experiments, easy to learn, group activities, nice book
202	Experiments
203	Experiments, group activities, nice book
204	Experiments, easy to learn, nice book
205	Experiments, nice book
206	Experiments, easy to learn, group activities, nice book
207	Experiments, easy to learn, group activities, nice book
208	Experiments, easy to learn, group activities, nice book
209	Experiments
210	Experiments, easy to learn, group activities, nice book
211	Experiments, easy to learn, group activities
212	Experiments, easy to learn, group activities, nice book
213	Experiments, easy to learn, group activities, nice book
214	Experiments
215	Experiments
216	Experiments, easy to learn
217	Experiments, nice book
218	Experiments, easy to learn, group activities, nice book
219	Experiments, easy to learn, group activities, nice book
220	Experiments, easy to learn, group activities, nice book
221	Experiments, easy to learn, group activities, nice book

Pupil No	What does the pupil enjoy most from science lesson
222	Experiments
223	Experiments, easy to learn, group activities, nice book
224	Experiments
225	Experiments, nice book
226	Experiments, easy to learn, group activities, nice book
227	Experiments, nice book
228	Experiments, nice book
229	Experiments, nice book
230	Experiments, nice book
231	Experiments, easy to learn, group activities
232	Experiments, easy to learn, group activities, nice book
233	Experiments, group activities, nice book
234	Experiments, easy to learn, nice book
235	Experiments, easy to learn, group activities, nice book
236	Experiments
237	Experiments, nice book
238	Experiments
239	Experiments, group activities
240	Experiments, easy to learn, group activities
241	Experiments, nice book
242	Experiments, easy to learn, group activities, nice book
243	Experiments, nice book
244	Experiments
245	Experiments, group activities
246	Experiments, easy to learn
247	Experiments, easy to learn, group activities, nice book
248	Experiments, easy to learn, group activities
249	Experiments, easy to learn, nice book
250	Experiments, group activities, nice book
251	Experiments, easy to learn
252	Experiments, easy to learn, group activities, nice book
253	Experiments, easy to learn

Pupil No	What does the pupil enjoy most from science lesson
254	Experiments, group activities, nice book
255	Experiments, easy to learn, group activities, nice book
256	Experiments, group activities, nice book
257	Experiments, nice book
258	Experiments, easy to learn, group activities, nice book
259	Experiments, easy to learn
260	Experiments, easy to learn
261	Experiments
262	Experiments, group activities, nice book
263	Experiments, nice book
264	Experiments, easy to learn, group activities, nice book
265	Experiments, easy to learn, group activities, nice book
266	Experiments
267	Experiments
268	Experiments, nice book
269	Experiments, easy to learn, group activities, nice book
270	Experiments, easy to learn
271	Experiments, easy to learn, group activities, nice book
272	Experiments
273	Experiments, easy to learn, group activities, nice book
274	Experiments, easy to learn
275	Experiments, easy to learn, nice book
276	Experiments, group activities
277	Experiments, easy to learn, group activities, nice book
278	Experiments, group activities
279	Experiments
280	Experiments, easy to learn, nice book
281	Experiments, easy to learn, group activities, nice book
282	Experiments, group activities, nice book
283	Experiments, easy to learn, group activities, nice book
284	Experiments, easy to learn, group activities, nice book
285	Experiments, easy to learn, group activities, nice book

Pupil No	What does the pupil enjoy most from science lesson
286	Experiments
287	Experiments, nice book
288	Experiments
289	Experiments, easy to learn
290	Experiments, easy to learn
291	Experiments, easy to learn
292	Experiments, nice book
293	Experiments, group activities, nice book
294	Experiments, easy to learn, group activities, nice book
295	Experiments, easy to learn, group activities, nice book
296	Experiments, easy to learn, group activities, nice book
297	Experiments, easy to learn, group activities
298	Experiments, easy to learn, group activities, nice book
299	Experiments, easy to learn, group activities, nice book
300	Experiments, easy to learn, group activities, nice book
301	Experiments, easy to learn, nice book
302	Experiments, group activities, nice book
303	Experiments, easy to learn, group activities, nice book
304	Experiments, nice book
305	Experiments, nice book
306	Experiments, nice book
307	Experiments, easy to learn, group activities, nice book
308	Experiments, easy to learn, group activities, nice book
309	Experiments, easy to learn, group activities, nice book
310	Experiments, nice book
311	Experiments, easy to learn, group activities, nice book
312	Experiments, easy to learn, group activities, nice book

Table 38: Pupils' information and responses. The fact that answers appear similar, in the last column is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
1	NO	NO	Time, equipment
2	NO	NO	Time, equipment
3	NO	NO	Time, equipment
4	NO	NO	Time, equipment
5	NO	NO	Time, equipment
6	NO	NO	Time, equipment
7	NO	NO	Time, equipment
8	NO	NO	Time, equipment
9	NO	NO	Time, equipment
10	NO	NO	Time, equipment
11	NO	NO	Time, equipment
12	NO	NO	Time, equipment
13	NO	NO	Time, equipment
14	NO	NO	Time, equipment
15	NO	NO	Time, equipment
16	NO	NO	Time, equipment
17	NO	YES	Time, equipment
18	NO	YES	Time, equipment
19	NO	YES	Time, equipment
20	NO	YES	Time, equipment
21	NO	YES	Time, equipment
22	NO	YES	Time, equipment
23	NO	YES	Time, equipment
24	NO	YES	Time, equipment
25	NO	YES	Time, equipment
26	NO	NO	Time, equipment
27	NO	NO	Time, equipment
28	NO	NO	Time, equipment
29	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
30	NO	NO	Time, equipment
31	NO	NO	Time, equipment
32	NO	NO	Time, equipment
33	NO	NO	Time, equipment
34	NO	NO	Time, equipment
35	NO	NO	Time, equipment
36	NO	NO	Time, equipment
37	NO	NO	Time, equipment
38	NO	NO	Time, equipment
39	NO	NO	Time, equipment
40	YES	NO	Time
41	YES	NO	Time
42	YES	YES	Time
43	YES	YES	Time
44	YES	YES	Time
45	YES	YES	Time
46	YES	YES	Time
47	YES	YES	Time
48	YES	NO	Time
49	YES	NO	Time
50	YES	NO	Time
51	YES	NO	Time
52	YES	NO	Time
53	YES	NO	Time
54	YES	NO	Time
55	YES	NO	Time
56	NO	NO	Time, equipment
57	NO	NO	Time, equipment
58	NO	NO	Time, equipment
59	NO	NO	Time, equipment
60	NO	NO	Time, equipment
61	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
62	NO	NO	Time, equipment
63	NO	YES	Time, equipment
64	NO	YES	Time, equipment
65	NO	YES	Time, equipment
66	NO	YES	Time, equipment
67	NO	YES	Time, equipment
68	NO	YES	Time, equipment
69	NO	YES	Time, equipment
70	NO	YES	Time, equipment
71	NO	YES	Time, equipment
72	NO	YES	Time, equipment
73	NO	NO	Time, equipment
74	NO	NO	Time, equipment
75	NO	NO	Time, equipment
76	NO	NO	Time, equipment
77	NO	NO	Time, equipment
78	NO	NO	Time, equipment
79	NO	NO	Time, equipment
80	NO	NO	Time, equipment
81	NO	NO	Time, equipment
82	NO	NO	Time, equipment
83	NO	NO	Time, equipment
84	NO	NO	Time, equipment
85	NO	NO	Time, equipment
86	NO	NO	Time, equipment
87	NO	NO	Time, equipment
88	NO	NO	Time, equipment
89	NO	NO	Time, equipment
90	NO	NO	Time, equipment
91	NO	NO	Time, equipment
92	NO, because their classroom is the science lab	YES	Time

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
93	NO, because their classroom is the science lab	YES	Time
94	NO, because their classroom is the science lab	YES	Time
95	NO, because their classroom is the science lab	YES	Time
96	NO, because their classroom is the science lab	YES	Time
97	NO, because their classroom is the science lab	YES	Time
98	NO, because their classroom is the science lab	YES	Time
99	NO, because their classroom is the science lab	YES	Time
100	NO, because their classroom is the science lab	YES	Time
101	NO, because their classroom is the science lab	YES	Time
102	NO, because their classroom is the science lab	YES	Time
103	NO, because their classroom is the science lab	YES	Time
104	NO	YES	Time, equipment
105	YES	YES	Time
106	YES	YES	Time
107	YES	YES	Time
108	YES	YES	Time
109	YES	YES	Time
110	NO	NO	Time, equipment
111	NO	NO	Time, equipment
112	NO	NO	Time, equipment
113	NO	NO	Time, equipment
114	NO	NO	Time, equipment
115	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
116	NO	NO	Time, equipment
117	NO	NO	Time, equipment
118	NO	NO	Time, equipment
119	NO	NO	Time, equipment
120	NO	NO	Time, equipment
121	NO	NO	Time, equipment
122	NO	NO	Time, equipment
123	NO	NO	Time, equipment
124	NO	YES	Time, equipment
125	NO	YES	Time, equipment
126	NO	YES	Time, equipment
127	NO	YES	Time, equipment
128	NO	YES	Time, equipment
129	NO	YES	Time, equipment
130	NO	YES	Time, equipment
131	NO	YES	Time, equipment
132	NO	YES	Time, equipment
133	NO	YES	Time, equipment
134	NO	NO	Time, equipment
135	NO	NO	Time, equipment
136	NO	NO	Time, equipment
137	NO	NO	Time, equipment
138	NO	NO	Time, equipment
139	NO	NO	Time, equipment
140	NO	NO	Time, equipment
141	NO	NO	Time, equipment
142	NO	NO	Time, equipment
143	NO	NO	Time, equipment
144	NO	NO	Time, equipment
145	NO	NO	Time, equipment
146	NO	NO	Time, equipment
147	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
148	NO	NO	Time, equipment
149	NO	NO	Time, equipment
150	NO	NO	Time, equipment
151	NO	NO	Time, equipment
152	NO	NO	Time, equipment
153	NO	NO	Time, equipment
154	NO	NO	Time, equipment
155	NO	NO	Time, equipment
156	NO	NO	Time, equipment
157	NO	NO	Time, equipment
158	NO	NO	Time, equipment
159	NO	NO	Time, equipment
160	NO	NO	Time, equipment
161	NO	NO	Time, equipment
162	NO	NO	Time, equipment
163	NO	NO	Time, equipment
164	NO	NO	Time, equipment
165	NO	NO	Time, equipment
166	NO	NO	Time, equipment
167	NO	NO	Time, equipment
168	NO	NO	Time, equipment
169	NO	NO	Time, equipment
170	NO	NO	Time, equipment
171	NO	NO	Time, equipment
172	NO	NO	Time, equipment
173	YES	NO	Time
174	YES	NO	Time
175	YES	NO	Time
176	YES	NO	Time
177	YES	NO	Time
178	YES	NO	Time
179	YES	NO	Time

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
180	YES	NO	Time
181	YES	NO	Time
182	YES	NO	Time
183	YES	NO	Time
184	NO	NO	Time, equipment
185	NO	NO	Time, equipment
186	NO	NO	Time, equipment
187	NO	NO	Time, equipment
188	NO	NO	Time, equipment
189	NO	NO	Time, equipment
190	NO	NO	Time, equipment
191	NO	NO	Time, equipment
192	NO	NO	Time, equipment
193	NO	NO	Time, equipment
194	NO	NO	Time, equipment
195	NO	NO	Time, equipment
196	NO	NO	Time, equipment
197	NO	NO	Time, equipment
198	NO	NO	Time, equipment
199	NO	NO	Time, equipment
200	NO	NO	Time, equipment
201	NO	NO	Time, equipment
202	NO	NO	Time, equipment
203	NO	NO	Time, equipment
204	NO	NO	Time, equipment
205	NO	NO	Time, equipment
206	NO	NO	Time, equipment
207	NO	NO	Time, equipment
208	NO	NO	Time, equipment
209	NO	NO	Time, equipment
210	NO	NO	Time, equipment
211	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
212	NO	NO	Time, equipment
213	NO	NO	Time, equipment
214	NO	NO	Time, equipment
215	NO	NO	Time, equipment
216	NO	NO	Time, equipment
217	NO	NO	Time, equipment
218	NO	NO	Time, equipment
219	NO	NO	Time, equipment
220	NO	YES	Time, equipment
221	NO	YES	Time, equipment
222	NO	YES	Time, equipment
223	NO	YES	Time, equipment
224	NO	YES	Time, equipment
225	NO	YES	Time, equipment
226	NO	NO	Time, equipment
227	NO	NO	Time, equipment
228	NO	NO	Time, equipment
229	NO	NO	Time, equipment
230	NO	NO	Time, equipment
231	NO	NO	Time, equipment
232	NO	NO	Time, equipment
233	NO	NO	Time, equipment
234	NO	NO	Time, equipment
235	NO	NO	Time, equipment
236	NO	NO	Time, equipment
237	NO	NO	Time, equipment
238	NO	NO	Time, equipment
239	NO	NO	Time, equipment
240	NO	NO	Time, equipment
241	NO	NO	Time, equipment
242	NO	NO	Time, equipment
243	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
244	NO	NO	Time, equipment
245	NO	NO	Time, equipment
246	NO	NO	Time, equipment
247	NO	NO	Time, equipment
248	NO	NO	Time, equipment
249	NO	NO	Time, equipment
250	NO	NO	Time, equipment
251	NO	NO	Time, equipment
252	NO	NO	Time, equipment
253	NO	NO	Time, equipment
254	NO	NO	Time, equipment
255	NO	NO	Time, equipment
256	NO	NO	Time, equipment
257	NO	NO	Time, equipment
258	NO	NO	Time, equipment
259	NO	NO	Time, equipment
260	NO	NO	Time, equipment
261	NO	NO	Time, equipment
262	NO	NO	Time, equipment
263	NO	NO	Time, equipment
264	NO	NO	Time, equipment
265	NO	NO	Time, equipment
266	NO	NO	Time, equipment
267	NO	NO	Time, equipment
268	NO	NO	Time, equipment
269	NO	NO	Time, equipment
270	NO	NO	Time, equipment
271	NO	NO	Time, equipment
272	NO	NO	Time, equipment
273	NO	NO	Time, equipment
274	NO	NO	Time, equipment
275	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
276	NO	NO	Time, equipment
277	NO	NO	Time, equipment
278	NO	NO	Time, equipment
279	NO	NO	Time, equipment
280	NO	NO	Time, equipment
281	NO	NO	Time, equipment
282	NO	NO	Time, equipment
283	NO	NO	Time, equipment
284	NO	NO	Time, equipment
285	NO	NO	Time, equipment
286	NO	NO	Time, equipment
287	NO	NO	Time, equipment
288	NO	NO	Time, equipment
289	NO	NO	Time, equipment
290	NO	NO	Time, equipment
291	NO	NO	Time, equipment
292	NO	NO	Time, equipment
293	NO	NO	Time, equipment
294	NO	NO	Time, equipment
295	NO	NO	Time, equipment
296	NO	NO	Time, equipment
297	NO	NO	Time, equipment
298	NO	NO	Time, equipment
299	NO	NO	Time, equipment
300	NO	NO	Time, equipment
301	NO	NO	Time, equipment
302	NO	NO	Time, equipment
303	NO	NO	Time, equipment
304	NO	NO	Time, equipment
305	NO	NO	Time, equipment
306	NO	NO	Time, equipment
307	NO	NO	Time, equipment

Pupil No	Do they do the lesson in a laboratory?	Are their misconceptions negotiated?	Problems they mention
308	NO	NO	Time, equipment
309	NO	NO	Time, equipment
310	NO	NO	Time, equipment
311	NO	NO	Time, equipment
312	NO	NO	Time, equipment

Table 39: Secondary Science teachers' information and responses. The fact that answers appear similar in the last column is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Number	Gender	Region	Place	Years	Aims of Science Subjects
1	Female	South Aegean	Rhodes	13	learning concepts and phenomena, becoming able to construct knowledge by themselves, success in the general exams
2	Female	South Aegean	Rhodes	11	learning concepts and phenomena, skill development- experiment carrying out, success in the general exams, becoming able to construct knowledge
3	Female	South Aegean	Rhodes_Symi	11	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
4	Female	South Aegean	Rhodes	18	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge, success in the general exams
5	Female	South Aegean	Rhodes	19	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge and professional development
6	Male	Attica	Athens	15	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
7	Male	Attica	Athens	20	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
8	Female	Attica	Athens	6	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
9	Male	Attica	Athens	17	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
10	Male	Thessaly	Volos	6	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
11	Male	Attica	Athens	13	learning concepts and phenomena, becoming able to construct knowledge by themselves
12	Female	Macedonia	Thessaloniki	11	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
13	Male	Thessaly	Trikala	18	learning concepts and phenomena, appreciating the contribution of science in the society, becoming able to construct knowledge
14	Male	Macedonia	Thessaloniki	19	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge and professional development

Number	Gender	Region	Place	Years	Aims of Science Subjects
15	Male	South Aegean	Kos	15	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
16	Female	Crete	Iraklion	20	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
17	Female	Crete	Iraklion	6	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
18	Female	Macedonia	Thessaloniki	17	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
19	Female	Macedonia	Thessaloniki	6	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
20	Male	Macedonia	Serres	9	becoming able to construct knowledge by themselves
21	Male	Peloponnese	Patras	23	concepts, skill development, appreciating the contribution of science, becoming able to construct knowledge and learning to use science and avoid its dangers
22	Male	Peloponnese	Patras	10	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
23	Female	Peloponnese	Patras	18	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
24	Male	South Aegean	Rhodes	6	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
25	Female	South Aegean	Kos	14	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
26	Male	Attica	Athens	22	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
27	Male	Central Greece	Fokida	9	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
28	Female	Central Greece	Fokida	7	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
29	Female	Macedonia	Thessaloniki	15	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
30	Female	Central Greece	Karpenisi	19	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
31	Male	Attica	Athens	11	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
32	Female	Trace	Xanthi	3	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge

Number	Gender	Region	Place	Years	Aims of Science Subjects
33	Male	Trace	Xanthi	25	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
34	Female	Trace	Alexandroupoli	14	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
35	Male	Trace	Alexandroupoli	8	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
36	Female	North Aegean	Thasos	12	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
37	Male	Thessaly	Volos	9	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
38	Male	Crete	Chania	17	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, becoming able to construct knowledge
39	Male	North Aegean	Lesvos	5	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
40	Female	Attica	Athens	14	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
41	Female	South Aegean	Santorini	19	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
42	Female	South Aegean	Santorini	21	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
43	Male	Epirus	Ioannina	13	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
44	Female	North Aegean	Chios	11	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
45	Male	North Aegean	Lesvos	20	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
46	Female	North Aegean	Lesvos	18	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
47	Male	Epirus	Ioannina	17	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge and professional development
48	Male	Attica	Athens	8	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge

Number	Gender	Region	Place	Years	Aims of Science Subjects
49	Male	Ionian Islands	Corfu	20	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
50	Female	Ionian Islands	Corfu	6	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
51	Female	Epirus	Ioannina	17	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
52	Male	Macedonia	Thessaloniki	6	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
53	Female	Macedonia	Thessaloniki	9	success in the general exams, learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
54	Female	Macedonia	Thessaloniki	2	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
55	Female	Crete	Rethymno	5	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
56	Female	Attica	Athens	16	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, and rejection of misconceptions
57	Male	Attica	Athens	15	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
58	Female	Attica	Athens	15	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
59	Male	Peloponnese	Patras	25	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
60	Female	Peloponnese	Sparta	13	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
61	Male	Thessaly	Larissa	19	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
62	Female	Epirus	Ioannina	9	becoming able to construct knowledge by themselves
63	Female	Epirus	Ioannina	23	concepts, skill development, appreciating the contribution of science, becoming able to construct knowledge and learning to use science and avoid its dangers
64	Male	Epirus	Ioannina	3	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
65	Male	South Aegean	Rhodes	18	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
66	Female	South Aegean	Kos	12	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge

Number	Gender	Region	Place	Years	Aims of Science Subjects
67	Male	South Aegean	Kos	10	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
68	Female	Ionian Islands	Lefkada	7	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
69	Male	Ionian Islands	Lefkada	15	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
70	Male	Crete	Iraklion	24	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
71	Female	Ionian Islands	Kefallinia	16	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
72	Female	Attica	Athens	12	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
73	Male	Attica	Athens	11	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
74	Male	Attica	Athens	5	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
75	Male	Central Greece	Karpenisi	21	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
76	Female	South Aegean	Naxos	17	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
77	Male	South Aegean	Naxos	8	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
78	Female	South Aegean	Naxos	2	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
79	Male	Crete	Chania	19	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge
80	Male	Thessaly	Volos	22	learning concepts and phenomena, skill development- experiment carrying out, appreciating the contribution of science in the society, becoming able to construct knowledge

Table 40: Secondary Science teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

number	knowledge expected	Expecting improvement on pupils performance because of the new primary science curriculum	Taking consideration of the fact that pupils have learnt science in the primary school?
1	some basic ideas	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
2	nothing, because of the curriculum	NO	NO, although sometimes they might remember something from primary school, depending on the primary school
3	nothing, because of the curriculum	NO, because teachers lack of science background	No generally
4	nothing, because of the curriculum	NO, because no actual in-depth change has taken place	No generally
5	some basic information	NO	children remember some things from primary school
6	observation and simple explanation of phenomena	Possible but Unlikely, as it is not sure whether the change actually HAPPENS	yes
7	observation and simple explanation of phenomena	NO, (not convinced that actual change has taken place)	NO, however on the way, children might recall something from primary school
8	nothing, because of the curriculum	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
9	nothing, because of the curriculum	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
10	nothing, because of the curriculum	NO,	NO, that is the big problem
11	nothing, because of the curriculum	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
12	observation and simple explanation of phenomena	NO, because teachers lack of science background	No generally
13	observation and simple explanation of phenomena	NO, because no actual in-depth change has taken place	No generally
14	nothing, because of the curriculum	NO	children remember some things from primary school
15	nothing, because of the curriculum	Possible but Unlikely, as it is not sure whether the change actually HAPPENS	yes

number	knowledge expected	Expecting improvement on pupils performance because of the new primary science curriculum	Taking consideration of the fact that pupils have learnt science in the primary school?
16	observation and simple explanation of phenomena	NO, (not convinced that actual change has taken place)	NO, however on the way, children might recall something from primary school
17	nothing, because of the curriculum	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
18	nothing, because of the curriculum	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
19	nothing, because of the curriculum	NO,	NO, that is the big problem
20	observation and simple explanation of phenomena (without mathematical formulas)	YES, the students will have more critical attitude towards phenomena	NO, even though the students behave like they have been taught science before
21	practice scientific method and observation and learn about the phenomena around them	Depends whether the change is actually applied	only that they have experience with science
22	nothing, because of the curriculum	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
23	some basic information	NO	NO, although sometimes they might remember something from primary school, depending on the primary school
24	some basic information	NO, because teachers lack of science background	No generally
25	nothing, because of the curriculum	NO, because no actual in-depth change has taken place	No generally
26	some basic information	Possible but Unlikely, as it is not sure whether the change actually HAPPENS	children remember some things from primary school
27	some basic information	Doubtful	yes
28	nothing, because of the curriculum	NO, (not convinced that actual change has taken place)	NO, however on the way, children might recall something from primary school
29	some basic information	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
30	some basic information	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
31	some basic information	NO,	NO, that is the big problem
32	some basic information	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
33	some basic information	NO, because teachers lack of science background	No generally

number	knowledge expected	Expecting improvement on pupils performance because of the new primary science curriculum	Taking consideration of the fact that pupils have learnt science in the primary school?
34	nothing, because of the curriculum	NO, because no actual in-depth change has taken place	No generally
35	nothing, because of the curriculum	NO	children remember some things from primary school
36	some basic information	Maybe	yes
37	observation and simple explanation of phenomena	No, not convinced that the change is implemented as expected	NO, however on the way, children might recall something from primary school
38	observation and simple explanation of phenomena	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
39	nothing, because of the curriculum	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
40	observation and simple explanation of phenomena	NO,	NO, that is the big problem
41	nothing, because of the curriculum	YES, the students will have more critical attitude towards phenomena	NO, even though the students behave like they have been taught science before
42	nothing, because of the curriculum	Depends whether the change is actually applied	only that they have experience with science
43	some basic ideas	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
44	nothing, because of the curriculum	NO	NO, although sometimes they might remember something from primary school, depending on the primary school
45	nothing, because of the curriculum	NO, because teachers lack of science background	No generally
46	nothing, because of the curriculum	NO, because no actual in-depth change has taken place	No generally
47	some basic information	NO	children remember some things from primary school
48	observation and simple explanation of phenomena	Possible but Unlikely, as it is not sure whether the change actually HAPPENS	yes
49	observation and simple explanation of phenomena	NO, (not convinced that actual change has taken place)	NO, however on the way, children might recall something from primary school
50	nothing, because of the curriculum	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
51	nothing, because of the curriculum	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
52	nothing, because of the curriculum	NO,	NO, that is the big problem

number	knowledge expected	Expecting improvement on pupils performance because of the new primary science curriculum	Taking consideration of the fact that pupils have learnt science in the primary school?
53	nothing, because of the curriculum	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
54	observation and simple explanation of phenomena	NO, because teachers lack of science background	No generally
55	observation and simple explanation of phenomena	NO, because no actual in-depth change has taken place	No generally
56	nothing, because of the curriculum	NO	children remember some things from primary school
57	nothing, because of the curriculum	Possible but Unlikely, as it is not sure whether the change actually HAPPENS	yes
58	observation and simple explanation of phenomena	NO, (not convinced that actual change has taken place)	NO, however on the way, children might recall something from primary school
59	nothing, because of the curriculum	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
60	nothing, because of the curriculum	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
61	nothing, because of the curriculum	NO,	NO, that is the big problem
62	observation and simple explanation of phenomena (without mathematical formulas)	YES, the students will have more critical attitude towards phenomena	NO, even though the students behave like they have been taught science before
63	practice scientific method and observation and learn about the phenomena around them	Depends whether the change is actually applied	only that they have experience with science
64	nothing, because of the curriculum	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
65	some basic information	NO	NO, although sometimes they might remember something from primary school, depending on the primary school
66	some basic information	NO, because teachers lack of science background	No generally
67	nothing, because of the curriculum	NO, because no actual in-depth change has taken place	No generally
68	some basic information	Possible but Unlikely, as it is not sure whether the change actually HAPPENS	children remember some things from primary school
69	some basic information	Doubtful	yes

number	knowledge expected	Expecting improvement on pupils performance because of the new primary science curriculum	Taking consideration of the fact that pupils have learnt science in the primary school?
70	nothing, because of the curriculum	NO, (not convinced that actual change has taken place)	NO, however on the way, children might recall something from primary school
71	some basic information	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions
72	some basic information	NO high school is oriented to the General exams	NO, only sometimes, if the children seem to remember anything
73	some basic information	NO,	NO, that is the big problem
74	some basic information	NO, as teachers are not experts in physics	YES, but on the way he finds out that students remember limited information and they have misconceptions
75	some basic information	NO, because teachers lack of science background	No generally
76	nothing, because of the curriculum	NO, because no actual in-depth change has taken place	No generally
77	nothing, because of the curriculum	NO	children remember some things from primary school
78	some basic information	Maybe	yes
79	observation and simple explanation of phenomena	No, not convinced that the change is implemented as expected	NO, however on the way, children might recall something from primary school
80	observation and simple explanation of phenomena	NO. Despite the fact that these changes could be fruitful, there is incompatibility between primary and secondary science	NO, the children don't remember it. Only some exceptions

Table 41: Secondary Science teachers' information and responses. The fact that answers appear similar is because of the fact that they are presented in accordance with the codes used in the qualitative data analysis using N-VIVO program.

Number	Changes in secondary school so far	Suggestions
1	curriculum, textbooks, however due to general exams no deep change has taken place	further training, equipment, use of experiments and the internet
2	curriculum, textbooks, however due to general exams no deep change has taken place	further training, equipment, books that actually represent the curriculum
3	nothing significant because of the general exams	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
4	nothing significant because of the general exams	unified curriculum
5	curriculum, textbooks, however due to general exams no deep change has taken place	further training, equipment, assessment
6	more effort for experimental tasks, which failed because of time pressure and the general exams	further training, promotion of experiments in the classroom and teaching, assessment
7	more effort for experimental tasks, which failed because of time pressure and the general exams	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
8	nothing significant because of the general exams	more drastical changes in the school functions, more co-operation with parents and the society
9	nothing significant because of the general exams	more drastical changes in the school functions, more co-operation with parents and the society
10	nothing significant because of the general exams	rationalisation of the teaching units, more time
11	more effort for experimental tasks, which failed because of time pressure and the general exams	further training, equipment, use of experiments and the internet
12	minor changes of the chapters	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
13	curriculum, textbooks, however due to general exams no deep change has taken place	unified curriculum
14	nothing significant because of the general exams	further training, equipment, assessment
15	nothing significant because of the general exams	further training, promotion of experiments in the classroom and teaching, assessment

Number	Changes in secondary school so far	Suggestions
16	only more opportunities for further training	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
17	minor changes of the chapters	more drastical changes in the school functions, more co-operation with parents and the society
18	only more opportunities for further training	more drastical changes in the school functions, more co-operation with parents and the society
19	more effort for experimental tasks, which failed because of time pressure and the general exams	rationalisation of the teaching units, more time
20	only more opportunities for further training	more laboratorial tasks and less mathematical formulas
21	only that they have experience with science	teacher training in the actual classroom and not in theory for 2 years at least after the University, laboratories but the schools should be provided the money to get the materials
22	minor changes of the chapters	further training, equipment, use of experiments and the internet
23	only more opportunities for further training	further training, equipment, books that actually represent the curriculum
24	curriculum, textbooks, however due to general exams no deep change has taken place	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
25	only more opportunities for further training	unified curriculum
26	children remember some things from primary school	further training, equipment, assessment
27	more effort for experimental tasks, which failed because of time pressure and the general exams	further training, promotion of experiments in the classroom and teaching, assessment
28	nothing significant because of the general exams	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
29	nothing significant because of the general exams	more drastical changes in the school functions, more co-operation with parents and the society
30	only more opportunities for further training	more drastical changes in the school functions, more co-operation with parents and the society
31	minor changes of the chapters	rationalisation of the teaching units, more time
32	more effort for experimental tasks, which failed because of time pressure and the general exams	further training, equipment, use of experiments and the internet

Number	Changes in secondary school so far	Suggestions
33	nothing significant because of the general exams	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
34	nothing significant because of the general exams	unified curriculum
35	nothing significant because of the general exams	further training, equipment, assessment
36	nothing significant because of the general exams	further training, promotion of experiments in the classroom and teaching, assessment
37	curriculum, textbooks, however due to general exams no deep change has taken place	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
38	more effort for experimental tasks, which failed because of time pressure and the general exams	more drastical changes in the school functions, more co-operation with parents and the society
39	only more opportunities for further training, but overall nothing significant because of the general exams	more drastical changes in the school functions, more co-operation with parents and the society
40	curriculum, textbooks, however due to general exams no deep change has taken place	rationalisation of the teaching units, more time
41	nothing significant because of the general exams	more laboratorial tasks and less mathematical formulas
42	nothing significant because of the general exams	teacher training in the actual classroom and not in theory for 2 years at least after the University, laboratories but the schools should be provided the money to get the materials
43	curriculum, textbooks, however due to general exams no deep change has taken place	further training, equipment, use of experiments and the internet
44	only more opportunities for further training	further training, equipment, books that actually represent the curriculum
45	nothing significant because of the general exams	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
46	nothing significant because of the general exams	unified curriculum
47	nothing significant because of the general exams	further training, equipment, assessment
48	minor changes of the chapters but nothing significant because of the general exams	further training, promotion of experiments in the classroom and teaching, assessment
49	more effort for experimental tasks, which failed because of time pressure and the general exams	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.

Number	Changes in secondary school so far	Suggestions
50	only more opportunities for further training	more drastical changes in the school functions, more co-operation with parents and the society
51	curriculum, textbooks, however due to general exams no deep change has taken place	more drastical changes in the school functions, more co-operation with parents and the society
52	nothing significant because of the general exams	rationalisation of the teaching units, more time
53	nothing significant because of the general exams	further training, equipment, use of experiments and the internet
54	curriculum, textbooks, chapters taught, however due to general exams no deep change has taken place	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
55	nothing significant because of the general exams	unified curriculum
56	children remember some things from primary school	further training, equipment, assessment
57	nothing significant because of the general exams	further training, promotion of experiments in the classroom and teaching, assessment
58	nothing significant because of the general exams	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
59	nothing significant because of the general exams	more drastical changes in the school functions, more co-operation with parents and the society
60	curriculum, textbooks, chapters taught, however due to general exams no deep change has taken place	more drastical changes in the school functions, more co-operation with parents and the society
61	curriculum, textbooks, chapters taught, however due to general exams no deep change has taken place	rationalisation of the teaching units, more time
62	nothing significant because of the general exams	more laboratorial tasks and less mathematical formulas
63	curriculum, textbooks, however due to general exams no deep change has taken place	teacher training in the actual classroom and not in theory for 2 years at least after the University, laboratories but the schools should be provided the money to get the materials
64	nothing significant because of the general exams	further training, equipment, use of experiments and the internet
65	nothing significant because of the general exams	further training, equipment, books that actually represent the curriculum
66	more effort for experimental tasks, which failed because of time pressure and the general exams	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies

Number	Changes in secondary school so far	Suggestions
67	curriculum, textbooks, chapters taught, however due to general exams no deep change has taken place	unified curriculum
68	nothing significant because of the general exams	further training, equipment, assessment
69	minor changes of the chapters, however due to general exams no deep change has taken place	further training, promotion of experiments in the classroom and teaching, assessment
70	minor changes of the chapters, however due to general exams no deep change has taken place	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
71	minor changes of the chapters, however due to general exams no deep change has taken place	more drastical changes in the school functions, more co-operation with parents and the society
72	only more opportunities for further training, however due to general exams no deep change has taken place	more drastical changes in the school functions, more co-operation with parents and the society
73	more effort for experimental tasks, which failed because of time pressure and the general exams	rationalisation of the teaching units, more time
74	curriculum, textbooks, however due to general exams no deep change has taken place	further training, equipment, use of experiments and the internet
75	curriculum, textbooks, however due to general exams no deep change has taken place	day-long schools, training on experiments, equipment (provision of simple materials to schools) use of modern technologies
76	nothing significant because of the general exams	unified curriculum
77	only more opportunities for further training, however due to general exams no deep change has taken place	further training, equipment, assessment
78	nothing significant because of the general exams	further training, promotion of experiments in the classroom and teaching, assessment
79	curriculum, textbooks, however due to general exams no deep change has taken place	More fundamental changes, to promote integration of the subjects and not segmental teaching, in three sort sessions every week.
80	curriculum, textbooks, however due to general exams no deep change has taken place	more drastical changes in the school functions, more co-operation with parents and the society