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UNIVERSITY OF SOUTHAMPTON

RELATIONSHIP BETWEEN MANAGING TEAMWORK WITH TEACHERS AND BUILDING
SELF CONFIDENCE FOR SCIENCE LEARNING AMONG CHILDREN

BY

TERENCE CHARLES FISH

This Thesis was Submitted for Examination for the Degree of
Doctor of Philosophy in

FACULTY OF EDUCATIONAL STUDIES

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ABSTRACT

FACULTY OF EDUCATIONAL STUDIES

Doctor of PhilosophyRELATIONSHIP BETWEEN MANAGING TEAMWORK WITH TEACHERS AND BUILDING
SELF CONFIDENCE FOR SCIENCE LEARNING AMONG CHILDREN

By Terence Charles Fish

The purpose of this study was to investigate the factors and strategies which enable pupils to focus their minds on the conceptual issue being taught, and how teachers may build and maintain the pupils' self confidence in articulating scientific ideas. The study focused on the work of the science department in a boys' 12 to 16 comprehensive school in Southern England, where the researcher was Head of the Faculty of Science and Technology. This was an ethnographic case study where the researcher was a participant observer in action research.

The research focused on national curriculum years 8 and 9 and involved three methodological stages; the exploratory, field operational and explanatory search. The exploratory stage involved the development of the Responsive Teaching Model and the writing and implementation, by all the science teachers, of schemes of work which bore this model in mind. Formal data collection involved; lesson observations, pupil questionnaire, analysis of end of year 8 pupil profiles and interviews with the science staff and the school's Special Needs coordinator.

The field operational stage involved a science teacher working with an advisory teacher in the production, implementation and reviewing of a module of work. This stage also involved the detailed observation of science lessons using an observation schedule developed from the initial findings from the other instruments.

During the period of the research, the GCSE examination results improved considerably and were found to be significantly higher than may have been expected.

The explanatory search stage revealed that successful lessons were associated with science teachers orchestrating a number of interrelated characteristics: the teachers' planning, individual pupils' conceptual understanding, the group social behaviour of the children and the interpersonal relations. It appears that the interpersonal relations have a central role to play in enabling effective learning. There was evidence that the manner in which whole class and small group work is organised could facilitate effective learning.

The way in which the science department had worked together as a team had encouraged teachers to reflect on their practice, and seemed to enable teachers to adapt their teaching styles and strategies. The reflectivity itself, and the fact that it was research based was felt to be particularly significant.

This study raises further issues related to; the initial training of teachers, the in-service training of established teachers and the possible advantages of undertaking action research in schools.

DEDICATED TO MY WIFE
AND CHILDREN

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CHAPTER I

ORIENTATION AND OVERVIEW

1.1 Introduction

This study attempts to travel along a pathway which few researchers have trampled because the issues appear to have been sidestepped. The path we are to follow investigates the self confidence of children in articulating their scientific ideas and it is divided into two strands. It attempts to describe the factors and strategies which enable children to focus their minds on the conceptual issue being taught and to describe how science teachers may build and maintain the pupils' self confidence in articulating their ideas.

1.2 Historical Overview

The place of this study in the history of educational research is outlined. The influence of Baconian empirical-inductivism, followed by the influence of the relativists (Popper, Kuhn, Lakatos, Feyerabend) is briefly discussed. The influence of the personal construct school of thought is then described, followed by a discussion on constructivism and children's informal ideas. The affective dimension of teaching and the methodological approach of this study is then described.

1.3 The Conceptual and Affective Domains

There is a growing body of ideas about children's learning, referred to as constructivism. This body of literature indicates that children develop ideas of their own about natural phenomena before they are taught science at school and the cognitive approach builds on these ideas. Throughout this study, the researcher has been surprised at the relative lack of discussion concerning the affective domain. The work of people such as Head and Shapiro, amongst others, has been most helpful in investigating this area. They argue that both the person and the learning situation are involved in changing one's mind. There is a

proliferation of work concerned with the conceptual domain, and whilst this is vital to an understanding of what happens in the classroom, classrooms are filled with people. It is interesting to note that John Stuart Mills, in his Rectorial address to the University of St. Andrews in 1867 said;

'Men are men before they are lawyers, or physicians, or merchants, or manufacturers; and if you make them capable and sensible men, they will make themselves capable and sensible lawyers or physicians.'

This reflects the researcher's view that the personal dimension cannot be ignored. It appears that the affective and cognitive domains must both be central issues if a greater understanding of the learning process is to be achieved.

This study attempts to bring together the conceptual and affective dimensions of teaching and to elicit a new insight into how teachers can best facilitate learning.

1.4 Motivation

Throughout this study consideration has been given to how it might be possible to harness individual children's motivation towards their school science. Questions concerning how children can be encouraged to focus their minds on the conceptual issue being taught, and how individual children's self confidence can be built and maintained have been the focus for this study. The work of Atkinson, Raynor, White, Holt, Entwistle, Rogers, Coppersmith, Hidi, Weiner and Reyes, among others have been helpful in reviewing motivation and interest and this work is discussed in Chapter 3.

1.5 Responsive Teaching

The above background, together with Millband's work on teaching styles and cognitive selection and Pritchard's work concerning 'Responsive Teaching' have been brought together in this study. To teach effectively, it appears that the teacher needs to consider the task, the learner and the situation. This is not easy, especially when classes are large, for each learner brings with him or her a unique set of parameters; prior knowledge, interest and motivation, to name but a few. How teachers can best 'Respond' to individual children, both in terms of the pupils' conceptual understanding and in the fostering of positive interpersonal relations, is investigated here.

1.6 Underlying Principles of this Classroom Research

Although classroom research is still in its infancy, there has been no shortage of literature for review. Millband (1984), comments: '*Numerous instruments have been used, hundreds of different ideas probed, and scores of reports published.*' Different methods have been discussed and debated. There seem to be two 'schools', the interaction-analysts and the ethnographers. The first has seen a rapid increase in observational systems and the other shows a proliferation of case studies. It appears that much research to date has resulted in lengthy narrations about sequenced actions and events, and whilst they do help, partly, in our understanding of teaching, the researcher feels that they fall short of increasing its effectiveness. Observation schedules abound but they seem to imply a didactic style of teaching and

concentrate on teacher talk. The research proposal behind the Science Teaching Observation Schedule of Eggleston et al (1976) was concerned to identify,

'processes of science teaching - that is the combination of a particular set of learning experiences which might constitute a method of teaching and then to investigate possible relationships.'

However, it also appears to fall victim to the didactic style, concentrating on talk and perhaps it is a victim of its time.

This investigation attempts to fill the gap, in part at least, between theoretical research and classroom practice by bringing research and practice together. It tries to build a bridge between the cognitive and affective dimensions and hopefully, will be of use to teachers in classrooms as well as researchers in universities.

Thirty years ago, Gage (1963), was talking about the gap between theory and practice. He advised that:

'teachers need to know how children learn and how they depend upon motivation, readiness and reinforcement. But teachers....similarly need to know how to teach....present the subject....and to shape cognitive structure. Too much educational psychology makes the teacher 'infer' what he needs to do from what he is told about teachers and learners.'

(Page 133).

Chapter four develops the research methodology used in this study. It discusses the value of case study, ethnographic work and action research whilst bearing in mind Gage's comments above.

The work of Ros Driver and the Children's Learning in Science Project have been prime movers in bringing theory and practice closer together. This study builds on this work, and attempts to extend the

draw them together, and to lead to a deeper understanding of how teachers can enable children to focus their minds and build their self confidence.

1.7 The Framework

This study is an ethnographic case study, where the researcher was a participant observer. The researcher was the head of the faculty of science and technology and this study concentrates on the development of the science department within the faculty. The whole science department was involved in the development and this study could also be classified as action research. The methodology is discussed in detail in chapter four.

1.8 Operational Strategies

The three stages of the design framework are extensively detailed in Chapter Five, but in outline are:

- the exploratory,
- the field operational,
- the explanatory search.

Because of the nature of this study, the formal exploratory and field operational stages overlap. The sequence of events, leading to the data which was collected is shown below:

<u>Date</u>	<u>Action</u>	<u>Stage</u>
September 1987	Appointment as Head of Faculty.	
September 1988		Background Theory / Exploratory
September 1989	Development of Teaching Model and resources.	Exploratory
September 1990		
Spring term	Work with SENASS. Exploratory lesson observations	Field Op. Exploratory
June 1991	Interviews undertaken. Questionnaires completed. Profiles completed by Year 8 pupils.	Exploratory Exploratory Exploratory
September 1991	Lesson observations	Field Op.
January 1992	Writing up	Explanatory-Search
February 1994		

Table (1.1) The Timing of the Research Process

1.8.1 The Exploratory

As mentioned above, the exploratory stage overlapped the initial development of the department, and the field operational stage. The initial stage involved the whole science department in moving from a fairly didactic style of teaching to a more open style, over a period of two to three years. During this rather more informal phase, ideas were investigated, a training session with the Southern England CLIS (Children's Learning in Science) project's representative was undertaken and various approaches were trialled. This led to the development of schemes of work which mirrored the Responsive Teaching model, discussed in detail in chapter two. The main focus during this

development was the increased appreciation, on the part of the teachers, of the ideas which children brought with them to their science lessons. Consideration was also given to how best these children's ideas could be elicited and used as part of the learning process. This development led to increased performance at GCSE and a significant increase in the number of children opting for the dual award science course over the period of three years. This part of the exploratory stage is difficult to document because it involved significant experimentation, and dialogue within the department. The developments were successful, and this success led to the more formal investigation which forms the largest part of this study. It should be noted, however, that the formal exploratory stage enabled teachers and pupils to reflect on the changes which had occurred and therefore gave an indication of the factors and strategies which appeared to have been successful. The researcher feels that the nature of action research means that developments will occur, be evaluated and amended on a continuous basis. The characteristic of the kind of small scale study undertaken here means that it is necessary, at some stage, to gather data for analysis in a more formal manner, although the developments do not, in fact cease. This formal data gathering is necessary for detailed analysis, and an attempt was made to gather data from the exploratory stage which would both help meaningful analysis and enable triangulation. This initial data helped the development of the observation schedule and facilitated the gathering of rich data from the detailed lesson observations.

The exploratory stage was divided into a number of phases, as shown earlier. These were;

- * Interviews with the science staff and special needs coordinator,
- * Analysis of pupil profiles,

- * Lesson observations.

From this stage there evolved;

- * an initial conceptualisation of the characteristics of successful classrooms,
- * the isolation of the factors and strategies which appeared to be particularly significant in enabling children to focus on the conceptual issue being taught and how teachers could build and maintain the children's self confidence,
- * experience in the techniques of conversational interviewing and data recording from observations.

1.8.2 The Field Operational

This stage of the study involved two main phases:

1. A detailed investigation of one teacher's work with a member of the Special Educational Needs Advisory and Support Service¹ (SENASS). Following the three years of developmental work, and the success the department had gained, it was felt that it might be useful to develop an exemplar module of work which conformed, more closely, to the responsive teaching model. Extension and overlearning material would be written and adapted as the module progressed. The SENASS member, together with a member of the school's special needs staff and the science teacher concerned met weekly to review the previous week and to plan work for the following week. The SENASS teacher was able to visit the school and help in one of the lessons each week. As the lessons proceeded, and the work was written and evaluated, the teacher was asked to keep a diary of events. This has been used in the explanatory search stage of the study. Similarly, the researcher attended all the

¹ At the time of writing, teacher advisors were available from SENASS to assist individual departments develop differentiation within their schemes of work.

meetings and observed some of the lessons. The researcher's field notes were also used during the explanatory search stage.

2. The other aspect of the field operational stage concerned the observation of a number of lessons using the observation schedule developed during the exploratory stage of the research. A large number of lessons had been observed during the study but for this detailed analysis, six representative lessons were chosen.

1.8.3 The Explanatory Search

The exploratory and field operational stages produced a significant amount of data. It was at this stage that the detailed analysis took place. The interviews, field notes from the lesson observations and the work undertaken with SENASS together with the teacher's diary were analysed. At the same time, the findings from the pupil profiles and pupil questionnaires (discussed in chapter five), were laid alongside this analysis. From this evolved a number of patterns and issues which form the findings from this study. A discussion on the methodology employed in this detailed analysis, together with the findings from the individual instruments can be found in chapter six. Chapter seven draws these findings together, summarises them and presents a discussion of the results.

The final chapter outlines the conclusions which have been drawn from the study as a whole together with a discussion of the limitations of this study.

1.9 Overview of Early Chapters

Firstly, however, the theoretical background to the study is presented; chapter two develops the background to the responsive teaching model, and chapter three discusses issues relating to the motivation, self confidence and achievement of children in school.

CHAPTER II

RESPONSIVE TEACHING

2.1 Historical Overview

Much of the curriculum development projects of the 1960s focused on the updating of content and on methods of scientific enquiry, the latter patterned along the line of Popper's (1959), *Logic of Scientific Discovery*, even though the projects were unaware of Popper's work. The American Association for the Advancement of Science sponsored an elementary school programme, 'Science: A Process Approach', designed to emphasise 'scientific processes' according to a hierarchical structure advocated by Gagne (1965). Novak (1969) commented that none of the U.S. or British major curriculum projects placed a central focus on the nature and role of concepts in scientific discovery, nor on the role of concepts for learning and understanding science.

Karl Popper (1934, 1959) asserted that 'the results of an enquiry into the rules of Science - that is, of scientific discovery may be entitled The Logic of Scientific Discovery'. The dogma that science was based on observation and experiment and that the methods used to perform these impartial, impersonal observations were the essence of science was accepted for 300 years.

The long and massive influence of Baconian empirical-inductivism on the philosophy of science is well recorded e.g. (Quinton 1980), and it was not until the late 1940s that its grip was weakened. It was attacked on these grounds:

- sensory input involves selective attention and therefore observation is theory laden,
- if observation is driven by theory then the quality of the observation is governed by the pre-existent theory,
- induction cannot logically take place. (Chalmers 1978)

2.2 The Phenomenological Movement

This has been followed by a series of perspectives, e.g. due to Popper (1972), Kuhn (1970), Lakatos (1970), Feyerabend (1978), which can, according to Gilbert and Watts (1983), be cautiously described as relativist. Despite many points of disagreement, what these views share is:

- * a belief in the provisional nature of knowledge,
- * an acceptance of the theory ladenness of observation,
- * an evolutionary approach to theory building,
- * a disagreement over the nature, or even existence of scientific method.

During the 1970s the influence of cognitive theorists, e.g. Bruner, Piaget and Ausubel increased. They argued that the process of development is neither direct biological motivation nor direct environmental pressure, but a reorganisation of psychological structures resulting from organism-environmental interactions. They advocated a psychology which monitored such interactions by establishing personal meanings attached to experience. Phenomenological approaches, such as that due to George Kelly (1955) rejected the 'outsider' methods of experimental psychology and the focussing of intellect to the neglect of emotion. The main concern of the phenomenological movement is the monitoring and examination of what is seen through the eyes of the person in the situation.

The theories of Kelly, with others, form the personal construct school of thought, and these reinforce the idea that we need to plan teaching strategies which take into account the cognitive demands being made on our students. If we do not do this then it is possible that some pupils may become bored because the demands are insufficiently challenging, or on the other hand, it is possible that some pupils may

become lost because the demands are too great. In either case, it is possible that the result could be off task behaviour which then distracts the teacher and other pupils from the learning process.

'Getting it right' is clearly not an easy task and involves the teacher appreciating the diverse stages of conceptual development of the pupils in his or her class. Ausubel's (1968) assimilation theory of cognitive development is based upon *'If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.'* (p. iv).

2.3 Ausubelian Influence

Ausubel distinguishes between three types of learning: cognitive learning, affective learning and psychomotor learning.

Cognitive learning results in an organised storage of information in the learner's brain and this organised complex is referred to as cognitive structure. Driver and Erickson (1983) talk of a conceptual framework as the mental organisation imposed by an individual on sensory inputs as indicated by regularities in an individual's response to particular problem settings.

2.3.1 The Affective Domain

Affective learning is concerned with the personal response of the individual. Novak (1969) suggests that as educators can only arrange for the cognitive experience, this must be our focus of attention. However, the researcher would argue, with Head (1985) that we must also concern ourselves with the affective domain; for two main reasons:

- (a) If we are interested in attitudes to science, and images held of it and scientists, then it is the realm of personal understanding which is under discussion. Other issues - the lack of women involved in science, the concern with the responsibility of

scientists for environmental damage, the lack of communication between the 'two cultures' of science and the humanities - might be better understood if the role of personal understanding were appreciated.

(b) Separating the cognitive and affective aspects of learning to aid understanding is one thing, but to ignore the affective domain is clearly inadequate. Classrooms contain people, and they will clearly interact with each other. The nature of this interaction could determine the success, or otherwise, of the lesson. Novak's emphasis on the cognitive experience is helpful, but although the influence of the affective dimension is difficult, the researcher feels that it should not be ignored.

The effect of the affective domain on understanding is discussed later.

Psychomotor learning is concerned with the training of the muscular response through practice and this is not considered in this study.

2.3.2 Meaningful Learning

The most important aspect of Ausubel's (1968) work is the concept of meaningful learning. He suggests that the essence of meaningful learning is that symbolically expressed ideas are related in a nonarbitrary and substantive (nonverbatim) fashion to what the learner already knows. It is suggested that pupils will resort to rote learning even to potentially meaningful subject matter and Ausubel identifies three reasons for this:

1. some learn from sad experience that substantively correct answers lacking in verbatim correspondence to what they have been taught receives no credit whatsoever from some teachers.

2. some lack confidence in their ability to learn meaningfully, and hence perceive no alternative to panic apart from rote learning.
3. others could be under excessive pressure to exhibit glibness, or to conceal, rather than admit and gradually remedy, original lack of genuine understanding.

Sensitive teachers are aware of these potential problems and have uncovered the adept use of abstract terms with apparent appropriateness even though the student's understanding of the underlying concepts can be virtually nonexistent.

Ausubel argues that for learning to take place, there must be some point for the new knowledge to be linked within the person's mental structure. Ausubel calls these points 'subsumers'. When new work is being undertaken Ausubel argues that an 'advanced organiser' is used to link the new information to be learned with existing concepts in cognitive structure. Novak (1971) argues that researchers have rarely taken into account the nature of the learner's cognitive structure and the potential meaningfulness of the new material to be learned. For this reason he chooses to emphasise the linking or bridging functions of advance organisers and refers to cognitive bridges rather than advance organisers.

2.4 Gagne and Ausubel

Gagne's work differs from that of Ausubel in that Gagne argues that prior knowledge is a determinant of what further learning can occur whereas Ausubel argues that prior knowledge influences the process whereby learning occurs. In essence, Gagne advocates a linear serialistic view of learning - a learning hierarchy, whereas Ausubel advocates a webbed-holistic view of learning - a cognitive framework based upon conceptual hierarchies. The School's Council Integrated Science Project (SCISP) was based on Gagne's work, but Pritchard (1989)

points out that '*Gagne's model provides the logic structure of any composite concept, but gives no indication of its psychological structure and so does not identify an efficient route for the individual learner.*' (p. 9).

2.5 Constructivism and Children's Informal Ideas

There is a growing body of ideas about children's learning which is referred to as constructivism. This body of literature indicates that children develop their own ideas about natural phenomena before they are taught science at school and the cognitive approach builds on these ideas. (Eg. Pfundt and Duit (1985); Jung et al (1982); Helm and Novak (1983); Driver and Erickson (1983); Gilbert and Watts (1983); Driver, Guesne and Tiberghien (1985)).

This body of work is characterised by the emphasis they place on the active construction of meaning on the part of the individual learner. The pupil will arrive at his or her science lessons with explanations and theories of their own, which may, or may not, be in keeping with what is regarded as scientific ideas. These notions are variously described as; preconceptions, misconceptions, intuitions, alternative conceptions, alternative frameworks, naive theories or spontaneous reasoning. The most frequently used terms now seem to be alternative conceptions and alternative frameworks. Head (1986) defines these as follows:

Alternative conception:

simple, concrete ideas, usually based on everyday experiences.
(E.g. the sun goes around the earth).

Alternative framework:

elaborate, abstract, explanatory models. (E.g. Ptolemaic model of the solar system.)

Bereiter (1985) suggests a core belief in contemporary approaches to learning is that knowledge and cognitive strategies are actively constructed by the learner.

This has important implications for the teacher in the classroom, for if learning is seen as an active process, whereby the learner relates existing 'mental representations' to new situations in order to construct meaning, as suggested by Driver (1988), then children's prior ideas must feature in the teaching model to be used. These ideas prior to 'teaching' will obviously influence subsequent learning.

Pritchard (1989) agrees and suggests that this view sees learning as involving conceptual change. He goes on to say that in order to encourage such change, teachers need to be aware of, and value, the ideas children bring with them to the classroom.

These ideas are elaborated upon later. The Children's Learning in Science Project (CLIS), University of Leeds, has undertaken research on children's alternative frameworks on the following subjects: Particulate Nature of Matter (1984), Heat (1984), Plant Nutrition (1984), Energy (1984) and Elementary Chemistry (1986). Scott (1987) summarises the common ground constructivists would agree upon as:

1. Learning is an active process;
2. What a person learns depends not only on the learning situation, but on what the person brings to the situation;
3. Personal knowledge is constructed so as to fit with experiences in a coherent and useful way;
4. Learning in a complex field such as science involves not only adding to and extending one's conceptual structure but, perhaps, radically reorganizing it;
5. Understanding is possible without belief;
6. Some constructions, amongst others, are shared.

Previous researchers seem to have taken a snapshot of pupils' ideas and left it at that. Head (1986) states that the new conceptualisation asks how pupils' ideas start, develop and are eventually extended, altered or replaced. He identifies five ways in which pupils' ideas arise:

1. Everyday experience and observation.

Young children learn much about their environment through the handling of objects and from these experiences certain ideas are likely to develop.

2. Analogies.

In Ausubelian terms, through the use of analogies the learner can integrate the new material with their existing cognitive structures. Analogies can cause problems, however, and this will be discussed later.

3. Metaphors.

Many words used within science are used in everyday speech and this can lead to confusion.

4. Peer culture or folk wisdom.

Many children may experience problems making sense of new scientific ideas when they are in conflict with the 'folk wisdom' of their peers. The suggestion is that science teaching may be resisted because the pupil's incorrect ideas are reinforced by peer influence.

5. The innate origin of some ideas.

Head suggests that a child may be genetically programmed to handle the environment in ways which are closer to the widely reported pupil's ideas than to conventional science.

Head then goes on to ask which science topics are likely to be open to these informal ideas. He suggests that they may be those which overlap with everyday experiences and observations, in addition to those which employ misleading analogies, either directly, or indirectly through metaphorical speech.

Head raises further questions:

1. Which pupils hold informal ideas? He refers to Shipstone (1984) for research concerning the ideas held by children on a specific topic related to age.
2. Does the possession of informal ideas relate to the Piagetian stage of the pupil?

2.5.1 Piaget and constructivism

It is sometimes suggested that the Piagetian and constructivist schools of thought are in rivalry, but Head (1986) suggests that we might anticipate a developmental progression in thinking. The youngest pupils will probably display pre-operational thinking - episodic and inconsistent. Later on concrete models will dominate, and later still formal operational thinking can be recognized. The pedagogic problem is that science is not 'organised common sense', as once suggested by Thomas Huxley. Alternative frameworks are often closer to pre-, rather than post-Newtonian physics, and common sense simply does not enter into relativity or quantum mechanics.

2.5.2 Conceptual change

3. How can you change pupils' ideas?

The cognitive processes have been described by Hewson (1981), and Posner, Strike, Hewson and Gertzog (1982). Hewson suggests that before a new conception can be accommodated, four conditions need to be satisfied:

- (a) There must be some dissatisfaction with the existing conception.
- (b) The new conception must be intelligible.
- (c) The new conception must be initially plausible.
- (d) The new conception must be fruitful.

The main pedagogic conclusion coming from such works is the need to create dissonance. An analogy can be made with Kuhn's (1962) paradigm shift.

2.6 The Affective Domain

These arguments are helpful, but they all ignore the 'so what!' question. The affective domain seems to have been ignored. Head suggests that pupils may feel commitment to their existing beliefs, and points out that pupils can respond to dissonance in a number of ways. Pupils may hold two context bound ideas simultaneously, even though they are contradictory. One idea in the context of science and the other in everyday life. Also, a pupil may reject the new ideas saying 'I cannot understand science'. It appears that both the person and the learning situation are involved in changing one's mind.

Novak (1977) expounds the use of concept maps but it seems that what is also needed is the creation of a supportive atmosphere in the classroom where pupils' ideas are respected and 'wrong' answers accepted.

Shapiro (1989) agrees with Head that the affective domain is important. A case study is outlined which showed how anticipation and expectation of the science classroom guide individual thought and action during science learning. It is suggested that changes in one's ideas about natural phenomena and about science learning requires the consideration and acceptance of new expectations and anticipations of

many interweaving factors. Shapiro discusses a pupil, Mark, and comments on his ability to accept science ideas as depending on:

- (a) respect for his teacher's scientific knowledge,
- (b) sense of himself as a successful student of science,
- (c) a willingness to accept his teacher's ideas without the need to see phenomena himself
- (d) the teacher was seen as a credible authority.

Another child, Pierre, needed to 'see for himself' and the fact that he couldn't was eroding an intense interest in science. Melody had a strong social interest and often wandered around the classroom (to the teacher's annoyance) to see what others were doing and thinking. Interestingly, by the end of the unit, (on light), she was one of the students who had actually grasped some of the more difficult concepts. Yet another child was judged to be the ablest in the group. Amy always had the correct answers and came top in test, yet she never grasped the idea of reflection of non-visible light rays, nor did she understand refraction or how prism glass and light combined to form a rainbow. Shapiro goes on to show how conceptual development is guided by a variety of cognitive, social and personal features which function together in the science classroom.

2.7 Conceptual Frameworks

The previous discussion stressed the importance recent researchers have placed on the ideas children bring with them to the classroom. Millar and Driver (1987) discuss the idea that contemporary perspectives on cognition reject the view that learning is a one way process whereby the learner receives and organises stimuli from an external world. Instead, they suggest that learning is an active process in which the learner brings prior sets of ideas, schemes or internal mental representations to any interaction with the environment. In our

everyday world, we have certain expectations about what is likely to happen next when crossing the road, catching a bus, going to school etc. These expectations enable predictions to be made and thus we act in certain ways. This is also true when learners interact with physical phenomena. Certain mental representations are brought to mind which enable predictions to be made. If the prediction is verified, then the mental representation is reinforced. For example, children and adults often conceptualise heat in a substantive way and talk about heat 'rising'. Millar and Driver go on to say that in more complex cognitive tasks, such as designing an experiment, what a learner does depends not only on the features of the task, but also on the conceptual scheme used in the situation.'

Children, themselves, can be aware of the problem; to quote a 15 year-old science pupil: '*You know, teachers have got all that knowledge but we are thinking about it differently because there are so many ways you take something in.*'

Several frameworks or models for the planning of science lessons based on similar views of learning to the one advocated here have emerged in recent years; noticeably: Barnes (1976), Karplus (1977), Erickson (1979), Nussbaum and Novick (1981, 1982), Renner (1982) and Rowell and Dawson (1983). According to Renner (1982) the most common practice amongst science teachers is the passing on of content. The theory of learning underlying this approach is that the material is given to the learner as information, it is then verified by the learner and then applied in some way. Renner suggests an alternative model. His initial concern is with the pupils gaining experience. Learners are provided with suitable experiences in order to create for themselves what is to be learnt. In the second stage the learner is introduced to some suitably specific terminology and the teacher uses this to assist the learner to interpret what has been found. In the third stage the

learners' new ideas are meshed with existing knowledge in order to expand that knowledge and the new ideas. Karplus (1979), like Renner was influenced by the Piagetian theories of development and was also concerned with the cognitive development of the learner. Karplus also proposes a three stage learning cycle. The first phase is one of exploration in which the pupils are expected to raise questions which they cannot answer with their present ideas or reasoning patterns. In the second stage the concept is introduced and explained. Finally, the concept is applied to new situations and learning is achieved by repetition and practice so that new ideas have time to stabilise.

A similar model has been suggested by Nussbaum and Novick (1981, 1982). Their strategy is based on the principle that science concept learning involves cognitive accommodation to an initially-held alternative framework. Osborne and Freyberg (1987) prefer to say that the task of teaching is concerned with ascertaining individual children's conceptions about science topics and modifying these towards the current scientific view. To bring about cognitive accommodation, Nussbaum and Novick suggest the first step is to expose the alternative frameworks - not only to the teacher but also to the pupils themselves. The teacher then provides additional experiences in order to provide conceptual conflict. Accommodation develops from pupils searching for a solution to their conflicting ideas.

Erickson's (1979) proposals are similar. Firstly, the learners are exposed to a wide range of phenomena so that they might expose a set of intuitive ideas or beliefs. This stage is covered in sufficient depth to allow the learners to clarify their ideas and to develop confidence so that they may make predictions. The second stage contains 'anomaly manoeuvres', involving the creation of unexpected outcomes. The third stage involves 'restructuring manoeuvres' to assist the

learner in the accommodation of the unexpected outcomes.

These are summarised below:

STAGE ONE	Experiences	Exploration	Exposing Alternative Frameworks	Experiential Manoeuvres
STAGE TWO	Interpretation	Explanation	Creating Conceptual Conflict	Anomaly Manoeuvres
STAGE THREE	Elaboration	Application	Encouraging Cognitive Accommodation	Restructuring Manoeuvres
	Renner	Karplus	Nussbaum & Novick	Erickson

Table (2.1) Teaching Models.

Barnes (1976) also feels that learners need to take a prominent part in the formulation of their own knowledge and proposes the following sequence:

- (a) A focusing stage in which the ground is prepared and only when the attention of the class is fully focused on the topic does the teacher move on.
- (b) An exploratory stage involving much discussion and other activities.
- (c) A reorganizing stage where the teacher refocuses attention and tells the groups how they will be reporting back, and how long they have to prepare for it.
- (d) a public stage where the groups of learners present their findings to each other, leading to further discussion.. Rowell and Dawson (1983) feel that children are less threatened by an approach where 'old' and 'new' ideas are the pupils' own in the sense that all are pooled knowledge.

They suggest the following sequence:

- (a) Through questioning, the teacher establishes the ideas which children bring to the problem situation. Conscious awareness of these ideas is of value to both children and teacher.
- (b) These ideas are accepted by the teacher as possible solutions.
- (c) Children are asked to retain their ideas, and the teacher states that he or she is going to put forward another possibility which the children will help in evaluating later.
- (d) The 'new' idea is taught by linking it to the basic idea already held.
- (e) Once the new idea is available to children the old ideas are recalled for comparison, with each other and reality.

Rowell and Dawson assume that old theories are rarely defeated by contrary evidence but only by better evidence and argue that the children with several ideas available to them are in the best possible situation to accept the scientist's one when it is tested against the others. Solomon (1983), however, argues that where children's old ideas involve 'everyday notions' and new ideas involve 'scientists' explanations, pupils are likely to retain both kinds of 'knowledge'; they need to be able to think and operate in both everyday and scientific domains, but they should also be able to distinguish between them. Osborne and Freyberg (1987) contend that while this may be true for some concepts, (for example, animal, plant, living), it may not be valid for others (for example, force, electric current), where everyday notions are neither necessary for everyday communication nor useful for explanatory purposes once the scientific perspective is fully appreciated and understood. They outline a teaching model for *generative learning*. In common with the teaching models mentioned here, it has three distinctive teaching phases (focus, challenge and application),

but these are preceded by an explicit teacher preparation phase where the teacher ascertains pupils' views; classifies these, seeks scientific views, identifies historical views and considers evidence which led to abandoning old views. The pupils might complete surveys, or other activities designed to pinpoint existing ideas.

2.8 Models of Conceptual Change.

Hewson (1982) advocates the following model of conceptual change and considers what could happen to the new conception, C' , in the light of the existing conception, C . He argues that it could be rejected or incorporated in three ways:

- (a) rotely memorised.
- (b) replace C and be reconciled with the remaining conception by the process of conceptual exchange (CE), or
- (c) be reconciled with the existing conception, including C , by the process of conceptual capture (CC).

Hewson stresses that reconciliation is an important term in the model, because it is the process whereby a person makes sense of a new conception and gives it meaning by seeing it in the context of his or her prior knowledge and understanding. It is suggested that reconciling two or more conceptions implies that there are significant inferential links between them, that they do not contradict one another, that they are parts of the same integrated set of ideas and that there is consistency between them.

The table below shows the relationship between the existing conception and the conception being considered.

The abbreviations for status are:

no status: not intelligible, plausible or feasible.

I: Intelligible, but not plausible or feasible.

IP: Intelligible and plausible, but not feasible.

IPF: Intelligible, plausible and feasible.

<u>Status of conception being considered C'</u>							
	I		IP		IPF		
	Irrec. Recon.		Irrec. Recon.		Irrec. Recon.		
<u>Status of</u>	I	R	R	CE	--	CE	--
<u>existing</u>	IP	R	--	--	CC(or R)	--	CC
<u>conception,</u>	IPF	R	--	--	CC(or R)	--	CC
<u>C.</u>							

Key:

R = Rejection of C'.

CE = Conceptual exchange of C' for C.

CC = Conceptual capture of C'.

Irrec. = Irreconcilable

Recon. = Reconcilable.

Table (2.2) A model of conceptual change

For example:

If C has status IP and C' is irreconcilable with C then C' can have a status no higher than I and it would be rejected.

If C has status IP and C' can be reconciled with C, then C' would have status IP in which case it might be rejected but would probably undergo conceptual capture or it could have status IPF in which case it would undergo conceptual capture.

Hewson argues that status does not change spontaneously - it is only lowered if there is a cause for dissatisfaction and it is only raised if sources of dissatisfaction are removed and some advantage gained. The model implies that instruction should, amongst other

things, be directed at lowering the status of undesirable concepts (thereby recognising that they be known) and raising the status of desirable concepts (which often can occur only at the expense of existing conceptions).

Gilbert and Watts (1983) expound three models of how this conceptual change may occur: stepped change model, smooth change model and catastrophic change model. The latter is based on a continuous, or constructivist notion of conception, yet allows for the rapid change of conception which is called the 'Ah ha' experience. It does allow for the slow, or rapid change of conception under the impact of a constant range and number of instances. Most of all, it does offer the possibility of manipulating psychological factors which have real meaning to the individual student, as a way of promoting conceptual change.

Engel Clough and Driver (1986) examined the consistency in the use of conceptual frameworks across different task contexts and found that despite some consistency in the use of frameworks at the level of the individual student, the evidence for this is much more equivocal. For some of the ideas students were using different alternative frameworks in response to parallel questions. It appears that the importance of eliciting individual pupil's ideas throughout the teaching of different topics should not be underestimated. It appears that the teacher cannot be sure pupils are using a 'new' framework when following a different topic.

2.9 Styles of Thinking and the Affective Domain

If our teaching model is going to help all children to succeed at science, then we need not only to consider how children's ideas change, but also, how children think. The work of Pask (1972) on knowledge structures and styles of learning, together with G.Kelly's personal

construct theory suggest that individuals have preferred learning styles, i.e. an individual tends to process information in a particular manner. Kelly refers to this as cognitive style. Pask suggests that students will either take a step-by-step learning procedure leading to narrow simple hypotheses or take a more global learning strategy where the hypotheses formed are more complex and related to several characteristics of the exercise. The former Pask called a Serialist approach and the latter a Holist approach. He noted further that when students who preferred using a serialist strategy were presented with a holistic learning strategy, they scored significantly worse than when presented with a serialist approach. Similar results were obtained with students whose preferred learning style was holist, when they were presented with serialist strategies.

Millband (1984) investigating teaching styles in relation to different biological concepts found distinct patterns in children's learning of the two type of biological concept Pringle (1963) described. In this study she found that children tended to use a serialist strategy in relation to biophysical concepts and, although less distinctly so, a holistic strategy in relation to biosocial concepts. Millband used the ideas of Biosocial and Biophysical concepts as postulated by Mayr (1961, 1968) and Pringle (1963). Millband suggests that the ideas of functional biology are similar to those of the physical sciences and refers to them as 'biophysical' concepts. She also suggests that evolutionary biology, whilst being concerned with the physical make-up of organisms, emphasises their purpose where its ideas are expressed in a social context. These ideas she calls 'biosocial' concepts. Millband identifies four differences between the

two types of concepts:

Biophysical concepts	Biosocial concepts
Stable	Unstable
Additive	Holistic
Little influence from intuition	Strong influence from intuition
Low affective load	High affective load

Table (2.3) Differences between Biophysical and Biosocial Concepts

These divisions are too rigid for this study, but the distinction is a useful one. The different types of concept require different teaching approaches. Importantly, she noticed that teachers tended not to change their teaching style in recognition of the type of topic being taught. Teachers tended to use an expository style with both types of topic and with biosocial topics in particular, a more inferential style would have been more appropriate.

These findings are important because if the learning of one type of concept requires one particular strategy and another a different one, then it is disadvantageous to the student to use only one strategy for all learning situations. The problems are compounded if the student's preferred style is the one not used by the teacher. The ideal would be for the learner to be able to use both styles and to be able to switch from one strategy to another as appropriate. Pask describes this ability to switch as versatile learning. The implication is that teaching strategies must also change according to the conceptual demands being placed on the learner.

The preliminary discussion outlined the work of Head (1986) and Shapiro (1989) who argue that both the person and the learning situation are involved in changing one's mind. Different aspects of topics affect motivation, and we need to take particular care in our approach if we are going to enable all children to develop. There have been many attempts to describe cognitive styles. Lewis (1976) was

critical of the, then, current state of research into cognitive styles.

Lewis suggests that different groups of researchers seem determined to pursue their own pet distinctions in cheerful disregard for one another. There is the impulsive versus the reflective distinction, which seems to indicate something of the tempo of learning. There is the field dependent versus the field independent distinction, the serialists and the holists , and a lot more. In Lewis's opinion, the right thing to do is to focus on the search for individual differences which are basic, in the sense that they underlie (and to that extent, explain) a whole range of readily observable differences.

Entwistle (1981) comments that each style, as well as each catagory, depends to a certain extent on the particular tests or tasks used to define it. To date few interrelationships between cognitive styles have been reported, at least among children, where style, differential ability, and developmental stages are still inextricably woven. Entwistle goes on to suggest that the terms holists, serialists and versatile learners provide some integration of the otherwise

disparate styles. The table below summarises the integration:

Research Area	Integrated A + B	Developed Style A	Developed Style B	Under-Developed	Author
Learning Strategies	Versatile	Holistic or comprehension	Serialist or operation	Reproducing	Pask
Levels of ability	- Intelligent (Level III)	Divergent Imaginative -	Convergent Analytic (Level II)	- Rote (Level I)	Hudson Jensen
Cognitive Styles	- Thematic Fast & accurate -	Broad catagories Impulsive Field-dependent (Global)	Narrow catagories Analytic Reflective & cautious Field-independent (Articulated)	Descriptive Slow & inaccurate -	Walla & Kogan Kogan Witkin
Level of understanding	Conclusion-orientated detailed	Conclusion-orientated mentioning	Description detailed	Description mentioning	Franssen
	Individuation ego integration	Extravert	Introvert	-	Jung
	Reasonable adventurer	Plunger	Non-Committer	(hustler?)	Heath

From Entwistle (1981), p. 218.

Table (2.4) Styles and Strategies

There is no perfect fit, but it is possible to see that style A and style B characteristics may be general descriptions of the terms above. Out of these it seems possible to describe both different levels of abilities and different styles of thinking at the same level of sophistication.

2.10 Relationship between Cognitive and Affective Domains

So far, most of the discussion has centred around the cognitive dimension, but the crucial point is that changing one's mind is not just a cognitive act. Head (1985) suggests that it involves abandoning the security provided by the previous way of making sense of the world

and entering the confusion of the unknown before achieving a new belief. He comments that the readiness to undergo that experience is likely to be determined by personality factors more than purely cognitive ones.

Witkin's (1975) work on field dependence and independence is widely accepted as having identified an important factor in cognitive performance. He comments however that his sketchy overview has sought to demonstrate that cognitive functioning is related to personality. In fact, it seems hard to tell where cognition ends and personality begins. It appears that the affective dimension is as important as the cognitive - if not more so.

Atkinson and Raynor (1974) suggest that people have both a positive interest in achievement and a negative fear of failure. Motivation can be both intrinsic and extrinsic. Extrinsic motivation concerns motivation outside the task itself, eg. the use of rewards and sanctions whereas intrinsic motivation concerns seeing the task as relevant and interesting in its own right. If children are sometimes intrinsically motivated then it is not always necessary to start with experiences outside the classroom. We would probably agree that the teachers' aim would be to lead pupils to be intrinsically motivated. Indeed, it could be argued that teachers should expand children's experiences such that they are introduced to topics which they will find interesting, but which they might not have experienced beforehand.

Another aspect of motivation is what White (1959) has called 'competence motivation'. Competence motivation describes the way achievement enhances future performance. Allport (1963) expounds his theory of 'functional autonomy', where achievement, however fostered, will lead to self confidence, to higher motivation, and to further learning. Holt (1964) has also argued that the opposite is equally true. He says that the continuing experience of failure is demoralising, creates

hostility to school, and feelings of personal humiliation. Entwistle (1981) comments that the importance of self confidence in learning has been emphasised by many researchers. Rogers (1969), for example, has argued that the learner's self concept, his view of how well he can tackle the work given to him, fundamentally affects his approach and his understanding. Empirical support for Rogers' ideas has come from Coppersmith (1959) who has shown that children with positive self-concepts are likely to be academically more successful than children with less belief in themselves. Further discussion can be found in chapter 3.

It seems reasonable that both the cognitive and affective dimensions need to be taken into account in both curriculum planning and teaching. In this way we might be able to overcome the problems of lack of interest resulting from the feeling that science is not suitable, useful or relevant.

2.10.1 Consideration of a Range of Strategies

One way forward may be to consider a range of strategies for the teaching of science, e.g.:

- (a) Using Science - topics relevant to the pupils. E.g. spots and hygiene for 14 to 16 year olds! It is important to choose topics which will be good motivators and which are seen as useful to the youngsters.
- (b) Implications of Science - issues relating to topics such as nuclear energy, cosmetics which are considered important to young people and which are therefore seen as relevant.
- (c) Doing Science - e.g. problem solving, doing investigations, Practical work etc. where the activities are suitable for the age, ability, interests etc. of the youngsters.

It is possible that some of the above could motivate some of the

children such that all children develop their ideas and knowledge as the topic progresses, no matter where they are on the maturity/age curve.

These ideas lead to a need to find good motivators for given ages and abilities, to develop the types of activity discussed above, to define the learning pathways which could be followed (not necessarily linear, as discussed earlier) and to define the resources which could be used (people, field work, computers etc.).

2.11 Responsive Teaching Model

This needs to be placed within the framework of a teaching model, and such a model has been developed at the University of Southampton - the Responsive Teaching model (Pritchard, Buckland and Falconer 1987). This model builds on previous models. It agrees with Barnes that the first stage must be a focussing stage, but also considers the motivational aspects discussed by Head. It agrees with the importance of exposing alternative frameworks and the creation of conceptual conflict, as discussed by Nussbaum and Novick, Osborne and Freyberg and Erickson and it agrees with the importance of the application of the new ideas to novel situations as discussed by Karplus. Central to the model is the importance of the affective domain and the consideration of motivational factors as described by Head and Pask. Also of importance is the notion of the spiral curriculum, where topics are revisited. With the advent of the National Curriculum it is vital that children are provided with opportunities to revisit levels of achievement. This revisiting is an integral part of the responsive teaching

model which is outlined below:

Responsive Teaching

Stage 1 Motivation and Focusing

Activities designed to :

- (a) allow learners to recognise that a topic looked at scientifically might be relevant to their primary interests.
- (b) allow learners to talk about the topic in their own language.
- (c) allow learners to ask their own questions and seek ways of looking for answers.

Stage 2 Elicitation and recognition of ideas

Activities intended to elicit the ideas of the learners in such ways as to establish the knowledge framework they are using, and to make the children aware of their ideas and the arguments they are using.

Stage 3 Negotiation

Activities intended to engage the learners with ideas which challenge theirs in non-threatening ways (i.e. ideas more in line with current scientific views - the level of concepts introduced here being dependent on the stage of development of the learner, more complex concepts being introduced using the principle of a spiral curriculum).

Stage 4 Integration

Activities which allow the learners to apply their new or reconstructed ideas to novel situations - revisiting wider issues arising out of stage one.

Pritchard (1989) (p. 51)

(This model is a continuum with feedback, consisting of four overlap-

ping stages.)

Stage one is primarily concerned with motivation. Pupils need to talk to one another, ask questions themselves, see the relevance of the subject matter and feel a commitment to its study. Stage two is to enable the pupils, as well as the teacher, to see the conceptual structures they are using. Strategies such as brainstorming, problem solving, data analysis and explaining phenomena could be used. The teacher will also be able to ascertain the status of the existing conceptions. These activities should enable the teacher to diagnose which activities are appropriate in order to raise the status of the scientific view and to lower the status of the everyday view and not just to create conceptual conflict, Rowell and Dawson (1983). This will require negotiation - hence stage three. As discussed earlier, new ideas need to be reconciled, Hewson (1982), or *integrated* (stage four) and must therefore be applied to novel situations. Wider issues may be discussed which not only help the reconciliation process, but also revisit issues arising out of stage one. This brings the topic to completion, but could possibly show the need to re-enter the model at an earlier stage. This model has been called Responsive. The teacher must respond to the needs of the pupils, and these needs will change as teaching progresses. The general approach outlined here has been tried at a 12 - 16 boys' comprehensive school within the city. The model was not rigidly adhered to in the early stages of the project, but the aspects of elicitation and integration of ideas, with continual dialogue between students and teachers was paramount throughout. The elicitation of ideas was felt to be crucial by the teachers because it seemed to enable a 'diagnosis' of the individual child's conceptual understanding. The ensuing negotiation phase was difficult to manage for some teachers, and yet natural for others. Activities to enable the child to apply their new ideas were then given. Within a 'normal' teaching

group, this would mean that different children would be at different stages of the Responsive Teaching process at any given time.

2.12 Preparation of a Scheme.

A central feature of the teaching model is the continual dialogue between teacher and learner. Through this dialogue the teacher is able to ascertain the level of understanding of the learner and hence diagnose the next most appropriate activity. If the scheme of work for the module has been written carefully, then there will be opportunities for the learner to either:

- (a) proceed through the scheme of work.
- (b) undertake some 'overlearning' activity.
- (c) undertake some 'extension' activity.

Overlearning activities were written with the expectation that some learners will have particular misconceptions. For many of these the work of the APU and CLISP was very helpful. Particular examples will be given when the scheme is discussed in detail. Also, the experience of the teachers were used to plan both overlearning and extension activities. Overlearning activities were designed with the intention of 'putting right', where the learner is guided to discover the misconception for himself, or is asked to undertake an activity to discover which view is correct; the existing conception, or the conception being considered. Similarly, extension activities were designed to enable the more able learners to explore phenomena more deeply or to revisit wider issues. Both overlearning and extension activities were written with the help of the Special Needs teachers at the school and the Special Educational Needs Advisory and Support Service (SENASS). During the early stages of the science department's development the overlearning and extension work occurred 'on the hoof'.

As would be expected, some staff found this easy to manage whereas others found it more difficult.

The model used is summarised below:

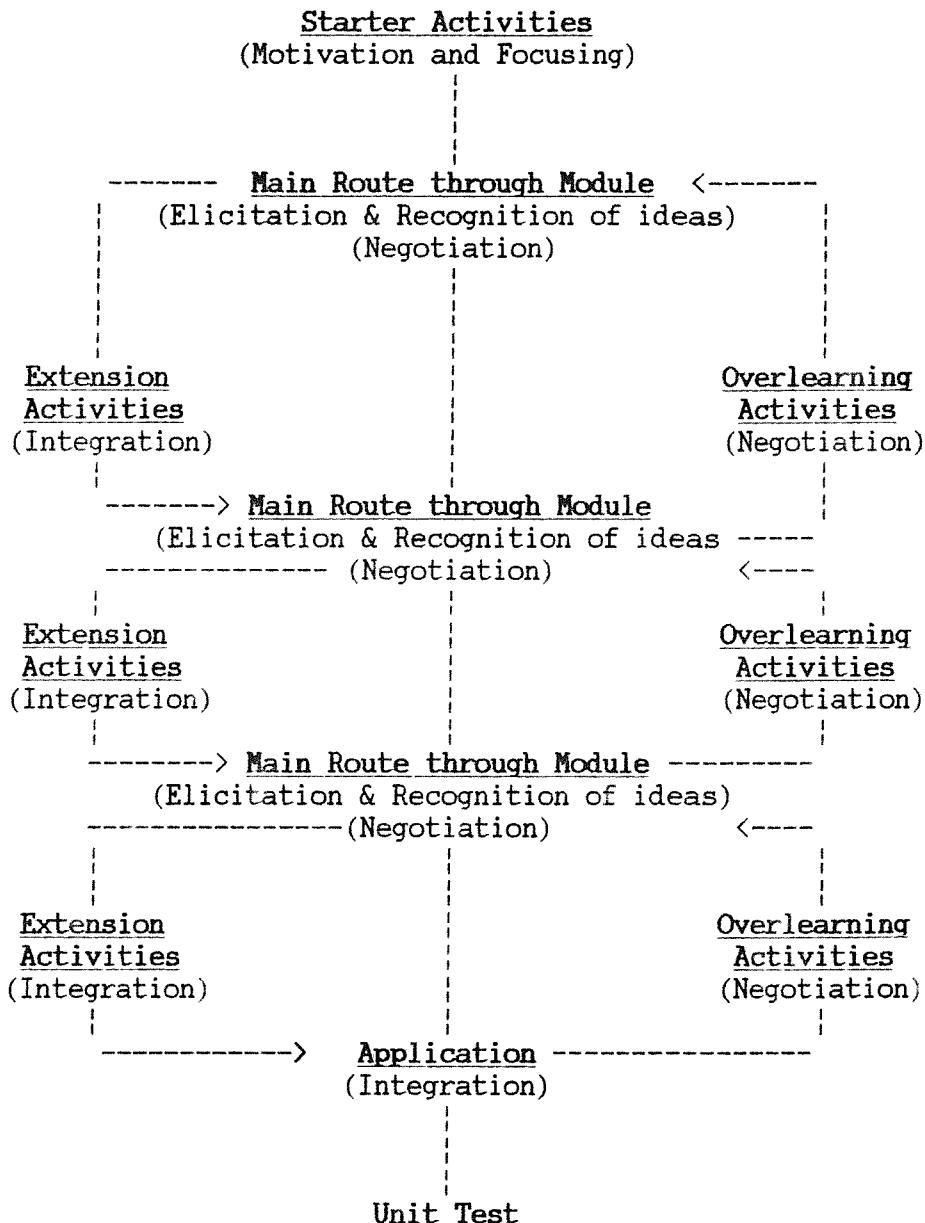


Fig (2.1) Responsive Teaching Model

In the above diagram, an attempt has been made to show the feedback which is inherent in the responsive teaching model. With the necessity to record attainment according to National Curriculum criteria and the requirement to enable pupils to revisit levels of attainment the cyclical nature of the model is vital. Also, it could be that pupils needing overlearning help will miss out on important aspects of the

module being taught. The Integration phase of the model is where learners apply their new or reconstructed ideas to novel situations - revisiting wider issues arising earlier, at an appropriate level of competence.

The model appears to provide opportunities for:

- (a) meaningful learning to take place.
- (b) assessment and recording of National Curriculum attainment.
- (c) revisiting levels of attainment.
- (d) extension work where appropriate.
- (e) overlearning work where appropriate.
- (f) a range of strategies to be used.

2.13 Some Evidence to Support the Success of the Approach

During the initial exploratory stage of the science departments's development, the anecdotal evidence for the success of this approach was as follows:

Schemes of work were written bearing the responsive teaching model in mind. The students were entered for either the SEG Double Award: Applications and Principles examination, or the SEG Science examination (single award). The results appeared to be significant.

When the GCSE results were compared with the cognitive ability test scores for the pupils, it appeared that the school had an almost national average, normal distribution intake of ability. The top 2%, however, were missing and it was thought that these boys attended the independent grammar school half a mile away. The examination results for the summer 1990 showed that 66.9% of the grades were Higher Grades (in the range A to C).

The national averages for the summer 1990 Science examinations were: 40.5% of candidates gained Higher Grades for Science at GCSE and

47.8% of candidates gained Higher Grades for all sciences at GCSE, ie including separate Sciences.

The results for 1991 and 1992 were similar and analysis showed that the GCSE results of the science department were better than those in other subjects in the school. It was clear that individual pupils gained, on average, higher grades in science, than their other subjects. This was considered significant and was thought worthy of investigation. This theme is discussed in more detail later in this thesis.

CHAPTER III

MOTIVATION, SELF CONFIDENCE AND ACHIEVEMENT

3.1 Introduction

Chapter two discussed briefly the role of the affective dimension in cognitive performance. It seems pertinent to develop this further.

3.2 Exemplary Practice.

Tobin and Fraser (1990) undertook a series of case studies of exemplary practice to provide a focus on the successful and positive facets of schooling. They found that exemplary science teachers:

1. Used management strategies that facilitated student engagement.
2. Used strategies designed to increase student understanding of Science.
3. Utilised strategies that encouraged students to participate in learning situations.
4. Maintained a favourable classroom learning environment.

It is worth looking at this in more detail. Typical characteristics of exemplary practice were:

- (a) Easy flow from one activity to the next. Little time lost in transmission, few instances of student misbehaviour or time off task.
- (b) Well managed.
- (c) Students know what to do and how to do it.
- (d) Teachers monitored student engagement, and when off task behaviour occurred, they quickly and quietly spoke to the individual in a manner that did not disturb the work of the others.

- (e) Teachers had time to consider what to do next and to reflect on the lesson as it progressed.
- (f) Teachers had a concern for assisting students to learn with understanding.
- (g) Teachers encouraged active engagement of all students.
- (h) Questions were used to focus student thinking.
- (i) Sufficient and appropriate resources were available, and students were given enough time to complete assignments.
- (j) The teacher positively acknowledged the contribution of all pupils.
- (k) The teacher summarised pupil responses, corrected misunderstandings and indicated when responses were incorrect.
- (l) Safety nets were used.
- (m) Students were treated with the utmost respect.
- (n) The teacher endeavoured to work from a given answer to the understanding that he wanted a student to have.
- (o) Explanations given were clear and appropriate.
- (p) Analogies and examples from outside the classroom were used.
- (q) Teachers anticipated areas of content that were likely to provide students with problems

It is felt, however, that two of the above characteristics, namely:

- (k) The teacher summarised pupil responses, corrected misunderstandings and indicated when responses were incorrect, and
- (n) The teacher endeavoured to work from a given answer to the understanding that he wanted a student to have.

show that the methodology described by Tobin and Fraser is at odds with the constructivist methodology described in this study. Correcting misunderstands, indicating when students were incorrect and leading students to the 'correct' answer may not lead students to increased

self confidence and greater understanding. A pertinent question might be; what about the student who always gets it wrong? However, many of the characteristics above are helpful and may prove useful in the field operational phase of the research.

3.3 Interest and Cognitive Performance

The work of Hidi (1990) is particularly pertinent because she argues that interest is central to determining how we select and persist in processing certain types of information in preference to others. She presents evidence to show that both individual and text-based interest have a profound effect on cognitive functioning and the facilitation of learning, and she suggests that processing interesting information involves elements that are not present in processing information that lacks such interest. The table below summarises selected examples of individual interests:

3.3.1 Some Examples of Studies Concerned with Individual Interest

Study	Grade	Findings
Estes & Vaughan, 1973	Fourth	Personally interesting passages lead to superior performance on tests involving retention and inferencing
Asher, 1979, 1980; Fifth & Sixth	Superior Comprehension of passages written on high interest topic.	
Asher, Hymel & Wigfield, 1978;		
Asher & Markell, 1974		
Fransson, 1977	College students	Superior comprehension and recall of interested and personally affected students.
Nenniger, 1987	Fifth & Sixth	Content oriented motivation towards mathematics is affected by interest in mathematics.
Prenzel, 1988	College students	Students who develop interest in a subject will re-engage and persevere in subject related activities.
Renninger, 1987; Renninger & Wozniak, 1985	Young children (about 3 years of age)	Objects of interest as opposed to non interest affect children's attention memory and representation of possibilities for play action.
Renninger, 1988	Fifth & Sixth	Individual interest influences comprehension of passages and mathematical set problems.
Schiefele & Krapp, 1988	College students	High interest produces qualitative knowledge difference in learning.

From Hidi (1990), p552.

Table (3.1). Some Examples of Research on the Effect of Individual Interests on Cognitive Performance.

Interest clearly has a role to play in enabling children to focus their minds on the conceptual issue being taught. It is possible that an interest in a subject facilitates higher cognitive understanding which builds self confidence, which leads to greater interest etc.

Hidi (1990) goes on to discuss further questions, eg. why does a person become interested in information in a particular domain?

Renninger (1989, 1990) especially emphasises that individual interest always involves stored knowledge and value and may or may not be a psychological state of which the individual is reflectively aware. Here

knowledge refers to cognitive representations stored from past experience, value refers to related affective responses, such as a feeling of competence. Hidi (1990) suggests that according to this view, individual interests and related knowledge are interdependent factors that develop hand in hand and influence how the individual engages in current as well as subsequent tasks. A teacher cannot possibly engage each individual child's personal interests all the time. It is also possible that the conceptual area under discussion might not have been within the child's sphere of experience. It is reasonable to assume that part of the role of the teacher is to introduce new topics and ideas to pupils. Interest, however seems to be an important parameter in enabling children to focus their minds and could well lead to superior comprehension as well as fuller, more adequate and more creative responses. (See Bernstein, 1955). What is particularly interesting for this study, is a discussion detailing sentences that have been found to generate text-based interest. The table is given below:

3.3.2 Some Examples of Studies Concerned with Text Based Interest

Anderson, 1982; Anderson, Shirey, Wilson & Fielding, 1986; Shirey & Reynolds, 1988.	The huge gorilla smashed the bus with its fist.
Garner et al., 1989.	When a click Beetle is on its back, it flips itself into the air and lands right side up while it makes a clicking noise.
Garner et al., 1989.	When a fly moves its wings about 200 times a second you hear a buzzing sound.
Hidi & Baird, 1983	No advertising is allowed on Swedish television, and there are no commercial stations.
	Adult wolves carry food home in their stomachs and bring it up again or regurgitate it, for the young cubs to eat - the wolf version of canned baby food.
	Thomas Edison became the most famous inventor of all time even though he left school when he was only six years old.
Hidi & Baird, 1983; Taylor, 1980.	A canary can also bluff by playing dead. A frightened canary may go limp in someone's hand.
Wade & Adams, in press.	The battle of Trafalgar was the greatest naval victory in British history, and it was the war for Great Britain.
	She (Lady Emma Hamilton) fell in love with the battered, one-eyed, one-armed naval hero and became his mistress.

Table (3.2) Some Examples of Sentences that have been found to Generate Text-Based Interest.

Even though the examples relate to texts, it is possible that the phraseology used by the teacher with children could have an impact on their potential interest in the area under discussion and their confidence in tackling new work.

3.4 Motivation

The work of Coppersmith (1959), Rogers (1969), White (1959), Entwistle (1981), Allport (1963) and Holt (1964) has been outlined in chapter two. There the importance of self confidence leading to higher motivation was outlined. Schunk (1990) introducing a number of articles concerned with motivation and efficacy agrees and stresses the idea

that motivation and efficacy are interacting mechanisms that include learner, social and instructional variables. It is suggested that an initial sense of efficacy for performing well can motivate learners to act in ways that enhance performance. As students perceive their progress, their sense of efficacy is validated, which sustains motivation. If this can be managed, then it could be a powerful tool in the hands of the teacher. Interestingly, this was discussed by teachers in the interviews, (see appendices).

3.4.1 Weiner's Attributional Theory

Reyes (1984) discusses motivation further and comments on the work of Weiner (1979, 1985). According to attributional theory, reasons for academic success and failure can be categorised according to the dimensions of locus, stability and controllability.

These terms will be explained:

Locus: refers to whether an attribution is to a cause within the individual, (eg ability or immediate effort) or to a different individual or source, (eg. help from others or task difficulty).

Stability: deals with whether an attribution is stable over time. In general, attribution to stable causes have a greater influence on student's motivation than do attributions to unstable causes because the student can expect stable causes to result in similar amounts of success or failure in the future. For example, blaming failure on lack of ability often results in poor motivation because ability is not likely to change dramatically and thus effort cannot overcome this cause for failure.

Controllability:

also has considerable implications for motivation. Effort is generally controllable whereas ability and task difficulty are not. When uncontrollable causes are blamed for failure, motivation is generally poor because the student feels there is little that he or she can do to increase his or her chances of success. (Eg: Blumfeld at al, 1982; Weiner, 1979, 1984; Wittrock, 1986.)

3.4.2 Classroom Climate**3.4.2.1 Performance Goal and Mastery Goal Orientation**

The teacher, as manager of the classroom could use the above to influence the orientation of the classroom climate. Ames (1988) talks of the distinction between performance goal orientation and mastery goal orientation. With performance goal orientation, there is a concern with being judged able, and one shows evidence of ability by being successful, by out performing others, or by achieving success with little effort. A performance goal reflects a valuing of ability and normatively high outcomes. With mastery goal orientation, importance is attached to developing new skills. The process of learning itself is valued and the attainment of mastery is seen as dependant on effort.

3.4.2.2 Effect of Emphasis on Performance

There is considerable evidence to suggest that classroom climate can affect the salience of specific goals. Children adapt to this, perhaps unknowingly, and different patterns of cognition, affect and performance are found. (Eg: Ames, 1984; Ames, Ames and Felker, 1977; Covington, 1984). Ames (1990) suggests that when social comparison has been made salient students focus on their ability, and their self perceptions mediate performance and affective reactions to success and

failure. By contrast, when absolute standards, self improvement, or participation have been emphasised, students have focused more on their effort and task strategies.

3.4.2.3 Mastery Orientated and Learned Helpless Students

Reyes (1984), talks of mastery-orientated students and learned-helpless students. Mastery-orientated students blame their failures on unstable causes (eg. lack of effort or bad luck) and therefore do not worry that failure is inevitable. Learned-helpless students often attribute failures to the stable, uncontrollable internal factors of lack of ability and attribute their success to external, uncontrollable factors of any easy task or good luck. It is possible that such attribution could lead learned-helpless students to see little hope for academic success. (Eg: Covington & Berry, 1976; Diener & Dweck, 1978; Weiner, 1979, 1984).

3.4.3 Relationship between Goal Structure and Students' Motivation

Reyes (1984) comments that self confidence in learning mathematics is probably related to cognitive processing about success and failure on the part of the students. There seems, then, to be considerable evidence to suggest that classroom climate could have a significant effect on students' self confidence and motivation. Ames (1988) suggests that a mastery, but not performance, structure provides a context that is likely to foster long term use of learning strategies and a belief that success is related to one's effort. Similarly, goal setting interventions that are aimed at getting students to establish realistic but challenging goals may be further enhanced when a mastery structure is in place. If students have, as a result of accumulated experiences, adopted a belief that they are not able, then modifying the goal structure of the classroom in such a way that mastery goals

are salient could improve the students' motivation.

3.5 Responding to Diverse Pupil Groups

The problem for the teacher is that different students have different needs. This poses a difficulty for the teacher if the teacher is to attempt to meet the diverse needs of the individual pupils.

Referring to Millband's (1984) work on teaching style, and using her categories for convenience, it is possible that the teacher needs to be aware of his or her style, strengths and weaknesses, the conceptual demands being placed on the students, the scheme of work and the student's needs in order to be able to switch from one style to another, perhaps in the same class. In other words, to be a *versatile* teacher. The table below summarises comparisons between the two styles discussed in her work.

3.5.1 Expository and Inferential Teaching Style

EXPOSITORY : STABLE	INFERENTIAL : UNSTABLE
1. Teacher subject centred approach	Subject social context approach.
2. Demonstrations, little use of film	Use of film, few demonstrations.
3. Teaching working in curriculum area which is convergent: simple and correct outcomes.	Teacher working in curriculum area which is divergent: unpredictable outcomes.
4. Teacher working in areas of knowledge inside own specialist qualifications: instructional.	Teacher working in areas of knowledge outside own specialist qualifications: reserve instructional.
5. Teacher dominant role: pre-determined guidance.	Teacher-pupil shared roles: responsive guidance.
6. Teacher in control of sequencing information.	Teacher delegates control whenever Few instances of side-sequencing and wherever possible. Many side sequences.
7. Openly didactic 'telling': imparts information.	Resorts to heuristic methods 'not telling': encourages self directed enquiry.
8. Communication viewed from one side, that of teacher.	Communication viewed from the side of the receiver.
9. Monologue predominant, few questions and few responses. Little pupil contributions.	Few monologues, high level of pupil participation.
10. Precise terminology: teacher verbally organises the work.	Ambiguous and confused terminology. Random system in the words.
11. Frequent use of factual statements.	Frequent use of statement of ideas.
12. Closed factual questions. Many subject-centred question and answer sequences.	Open questions. Emphasis placed upon ideas.
13. Teacher shows that facts are coherent and connected.	Facts are seemingly unconnected.
14. Hierarchical arrangement of concepts.	Variable arrangement of concepts.

From Millband (1984) p 33.

Table (3.3). Comparison between each Style of Teaching and the Stable/Unstable Characteristics.

Millband (1984) goes on to show a comparison between each style of teaching and the additive/holistic characteristics:

EXPOSITORY : ADDITIVE	INFERENTIAL : HOLISTIC
1. High definition control: verbal exchanges.	Low definition control: verbal exchanges.
2. True/false question and answers.	Hypothetical statements, descriptions.
3. Each constituent concept reductionist, treated as a discrete part of conceptual structure.	Each constituent concept holistic, independent of an invariable arrangement.
4. Linear pattern.	Branching programme.
5. High concept loading.	Low concept loading.
6. High correlations of presentation of concepts with time.	Low correlations of presentation of concepts with time.
7. Additive role of instruction.	Cyclical methodology.

Table (3.4) Comparisons Between each Style of Teaching and the Additive/Holistic Characteristics.

3.5.2 The Idea of the Versatile Teacher

For the teacher to be *versatile* he or she would need to know when to switch. For example, High definition control with one group of children to hypothetical discussions with another group. Reductionist explanation to one child followed by a branching discussion with another and so on. The researcher is proposing that it is this versatility which is inherent in teaching responsively. It is proposed that if the teacher can meet the diverse needs of the children in his or her care then the children should have greater confidence in articulating their ideas and hence greater understanding and knowledge than if a more traditional teaching approach is used. It is also possible that by meeting the needs of the children in this way then the children might be helped to focus their minds on the conceptual issue being taught and that there might be less 'off task' behaviour.

3.6 The Maintenance of Order in the Classroom

Before turning to the research methodology it might be useful to

look at some of the work which has focused on how order is achieved in the classroom. Fry (1984) outlines research where he, and his associates explored the possible effects of classroom environments and classroom processes on problem and non-problem children's behaviour and motivations. He lists eight teacher behaviours and seven student behaviours which are given below:

3.6.1 Teacher Behaviours

1. Positive affect:

Teacher behaviours that show support or positive regard for students and their behaviour, including such behaviour as smiling, joking, reinforcement and praise.

2. Negative affect:

Verbal or non-verbal behaviours reflecting hostility or negative feelings of the teacher. This category includes negative teacher evaluation of student behaviour, expressing anger or criticism.

3. Social contacts:

Contacts that are non-academic in nature but initiated by the teacher as a means of exchanging greetings or conveying some personal message.

4. Teacher-initiated problem solving:

The degree to which the teacher addresses questions and problems to the individual student. This category includes high level synthesis questions requiring reasoning, interpretation of materials or abstract thinking on the part of the student.

5. Random, memory or fact questions:

Questions requiring brief factual answers. The student responds from rote memory.

6. Convergent-evaluative interaction:

Teacher behaviour in this category is directed towards obtaining a correct answer, with little or no attempt to follow up on the contact, once the response has been made.

7. Sustaining feedback:

This category includes several sequences of events in which the teacher provides sustained response opportunity to the student if the first response is not correct, or incomplete or unclear.

8. Personal questioning:

In which students are required to give their personal views and preferences.

3.6.2 Student behaviours

1. Level of sustained attention:

Or absence of attention. This category rates the overall quality of orientation towards the teacher or task in hand.

2. Call outs:

Response opportunities created by students calling out answers to questions without getting teacher's permission.

3. Mild misbehaviour:

Behaviours judged to be inappropriate but not disruptive; behaviours that involve students talking to, or visiting each other.

4. Serious misbehaviour:

Students' behaviours that are inappropriate and very disruptive to the class.

5. Student-initiated questions:

Questions that students, rather than teachers, initiate publicly.

6. Pupil to pupil interactions:

Substantive pupil utterances in which one pupil interacts with another pupil, a group of pupils, or responds indirectly only to the teacher.

7. Passive behaviour:

The extent to which pupils engage in passive, as opposed to active, models of behaviour. Passive behaviours include withdrawal by pupil from engagement, visual wandering, and passive observation.

3.7 Problem and Non Problem Children's Behaviour

Fry was mainly concerned with conduct disorders and personality disorders. Conduct disorders included seeks attention; disruptive (eg: annoys and bothers others, fights, has temper tantrums); is disobedient (eg: difficult to control, uncooperative in group situations); is negative (eg: tends to do the opposite of what is requested); is impertinent; always blames others; is deliberately cruel to others. Personality disorders included repetitive speech; incoherent speech; expresses strange, far fetched ideas; expresses beliefs that are clearly untrue (delusions); tells imaginary things as though true; unable to tell real from imagined; repeats what is said to him or her; parrots others' speech.

3.7.1 Problem Children

These categories are useful and will help in the discussions later concerning the field operational phase of the research. What is particularly interesting is Fry found that problem children, over a four month period:

- * received more negative affect from teachers.
- * obtained fewer social contacts from them.

- * were asked less frequently by their teachers to express their personal views and preferences on academic and class-related issues.

3.7.2 Non-Problem Children

By comparison, non-problem children received a more positive orientation to their intellectual capabilities from their teachers.

Non-problem children:

- * were asked more complex, higher level cognitive questions by their teachers.
- * received more sustained contact and feedback.
- * were given more opportunities for individual interaction.

3.7.3 Comparison of Problem and Non Problem Children's Behaviour

With respect to student behaviours, a comparison of problem and non-problem children showed that problem children:

- * engaged in greater frequency of serious misbehaviours.
- * had fewer instances of sustained attention in the task on hand.
- * showed more passive withdrawal behaviours (for example, preoccupied look; doodling, drowsy; not wide-awake, avoiding eye contact; preferring solitary activity).

3.7.4 Effect of Teachers' Perceptions on Pupils' Behaviour

What is particularly interesting for this study is that Fry found that teachers reacted to children according to their initial perceptions. The study was undertaken from January to April. Fry found that in January, positive affect was extended equally to both problem and non-problem children, but that by April their patience was wearing rather thin, especially with problem children who were being more frequently criticised. Teachers were observed to be expressing more

anger and annoyance toward problem children. Similar variations in social contacts were observed. The number of social contacts decreased over the four month period, as did the frequency of sustained feedback they provided to students. A substantial amount of this decline was observed with respect to problem children. It seems as though the teachers' relations became more negative toward their students, especially so towards the problem children.

3.7.5 Deterioration in Behaviour as the Term Passed

At the beginning of January more problem children, compared to non-problem children, had engaged in 'call outs' and conversation with other pupils independently of the teacher but by the end of the term, more non-problem children had also begun to engage in substantive utterances and responses directly with other pupils without the teacher's consent. At the same time it was observed that the number of serious misbehaviours also increased over the four month period. This occurred among both the problem and non-problem children, but the trends were most pronounced for problem children during the months of March and April. It suggests that the problem children, in particular, had become much less sensitive to the teacher's expectations of good behaviour and orderly conduct. Fry also noticed a decline in sustained attention, and once again, the effect was more noticeable amongst the problem children. This could have been due to the decline in sustained feedback and positive interactions on the part of the teachers.

3.8 Some other Studies Concerned with the Impact of Teachers' Expectations and Pupil Behaviour

The work of Schunk (1990) was outlined earlier in this chapter but it is useful to reiterate it here. He stresses the idea that motivation and efficacy are interacting mechanisms. The work of Coppersmith (1959), Rogers (1969), White (1959), Entwistle (1981), Allport (1963)

and Holt (1984) has been outlined on chapter two. There, the importance of self confidence leading to higher motivation was outlined. The work of Fry (1987) outlined here supports the above studies and perhaps the teacher, through his or her actions (both consciously and unconsciously) can help (or otherwise) children to focus their minds on the conceptual area of interest and to build their self confidence at articulating their ideas. Fry's work gives clues as to the way in which the teacher may be able to achieve this. There is convincing evidence from studies such as Cornbleth, David and Button (1974) and Rubivits and Maehr (1971) which shows that teachers' positive and negative expectations and labelling of children do indeed affect student behaviour and produce inequalities in teacher-pupil contacts and the quality of intellectual and cognitive interactions. It is possible that teachers, after forming initial assessments of pupils' behaviour of performance transmit their perceptions through a complex series of verbal and non-verbal cues to the students. For example, Brophy and Good (1970) showed that students received differential praise, according to their teachers' perceptions; Rothbart, Dalfren, and Barrett (1971) found that teachers gave greater attention to pupils labelled as bright. Similarly, Garner and Bing (1973) noted that different levels of teacher contacts were received by children perceived as being 'active', 'bright' and 'personable', as opposed to children perceived as being 'dull' or 'misbehaved'. Fry (1987) comments that teachers appear to respond differentially to students according to the perceptions they hold of individual students being well behaved or having conduct problems. This differential treatment seems to result in a distinct deterioration in pupil behaviour and sustained attention of the children perceived to be 'dull' or 'misbehaved'. These children received more negative affect and less sustaining feedback from their

teachers over the course of four months.

3.9 Openness and the Social Climate of the Classroom

There is a large body of literature (for example, Bennett (1976), Marshall (1981), Solomon and Kendall (1979)) which has considered the positive and negative effects of 'openness' in the social climate of the classroom. Their research recognises that different components of openness may exist in varying degrees in different classrooms. Wright (1975) notes that the implicit assumption is that 'openness' in the social climate of the classroom generates more self directed learning, stimulates greater creativity and independence, and thus provides the foundation for greater social-cognitive growth and development in children. 'Openness' in the social climate of the classroom is viewed by Walberg and Thomas (1972) as having four important dimensions:

- * Openness in provision,
- * Open instruction, guidance and extension of learning,
- * Humaneness, respect and warmth,
- * Assumptions of interest and involvement in children.

The Walberg-Thomas scale, as adapted by Fry and Addington (1984) is shown below: (Note that * indicates negative coding).

Openness in Provisioning for Learning:

Manipulative materials are supplied in great diversity and range with little replication, that is, not class sets.

Children move freely about the room without asking permission.

Talking among children is encouraged.

The teacher does group children by ability according to tests or norms.*

Children generally group and re-group themselves through their own choices.

Open Instruction, Guidance and Extension of Learning:

Teacher bases her instruction on each individual child and his or her interaction with materials and equipment.

The work children do is divided into subject matter areas *

The teacher's lessons and assignments are given to the class as a whole. *

Teacher bases her instruction on curriculum guides or textbooks for the grade level she teaches.*

Before suggesting any extension or redirection of activity, teacher gives diagnostic attention to the particular child and his or her particular activity.

Humaneness, Respect, Openness and Warmth.

Children use 'books' written by their classmates as part of their reading and reference materials.

The environment includes materials developed or supplied by the children.

Teacher takes care of dealing with conflicts and disruptive behaviour without involving the group.*

Children's activities, products and ideas are reflected abundantly about the classroom.

Assumptions About Children and Learning Process.

The emotional climate is warm and accepting.

The class operates within clear guidelines made explicit.

Academic achievement is the teacher's top priority for the children.*

Children are deeply involved in what they are doing.

Table (3.5) Dimensions of Openness Adapted from the Walberg-Thomas (1972) Scale. Fry and Addington (1984)

It is felt that the categories above are too limiting for this study, but that many of the characteristics might be present, at times, in a classroom where the teacher was teaching 'responsively'. For example; children moving freely about the room; talking amongst the children encouraged; the teacher gives diagnostic attention to the particular child before suggesting any extension or redirection of activity; children's activities, products and ideas are reflected abundantly about the classroom; the emotional climate is warm and accepting; the class operates within clear guidelines made explicit and children are deeply involved in what they are doing. It would seem that characteristics such as these would suggest a positive atmosphere where the teacher valued the children. This is considered to be important, but if the teacher is attempting to respond to the needs of diverse pupil groups, then it might be appropriate, on occasions, for the teacher to be rather more 'traditional', or particularly authoritarian, than is suggested here.

3.10 The Effect of Sustained Feedback on Pupil Motivation

A key component of the above could be the teacher listening to children's ideas about their science and responding to those ideas. The work of Fry and Addington (1984), Fry (1983) and Fry and Coe (1980) leads Fry (1987) to suggest that student-teacher 'dialoguing' interactions help the teacher to provide students with opportunities for sustained response and sustained feedback. As has been outlined earlier, this sustained response and feedback can have a marked affect on student motivation - not only in terms of limiting 'off task' behaviour but also in terms of sustained attention to the task in hand.

The researcher suggests that it might be appropriate to consider how these characteristics may play a part in helping children to focus their minds on the conceptual area of interest and in the building and

maintaining of their self confidence. It will be necessary to consider the quality of the questioning during lessons, the balance of pupil initiated and teacher initiated discussion together with both positive and negative motivational factors.

3.10.1 Some Observable Characteristics Associated with Positive Motivation in the Classroom

Considering the discussion above, it would seem appropriate to think of the positive motivational factors in terms of positive affect. For example, sustained contact, opportunities for individual interaction, sustained feedback, warm and accepting climate, and the asking of higher level cognitive questions. It is suggested that this positive affect could be observed in terms of:

Category	Observable Characteristic
sustained contact,	Accepts and Uses the ideas
Individual interaction	of
Diagnostic attention	pupils.
Sustained feedback &	Encourages pupils &
Warmth and accepting	Praises pupils.
Asking higher level questions.	Open questioning.

Table (3.6). Some observable characteristics associated with positive motivation in the classroom.

Open questioning is discussed in detail in chapter five.

3.11 Initial Consideration of Negative Motivational Characteristics

Children will clearly need reprimanding at times. It is suggested, that the question is whether the reprimanding is reasonable or whether

it is unnecessarily excessive. Similarly, as discussed earlier, it is reasonable to assume that teachers transmit their perceptions through a complex series of verbal and non-verbal cues and that non-verbal cues should not be discounted. The teacher, by definition, is in a position of authority. How the teacher exercises this authority could be an important factor in how children respond to the work before them. It is suggested that a negative motivational factor could be the use of unnecessary and excessive authority. In essence, this is negative affect; the opposite of the characteristics listed above. The way in which teachers use their authority to manage the classroom situation could well have an impact on the climate of the classroom. This, together with the ignoring of pupils, could well have an impact on the effectiveness with which children focus their minds on the conceptual issue being taught. These factors are discussed at greater length in chapter five.

3.12 The Establishing of Order and Classroom Management

The work of Doyle and Carter (1987) is particularly interesting for this study. They attempt to explain more fully the procedural knowledge and interpretive processes teachers use to manage classrooms successfully. They found that there were at least two factors which contributed to the early stabilisation of order in the first few weeks of the school term. This was particularly noticeable during seat-work segments:

3.12.1 Initial Order and the Emphasis on Getting Work Done

1. Successful managers gave precise instructions for doing the work, often going over the first few items of an exercise during the introduction to the work. The teachers would then move around the room checking to see whether students were doing the exercise properly and

urging slower students to get started. Contacts with individual students were very brief as teacher attention was distributed widely across a class. The teachers even gave answers to students who were having trouble completing the assignment. In other words, the teacher's presence was announced continuously, and the emphasis was on getting work done.

It is interesting to note that after a month or so, this hovering and ushering declined and there was a 'settling in' to work routines. The teachers were less active as organisers and conductors during seat-work segments and spent more time with individual students. Less successful managers seemed to make this shift to individualised attention prematurely and had more difficulty sustaining seat-work segments.

3.12.2 Deferring Minor Rule Violations and Private Reprimands

2. It was also noticed that successful managers blocked any event or incident that might interrupt the flow of activity or break the rhythm of the class. During public presentations, for example, they tended to defer interruptions caused by students' questions ('We can take care of that later.') or ignore rule violations that did not disrupt the activity (for example, gum chewing), until transitions or seat work so that disciplinary contacts were less public. Doyle and Carter noticed that successful managers seemed very reluctant to have public confrontations over misbehaviour. In classes where students often tried to misbehave, the more successful managers would often ignore minor inappropriate actions such as talking or calling out answers, and push on with activities even though some rules were eventually never enforced. Less successful managers, on the other hand, often readily accepted interruptions and frequently attended to rule violations even if such attention stopped the flow of activity.

3.12.3 The Direction of Public Attention to Activity Rather than Rule

Violations

One teacher in the study provided a particularly interesting case of activity management. In one class, there was a small group of boys who frequently initiated misbehaviour and ignored the teacher's reprimands. Moreover, these students joined one another quickly whenever an incident of misbehaviour began. There was, in other words, a rapid 'spread of effect' for inappropriate and disruptive behaviours. The teacher appeared to respond to this situation by pushing ahead with activities, talking continuously about work, and hovering over seat-work assignments. In addition, she ignored the misbehaviour of the small core of disruptive students and reprimanded less serious offences by students who were more likely to cooperate. In effect, she focused public attention on activities and protected these activities from misbehaviour by excluding the disruptive students and preventing other students from joining their ranks. In fact, the original core of disruptive students eventually became involved in academic work, and ratings of indicators of management success showed improvement.

It appears that successful managers directed public attention in classrooms to activities rather than misbehaviour. These teachers seemed to prefer handling misbehaviour privately in order to maintain the rhythm or flow of class events. When faced with situations which were difficult to manage, they pushed ahead with the activity system and protected it by ignoring misbehaviour and raising their threshold for accepting rule violations. Doyle and Carter conclude that this approach appeared to contribute to achieving and sustaining order.

3.12.4 Orderliness in the Classroom does not Necessarily mean that Students will Learn

In the same study one teacher had high achievement and low ratings of order and management success. This teacher used many of the practices of less successful managers. Openings of lessons were slow and there was a looseness around the edges of activities. Inappropriate behaviour was high and the teacher seldom attended to details. Yet, the teacher appeared to push students through the curriculum. In addition, she frequently graded assignments in class either by herself or in whole class checking sessions. A similar picture of pushing students through the curriculum was apparent in another teacher's low-achieving class. The teacher often seemed to tolerate more inappropriate behaviour than she wanted but continued to direct attention to content and held students accountable for their work. Doyle and Carter (1987) comment that this combination of low management success and high achievement gain is probably unusual. Nevertheless, they say, it does call attention to a potentially important connection between management and curriculum. It appears that orderliness does not necessarily mean that students will learn, especially if teachers abandon the curriculum to stop misbehaviour and maintain cooperation in activities.

3.12.5 Some Characteristics of Successful Classroom Managers

They suggest that successful managers were able to:

1. Construct lessons that fit the externally-paced schedule of the school day.
2. Use activities that have a clear programme of action for participants.
3. Explicitly mark boundaries of activities and the transitions between activities.
4. Demonstrate situational awareness by attending to details and

commenting on events taking place in the room.

5. Protect activities until they are established by actively ushering them along, focusing public attention on work, and ignoring misbehaviour that disrupts the rhythm and flow of classroom events.
6. Push students through the curriculum even when misbehaviour is prevalent in the class.

3.12.6 The Apparent Connection between Successful Classroom Managers and the Way in which they Viewed the Problem of Order

The results of this study implied that teachers who differed in managerial and instructional success thought about classrooms and the problem of order in very different ways. Carter (1985, 1986) explored this possibility and found that there were sharp differences in classroom knowledge and comprehension between more and less successful managers.

3.12.6.1 Further Comments on Teachers' Management Practices

3.12.6.1.1 The Driver Navigating a Complex Route

Doyle and Carter (1987) comment on the results of the study. Much of what teacher 32 did to manage her class successfully can be accounted for by a conception of her role as *driver navigating a complex route*. She sustained activities, in other words, by steering around obstacles rather than confronting them directly. One day, for instance, teacher 32 struggled to get a discussion moving. Rather than criticise the students for not participating, she quickly switched the topic to students' preferences for hamburgers. A lively discussion followed during which students practised the routine of hand raising and turn taking in class discussion. The teacher then returned to the official curriculum and the activity flowed smoothly.'

This teacher emphasised movement and navigation. She was reluctant

to reprimand students if that would disrupt the flow of the activity. She would rather speak to misbehaving students privately at the end of the lesson.

3.12.6.1.2 Defender of Territory

Another teacher was described as a *defender of territory*. She emphasised reprimands, authority and supervisory power to control inappropriate and disruptive behaviour. She reacted to nearly all instances of misbehaviour and this stopped the flow of the lesson on occasions. This irregular flow of activities meant that order was often in jeopardy.

3.12.6.1.3 Pathfinder and Pacesetter

Comparison between two other teachers is also interesting. One moved briskly through activities, set a fast pace and established a regular and predictable classroom setting. Doyle and Carter describe her as *pathfinder and pacesetter*. The teacher invested her energies in creating an activity system to carry the burden of order in the classroom and then monitored and guided that system to ensure the group work effectively. She resolved tensions between work and order by setting a pace to sustain order, pulling outliers into the group flow, making public the ground that was being covered and prompting and guiding students through assignments.

3.12.6.1.4 Gentle Persuader and Arbiter of Adult Conscience

Another teacher was described as *gentle persuader and arbiter of adult conscience*. She was especially conciliatory to students who misbehaved and tried to 'win them over'. She concentrated on the individual and this often meant that the group was neglected. As a result, order was often tenuous and she spent much of the time showing films or having students or the teacher read aloud.

3.12.6.2 Summary of the Work of Doyle and Carter

Doyle and Carter (1987) summarise their work by suggesting that these case analyses indicate that it is not the skills which individual teachers possess that determines how the problem of order will be solved in a classroom. They conclude that what is significant are the knowledge structures and comprehension processes a teacher uses to interpret classrooms. This, they suggest will determine the management practices which will be used.

An interesting implication is that successful classroom managers appear to think about classrooms in terms of activities and movement, whereas less successful managers seem to concentrate on individual student contacts. The research outlined above builds on that of Kounin (1970) and directs teachers to think about activities that organise students for working in classrooms rather than what action to take after students misbehave.

3.13 Students' Perception of Teachers' Classroom Control Techniques

Lewis and Lovegrove (1987) undertook a study where they investigated what students thought about their teachers' classroom control techniques. This is particularly interesting and as a first step they identified the management techniques used by those who the students felt to be their 'good teachers'. They documented the characteristics in terms of whether the teacher's behaviour was not significant, relevant, important or very important. Their initial findings are summarised below:

Good Teachers DO	Good Teachers DON'T
<u>Very Important:</u>	
Punish misbehaving kids rather than the whole class.	Walk out of a class when most of the class misbehave. Cane/Strap kids. Keep class in because some kids misbehave. Hit kids who misbehave. Swear at kids. Confiscate or destroy objects belonging to misbehaving kids. Tell off kids when it's not necessary. Tell off the wrong kids.
<u>Important:</u>	Ignore kids who misbehave.
Remain calm when telling off kids who misbehave. Give a warning before moving kids. Praise the class when everyone is behaving well.	
<u>Relevant:</u>	
Explain that too much noise prevents learning from taking place. Tell kids off in private. Allow students to work out the rules for behaviour themselves. Make rules for behaviour very clear. Follow up a threat if misbehaviour occurs again. Generally treat the same kind of misbehaviour with the same kind of punishment. Explain that he/she is annoyed by misbehaving kids. Praise kids when they behave properly. Give a warning before sending kids out of class. Separate kids who misbehave. Keep individual kids in (eg. detention). Send misbehaving kids out of class. Explain that he/she can't work when kids misbehave. Explain that the kids in class can't work when other kids misbehave. Have kids catch up on work missed due to misbehaviour. Give reasons why some types of behaviour are not allowed.	Keep class in for detention. Send kids to other teachers for telling off. Send note to parents of misbehaving kids. Embarrass kids who misbehave. Stand and wait for misbehaviour to stop. Let kids off after promising punishment. Make a loud noise to attract attention. Stare at kids who misbehave. Have interview with parents of kids who misbehave. Remove privileges from kids who misbehave. Have misbehaving kids attend a different class. Reward kids when they don't misbehave.

Adapted from Lewis and Lovegrove (1987) p. 99

Table (3.7) Students' perceptions of their teachers' classroom control techniques

Lewis and Lovegrove (1987) summarise:

'One can infer that students appear to desire the teacher to take responsibility for the maintenance of order in the classroom and not involve either parents or other teachers. They want clear rules, designed in conjunction with students and based on a number of reasons including the needs of the students and the teacher. The use of sanctions should occur after a warning, should involve only the miscreant and should be applied in a calm manner, minimizing embarrassment to the miscreant. The sanctions used should focus on isolating students who misbehave and should not include arbitrary or harsh punishments. They should be applied consistently. Finally, good teachers should recognise appropriate behaviour, both by individuals and by the class.' (p. 98)

3.14 Comments on These Studies

What is interesting about the above is the 'fairness' and 'reasonableness' expected by students. It is as though schools have become places where the rights of the individual students need to be recognised. It seems that the teacher is not expected to be the sole authority figure. Perhaps there is a realisation that schools are no longer places where pupils mainly learn skills and knowledge to prepare them for the world of work. It is as though schools now have broader aims including the development of many of the social and leisure skills and attitudes which were once the exclusive domain of the parents.

Another explanation is expounded by Balson (1982) who suggests that:

'The type of society which supported the superior-inferior continuum and the resultant pattern of interpersonal relationships started to change in the late 1950s. Beginning with the Black Power movement, there was a series of similar social revolts including women's liberation, student power movement, and the industrial power movement. All had in common a refusal by a traditional inferior group to accept a position of inferiority. Whites found that they could no longer dominate the coloured people while men, parents, and teachers found a similar resistance whenever they attempted to impose their values on women, children and students.' (p. 3)

Another factor could be that pupils are now faced with a difficult economic situation. Schools cannot be concerned with simply preparing pupils for work, because for many, there will not be any work available. It is also likely that many people may change career, or

job, more frequently than has been the case in the past. The growth in students taking up places at further education colleges must, in part, be due to the economic situation, but for some pupils, this might not be a particularly desirable option. It is as though pupils will not put up with unpleasant behaviour on the part of their teachers for the sake of their vocational training. Raffini (1980) comments:

'They, unlike the present generation, were goal-orientated; they were willing to subordinate themselves and their identities to the tasks or jobs that had to be done. While they may not have enjoyed studying or doing the work required in schools any more than present-day students, they realised that they must force themselves to do it anyway if they wanted to better themselves in society; their identities or feelings of satisfaction came second. Glasser believes that children are no longer willing to subordinate themselves, their sense of worth, or their personal identities to the goals of the school. They seek reinforcement as persons, as separate human beings first, before they become involved with goals or tasks.'

(p.18)

What appears to be significant for this study is an appreciation of the nature of the relationships between pupils and their teachers. It seems that if teachers are to be able to help children to build their self confidence in articulating their ideas in a particular area then adopting an authoritarian stance, where the view of learning is that of the impartation of knowledge from the 'expert' teacher to the learner might not be particularly helpful for many children. The Responsive Teaching Model outlined in chapter two takes into consideration the factors described in this chapter. If teachers are to help children to learn, effectively, then it seems that the curricular material, the learner, the teacher and the situation need to be woven together into a complex pattern. An investigation into how this may be achieved is the focus for this study.

CHAPTER IV
RESEARCH METHODOLOGY

4.1 Introduction

Helen Simons (1985) explains very succinctly that most descriptions of evaluation now refer to the particular, whereas this has not always been the case. She points out that this emphasis on the particular marked an important change in thinking about programme evaluation and reminds us that the requirement for evaluation was almost exclusively met by experimental psychologists '*steeped in the null hypothesis*', (p9). She suggests that it called for little modification of that tradition to conceive of curriculum innovations as treatment variations designed to elicit new behaviours on the part of students. She goes on to say that it was a small step for the innovations to be seen as 'made to measure' and that the psychometrist evaluators continued to measure learning gains as they understood them.

It was Myron Atkin (1963) who first expressed misgivings about this approach, but it was Stake (1967) who first suggested that evaluators needed to rethink their methodology. He set in motion a reconceptualisation of the evaluation task, away from the idea of curriculum developments as 'experiments' to the idea of 'telling a story'. He was saying that 'consumers' needed to know a lot more about the prestigious innovation than whether it survived the null hypothesis test. By the end of the sixties, Stake was moving towards the notion of evaluation as 'portrayal' (Stake 1972). At this time, MacDonald was using case studies for consumer guidance (MacDonald 1971) and Smith was advocating the need for innovators to pay attention to the contexts of implementation (Smith and Keith 1971).

This background is mentioned, not only to attempt to place this study in an historical context, but also to give guidance as to where this study 'sits' in terms of the contemporary view of research

methodology. At the current time, there appears to be a movement which is sceptical about 'meaningful' educational evaluation with an apparent preference for simplistic raw data with which to compare schools. Simons (1989), makes the observation that schools seem to be under an increasing pressure to demonstrate their effectiveness and it appears that this pressure is from some parents, politicians and employers. It is interesting to note that many of the indices being used seem to focus solely on pupil outcomes; eg, attendance and truancy rates; the percentage of pupils gaining five or more grades at C or higher; destinations of school leavers at 16+ etc. Whilst these indices are important, the researcher feels that much more needs to be evaluated; such as the learning opportunities for all pupils, curriculum policies, the relationships between pupil, classroom, school, and community, and above all the 'value added' of a school in terms of its pupils' achievements in the widest sense.

The National Curriculum reforms were once supported by many science teachers, but have met resistance. The Key Stage Three tests have been boycotted and the truancy figures have not been supplied for publication by many schools in England and Wales. The preoccupation with 'raw data' - GCSE results, end of Key Stage tests etc, for the publication of league tables of schools, school by school, does not seem to be in sympathy with a large majority of teachers. There has been a view that it is the 'educational establishment' which has highjacked the National Curriculum and has made it unworkable. Perhaps, in their attempts to make meaning out of the reforms, this is indeed what has happened. The researcher's view is that the measurement of educational outcomes is not a simplistic issue. It is not necessarily sufficient to publish raw test results, school by school to enable parents to make a meaningful assessment of an individual school's

effectiveness. Education is a complex process and it is hoped that this study will help demonstrate that by collaboration and debate, with a desire to have a greater understanding of what seems to be effective in the classroom, that real results can be achieved. Simons, commenting on the works of Stake, House, Cronbach and MacDonald suggests that these writers have recognised a threat to 'some of the most valued dimensions of liberal democratic societies (such as discourse, dissent and diversity)' and have enabled a more communal approach to evaluation practices.

This study is in this tradition, and even though this approach might be considered to have been discredited by many of those with influence over the National Curriculum, it is possible that this is one way that real improvement might be encouraged to take place. The dramatic improvement in the science results at the school in this study would be applauded, but the methodology itself might be considered unacceptable.

4.2 Research for Teachers

This study has been undertaken by teachers and it is hoped therefore, that it will be accessible to teachers and teacher educators. Woods (1986) comments that teaching and educational research do not have a happy association and that to many teachers much educational research appears irrelevant.

It appears that much of the educational research to date has not been undertaken for teachers. Perhaps it has been generated within a body of knowledge related to one of the disciplines, such as psychology, sociology, philosophy and its theoretical interests. Adelman (1985) argues this case well. It is not that it is irrelevant to teachers, but that the language and methodology is not always accessible to them. Perhaps the practical usefulness of the work is not

always apparent to the teacher in the classroom. May and Ruddick (1983) quote a teacher who feels that much of the educational research is irrelevant to him and that some of the research is undertaken in order that the researcher may win a further degree. Woods (1986) suggests that:

'The ideal situation in principle is to amalgamate the two functions - the production of knowledge and the demonstration of its applicability to educational practice - within the same person.' (p. 2)

4.3 Teacher as Researcher

Stenhouse (1975) comments that there has been some movement towards this from both sides - from the research, academic end in the form of 'teacher educators' and from the teacher end in the form of 'teacher researchers'. This study attempts to help, in a small way, to bridge this gap by undertaking this research from within the teaching profession, as a practising teacher with the help and advice of the local university. It is hoped that this study will help to enhance teachers' understanding, in part at least, of how they may best help their pupils to learn. The researcher would argue that this is the main function of school and hence this has been the main concern. Within the area of science education, the Children's Learning in Science Project (CLIS), (arising out of the work of the Assessment of Performance Unit (APU)), has highlighted the importance of children's existing ideas and how these ideas may be identified and used by teachers and pupils to help learners move towards what is regarded as the scientific view. The work of CLIS has been within the sphere of teaching-related research and this study hopes to help take this tradition forward. Indeed, it was the work of the CLIS team which stimulated the development of the science department in question and which formed the foundation of this

study.

4.4 Case Study - Background to the Methodology

4.4.1 Characteristics of Case Study

Simons (1987) discusses her involvement in the evaluation of the Humanities Curriculum Project of the late sixties. The project itself was directed by Lawrence Stenhouse (see Stenhouse et al, 1970) and was aiming to develop a discussion based programme of controversial issues, embodied in packs of documentary materials, for secondary schools.

MacDonald was responsible for the evaluation of the Project and has written of how he arrived at the need for case study when he began the evaluation in 1968 (MacDonald 1978). Helen Simons was the team member responsible for the case study of schools and in her book (Simons 1987) she describes what she considers to be the three indispensable characteristics of the kind of case study required, where she believed that the best way to advance the practice of innovation was to make available fully documented accounts of individual cases. She says that the characteristics of the accounts are:

- * they must be true,
- * not omit relevant data, and
- * must be publishable.

The comments made about these characteristics are pertinent to this study and it might be helpful to elaborate a little further. She goes on to say that fictions have low credibility pointing out that 'our present grasp of the complex reality is far too tentative to permit accurate predictions about what might have been in hypothetical situations' (p 66). She also states that the same is true of composites and that case studies should be based not only on actual schools, but 'must report authentic situations'. Secondly, she comments that descriptions are all very well, but that this will do little to advance

understanding unless there is sufficient interpretive data. She says that 'if people are to make judgements about why innovation took the course of action that it did in a particular school, they will need a great deal of contextual information' (pp. 66- 67). This is where a significant problem lies. If a great deal of contextual information is provided, then it will probably not be possible to protect the school from recognition by the people who work in it. It is not too difficult to protect the school and its personnel against public identification, by employing fictitious names etc., but internal anonymity is a different issue. Simons goes on to suggest that this could be less of a problem if certain developments take place. She suggests that the case study should not only be authentic and detailed, but that it should also be rigorously accurate and impartial; '*The purpose of the case study is to make the experience of innovation accessible to public and professional judgment, and not to provide a vehicle for the biases or personal judgments of the evaluator.*' (p 67).

4.4.2 Impartiality of the Researcher

She also suggests that it is important for the evaluator to be seen to be impartial. She suggests that this is much more likely to be the case when the case study contains accurate records of the judgments, whether they be conclusive or inconclusive, of those involved. Simons also suggests that misinterpretations may be largely avoided if interviews and lesson observations are tape recorded, and if those involved are able to scrutinise the report and agree its fairness. Of course, the evaluator will decide what to put in the report and what to leave out, but if he or she can be seen, by close consultation, to be avoiding 'rigging the evidence' then potential problems associated with publication and respectability might be significantly reduced.

The researcher has attempted to address these issues in this study, but before turning to the research methodology, it is appropriate to discuss the researcher's view of the differences between the qualitative and quantitative traditions.

4.5 Qualitative versus Quantitative Traditions

4.5.1 The Goals of the Two Traditions

Perhaps the most striking difference is the way in which the two traditions treat their analytic categories. The quantitative goal seems to be to define categories as precisely as possible before the study is undertaken, and then to determine the relationships between them. The qualitative goal, however, seems to be to define and isolate categories during the research process. It is as though the qualitative researcher expects the nature and definition of the categories to change during the course of the research.

It seems that the qualitative researcher often looks for patterns of interrelationship between many categories rather than the sharply defined relationship between a limited set of them. It is as though the quantitative researcher uses a lens to bring a narrow strip into a very precise focus, whereas, the qualitative researcher uses a lens which permits a much broader view.

4.5.2 The Nature of the Questions being Asked and the

Appropriateness of the Quantitative and Qualitative Approaches

Another difference seems to concern the reporting abilities of the respondents. Some social science questions are easy to answer. They elicit precise and rapid responses from the respondents. Other questions are much more demanding and the respondent can have great difficulty in determining what is wanted. It can be difficult to articulate a response. This highlights another difference. It would

seem reasonable to assume that when the questions allow the respondent to answer readily and unambiguously, closed questions and quantitative methods are called for, but when the questions are likely to cause the respondent greater difficulty and imprecision, then the broader, more flexible net provided by qualitative techniques is appropriate.

4.5.3 Questions Concerning the Number and Kind of Respondents

Required

A final difference appears to be the number and kind of respondents that should be recruited for the research process. The quantitative researcher appears to require investigators to construct a sample of the necessary size and type from which generalisations may be made. In the qualitative case, however, the purpose seems not to discover how many people share a particular characteristic, but to gain an insight into the cultural categories and assumptions according to how one culture views the world. It appears that it is not the number of people who hold a particular view that matters, but the categories and assumptions themselves which matters. In a sense, qualitative research appears to be much more intensive than extensive in its objectives. The above has implications for the selection of respondents. The researcher feels, for this study, that it is more important to work longer and with greater care with a relatively small group of people than more superficially with more of them. The research documented here concerns an in depth investigation into the Science department of one school and not a superficial study of many Science departments.

4.5.4 Using Qualitative and Quantitative Techniques

It is felt that the qualitative and quantitative approaches are never substitutes for one another - they observe different aspects of the same reality. Quantitative research never obviates the need for

qualitative research; what seems important is a keen regard for what each of the methods can and cannot do. In this way, it might be possible to use them in conjunction to exploit their analytic advantages. This study is a qualitative study, but quantitative techniques have been used where thought appropriate and these are explained in the appropriate sections.

4.6 Case Study, Participant Observation and Ethnography

The research methods used in this study consist of case study, participant observation and ethnography. Indeed, Smith (1978) considers these terms to be, essentially, synonymous, and whilst the researcher agrees, it is useful to consider them separately.

4.6.1 The Value of Ethnography in Classroom Research

Woods (1986) suggests that there are certain parallels between ethnography and teaching that make them suitable co-enterprises. In the first place, they are concerned with 'telling a story'. Both research, prepare their ground, analyze and organise, and present their work in the form of a commentary on some aspect of human life. Also, ethnography and teaching are both, to some degree, scientific and artistic pursuits. Teachers themselves have considerable experience as participant observers and as interviewers as part of their everyday teaching experiences (see Pollard 1985). With guidance, building on their classroom experiences, it is possible that ethnography is more available to teachers than some other approaches. Secondly, this approach seems to promise to yield results that are newsworthy and which cannot be acquired in any other way. Ethnographers have explored teacher and pupil perspectives, cultures, strategies and careers (see Woods 1983 for an account of these), and would claim to have shed new light on these areas. They have, for example demonstrated the strategical (as opposed to the pedagogical) orientation of much teacher

activity (for example; Edwards and Furlong 1978, Ball 1981, Hargreaves 1977); the structured, meaningful nature of some apparently 'wild' and meaningless pupil behaviour (for example Rosser and Harre 1976, Beynon 1984); the social construction of school knowledge (Hammersley 1977, Goodson 1981, Ball 1982); the functional properties of pupil cultures (Willis 1977, Davies 1982) and so on. All these exhibit levels of meaning that are hidden from manifest observation and that are also frequently different from what they are purported to be. This is the type of information that teachers need to know if it is to have an influence on their classroom practice and work in the school. Of course, some teachers will be natural, reflective, participant observers and may anticipate many of the conclusions. It is the very familiarity to teachers, however, which constitutes one of its strengths. It has been pointed out that much educational research '*has explicitly ignored the routine, the mundane and the way in which in the most ordinary and commonplace fashion, members make sense of and understand the environments in which they live.*' (Hitchcock, 1983, pp 9-10). Ethnographers try to understand the mundane and ordinary and Woods suggests that teachers and ethnographers are 'in league in the same terrain, with the same identifiers.'

Pollard (1985) sums up his personal experiences as a teacher-ethnographer thus:

'I found that the research process as a full participant was often tiring, frustrating and difficult, and yet it was also fascinating and very rewarding to identify patterns in the data and to hesitantly, step-by-step, attempt to construct a deeper understanding of the events and social relationships in which I daily participated.' (page 232)

The chief method of ethnography is participant observation, which Woods (1986) suggests tends to be a combination of methods, or rather a style of research. Ethnography also relies on interviews and in

addition to interviewing, written materials (teacher diary, pupil profiles, schemes of work and curriculum support materials) have been used to support the observations and interviews. Participant observation is discussed first.

4.6.2 Participant Observation

Borg and Gall 1983 comment:

'The participant observer, by virtue of being actively involved in the situation she is observing, often gains insights and develops interpersonal relationships that are virtually impossible to achieve through any other method.' (page 490)

Bryman (1988), commenting on participant observation, says that it entails the sustained immersion of the researcher among those whom he or she seeks to study with a view to generating a rounded, in-depth account of the group, organisation etc. This research strategy was specifically advocated by Malinowski soon after the turn of the century when he pleaded for the anthropologist to come down from the verandah and to mix with the natives. Bryman believes that the debt owed by participant observers and qualitative researchers in general to anthropology can be discerned in the widespread use of the term 'ethnography' to describe their approach, a term coined in the context of anthropology to denote 'literally, an anthropologist's "picture" of the way of life of some interacting human group' (Woolcott, 1975, p 112). Participant observation, is then, very much 'entwined' with ethnography and the term 'participant observation' is used to describe one aspect of the ethnographic process. The other aspects have been mentioned earlier.

4.6.2.1 The Problem of Deception

There are obviously problems associated with complete participation. One potential problem is that of deception. Whilst this could have been a problem, It is felt that this was not an issue with this

study. All the participants were fully aware of the study and the reasons for it. They had all been part of the successes at the school and had every reason to elicit a greater understanding of the factors contributing to the success. Indeed, the readiness of the staff to allow classroom observations and participate in interviews seemed to indicate that the teachers were happy with the focus for the study. There was a desire to improve performance still further. When the examination results for GCSE, summer 1992 had been published, showing approximately 70% of the pupils gaining at least one higher grade pass (against a national average of just under 40%), the deputy head of the school asked; '*How on earth do you do it?*' The results for Science far exceeded those for any other subject, and the deputy head of the science department replied '*Because we're brilliant!*' There was a feeling of pride and success within the science department and the underlying reason for the research was to try to answer the question posed by the deputy head. The focus for the research was understood by all and it was in everybody's own interest to try to gain a deeper understanding. It is felt, therefore, that deception is not a significant issue for this study.

4.6.2.2 The Problem with Objectivity

The issue of objectivity has been mentioned earlier, but it is necessary to elaborate further. In his critique of the Follow Through Evaluation, House (1980) cites an example of what he means in commenting that the major error of the systems analysis approach adopted in that evaluation was to mistake objectivity for impartiality:

'The analysts thought objectivity was sufficient to ensure superiority and influence. More often it means irrelevance. Objectivity sought to deal with interests by excluding them. What is needed is impartiality which deals with interests by including and balancing them.' (House 1980) p. 224

The researcher has attempted to include such interests, to explain

their position in the study and present a balanced picture.

4.6.2.3 The Importance of Triangulation

A potential problem with participant observation is that it is possible for the observer to become emotionally involved. In a sense, this must have been happened, it would be unrealistic to suppose otherwise. It had been whilst the researcher had been the faculty head that the improvement in examination results had occurred. But, it is felt that there was an important reason for attempting to maintain an objective stance. The improvement in examination results had already been achieved and there was a real desire to try to understand some of the factors which had enabled this to happen. The researcher was aware of the inherent dangers of being an active participant in the department and the research. A number of research methods were used, both qualitative and quantitative, to attempt to keep an objective stance. These included observation (using a pre-designed schedule and field notes), interviews (pupils and teachers), and document analysis. Triangulation was important to attempt to demonstrate the validity of the findings, particularly with this research methodology, to others.

4.6.2.3.1 Bias in Participant Observation

Being a 'teacher-researcher' can bring many advantages, as outlined here, but it is vital that the researcher is aware that there might be shared 'common knowledge' which is taken for granted by the researcher and the researched. Burgess H. (1985), talking about interviewing points this out. This could lead to bias and was one reason why triangulation was felt to be so important, in addition to the obeying of 'the rules'. Above all, however, it was necessary to attempt to 'wash clean' the researcher's own thought processes and to

try to keep the school 'anthropologically clean'. In this way, an attempt was made to make the views of others more open and to combine a deep personal involvement with a measure of detachment. Redfield (1953) urged his anthropological colleagues not to hide behind a mask of neutrality, and Robinson (1974) advises the researcher to enter a public debate with himself in an attempt to elicit the basis of his own perception. In some way, it is felt that the important factor was to be be aware of these issues, to be 'on one's guard', and to 'obey the rules' of participant observation. Bruyn (1966) suggests that the researcher should be able to find the 'cultural meanings' in the group being studied provided the researcher is aware of the hazards and the rules of participant observation.

4.6.2.4 Subjective Judgements and Participant Observation

The researcher does not want to imply that use has not been made of subjective judgments. It is felt that subjective judgements are an important part of the process. Simons (1989), commenting on this very issue stresses that the judgements of people are an important source of data. She suggests that professional judgements are an integral part of classroom interaction and policy decisions and that it would be foolish to ignore them. What is important is that a range of people's judgments are sought and that a range of methods are used to enable a cross check to be made on the accuracy of the information. In this way, the validity of the judgments can be assessed.

This study involved participant observation and it is felt that it is legitimate for the teacher-researcher to make subjective judgments. Where this has been done, however, the basis and/or background, together with supporting evidence for the judgement has been given. In this way, it is hoped that others may be able decide if those judgments can be considered to be reasonable.

4.6.2.5 The Rules of Participant Observation

Smith (1978) developed the following criteria to judge the validity of a study in which participant observation is used:

1. Quality of Direct On-Site Observation:

Smith noted that individuals, organisations, and groups often "mask" what is really going on from the researcher. Masking seems to be much more difficult to do with participant observers than with other kinds of data collection, such as questionnaires.

2. Freedom of Access:

In doing participant observation in the school setting, broad access is essential. If the administrator succeeds in steering the observer to particular schools, teachers or events, then biased data will probably be gathered. Similarly, free access to attend classes, meetings and so forth unannounced and without prior arrangements is necessary to obtain a normal, unbiased picture of what is going on.

3. Intensity of Observation:

A great many hours of observation are needed when this method is used. As the amount of direct observation increases, the chances improve of obtaining a valid and credible picture of the phenomena being studied. As intensity increases, the data are likely to improve for a number of reasons. First, the likelihood of "faking" or "putting on an act" is decreased. Second, since schools operate over long, established cycles - the term or year - it is necessary to observe the entire cycle in order to gain a complete picture.

4. Qualitative and Quantitative data:

Although traditionally ethnographic data have been almost entirely qualitative, there is a trend in educational ethnography to collect both qualitative and quantitative data. Smith considers arguments about these two forms of data to be "pseudo-issues" and sees a gradual merging of the two views.

5. Triangulation and Multimethods:

This refers to the strategy of using different kinds of data, such as tests, direct observation, interview and content analysis, to explore a single problem or issue. Although educational ethnography is built primarily upon participant observation, Smith argues that this method should be supplemented by other data-collection procedures if possible.

6. Sampling of Data:

Since the participant observer cannot see everything that is relevant in the situation being studied, some procedure for getting a representative sample of the total data universe is necessary. The first step is to get a picture of the total territory that is relevant to the observer's goals. In a school, this could include the principle, parents, teachers, students, and non-teaching staff in a variety of settings such as classroom, faculty lounge, cafeteria, and playground. Then, with the total amount of observation time in mind, the observer can develop a sampling plan that covers the entire territory to some degree.

7. Unobtrusive Measures:

The participant observer should be alert to unobtrusive cues that provide insights into the behaviour being observed. Such cues provide the observer with a clearer picture of what is going on. For example, a teacher who is always late for appointments with the observer may be giving an important cue about his or her attitude and this could be probed.

4.6.2.5.1 Applying the Rules to this Study

Addressing each of the above criteria in turn:

1. Because of the position of the researcher in the school, and the fact that he had worked with the staff and pupils since September 1987,

it was possible to have a significant amount of knowledge about the individuals concerned. There was a familiarity with the school, its systems, the background of the pupils and the personalities of the staff. He was not a 'remote' researcher, but an active participant in the development of the department and the teaching of the pupils. Over such a period of time it would have been difficult for significant masking to have taken place.

2. The researcher had complete freedom of access and was able to move about the school with complete freedom. He was known by all teachers and pupils, ran and attended meetings, was able to choose samples freely and had complete access to any documentation required.

3. The research was conducted over a number of years, not by a visiting researcher gathering data over a very limited period. During this time it was possible to build up a picture of the school as an organisation and to gain an understanding of the personalities involved. This knowledge was invaluable when approaching people for interviews or observations, in the collection of the data and its interpretation.

4. Qualitative and quantitative techniques have been used. The methods included interviews, observations, field notes and document analysis

5. It was felt important to use a number of methods, as indicated above. It is all very well being aware of the issue of objectivity but it is quite another to demonstrate the validity of the findings to 'completely' objective researchers. The research issue was explored using a variety of methods.

6. Data was sampled, but being a case study, sampling was limited as much as possible. Each member of the Science staff was interviewed, together with the special needs coordinator who was involved in the

production of some of the curriculum material. The study is concerned with pupils in the lower school (National Curriculum years 8 and 9) and both year groups were observed, including the lower and upper ability band pupils. All the pupil profiles were analysed but samples of lessons were observed. The problem of sampling bias was appreciated. Hammersely (1984) also reflects on how, in his research, he made ad hoc decisions about which lessons to record, concentrated on oral aspects of classroom work, made irregular visits to the staffroom, indulged in uneven intervention with teachers - all of which raises questions about '*the representativeness of my data to which the lack of systematic sampling gave rise*' (p. 51). These issues are addressed later in this thesis.

7. The researcher was alert for unobtrusive cues and comment has been made on these where appropriate in the research material.

4.6.2.6 The Descriptive Versus the Judgmental - a Potential Problem

At this point it is worth mentioning another aspect of potential bias. The above 'rules' are all very well, but it must be remembered that the researcher was undertaking this research as the Head of Faculty. Griffiths (1985) talking about undertaking research in a school where he was the Head of the Remedial Department suggests that some teachers may feel threatened by the teacher-researcher and could feel that the research was a case of 'checking up' on them.

It is possible, of course, that perceptions of the research could easily move away from the the descriptive to the judgemental. It was important to be sensitive to the issues of how and what data were to be collected, treated and handled. It is not felt that this was a major issue because the purpose of the research was discussed with all concerned. It was understood that the aim was to try to identify why the department appeared to be successful, so that the science depart-

ment could attempt to identify the significant factors for further development. It is worth noting that it was, in a sense, the whole department which was the 'participant observer' in the study. Whilst the researcher was the person formally undertaking the research, the whole department was involved in the formulation and implementation of ideas. This is felt to be significant for two reasons. Firstly, everyone was involved - from within - for their own development as well as that of the department, and secondly, the problem solving ethos which developed aided the objectivity of the study. The researcher was not relying on his perceptions alone. Ideas were discussed, trialled and discussed again, hence enabling a clearer picture to develop. It is also worth noting that the focus for the study was not concerned with finding faults. If this had been the purpose of the research then the issue of the study turning from the descriptive to the judgmental would have required a much higher priority. Also, the audience of the research was understood. It was not for the school management or for outside inspectors or for the LEA. The intended audiences were the people themselves and the university. Griffiths (1985) identifies with this, suggesting that '*an investigation which is conducted by a teacher-researcher for his or her own enlightenment of professional development may be seen as less threatening than an exercise aimed at wider audiences*' (p. 210). He stresses that this would be particularly true if the wider audience was to be those who had influence over the careers of those upon whom the focus of the research falls. This is not to say that this was not an issue, but that it was not felt to be significant in this study. In some way, this was because of the success of the department and the apparent credibility which had been built up during the researcher's time at the school. It was, however, important always to bear this potential issue in mind, and that there was no substitute for sensitivity, an awareness of the issue and 'keeping to

the rules'.

4.6.3 Case Study

Some issues related to case study have been discussed earlier in this chapter. This will now be developed further.

The case study approach has a long history in educational research and has been used extensively in other areas of research such as clinical psychology and the study of individual differences. For example, much of the work of Sigmund Freud and Jean Piaget employed case studies. Case studies are also common in practical work. For example, a physician who examines a patient with a severe illness will make a medical case study which covers previous illnesses and the development of the present one. A police officer may be ordered to study the case of a gang of youngsters who are accused of crime, and he creates a 'file' which includes personal data on the gang members their previous criminal records, and data on the crime in question. Most of us have a file in our boss's office; it will be used when we apply for a promotion. Werdelin (1981) comments that a case study is a natural way of studying an individual or a permanent closed group. She considers that this approach might be able to provide important insights into the factors that effect and influence people which may not be detected by experimental or other traditional approaches.

Skilbeck (1983) claims that as a style of research, the case study is doubly effective, suggesting that while perfecting the use of observational methods and documentation it also illuminates the process of schooling and opens it up to evaluation by all those concerned with education.

4.6.3.1 Limiting the Scope of the Study

It is evident that a case study could mean an enormous undertaking

if a researcher wanted to study all aspects of an individual or group and tries to collect all the available data. In many cases, this is clearly unrealistic, and it will be necessary to limit the scope of the study. This can be done in two ways:

- * by limiting the study to essential aspects, and
- * by using a systematic way of approaching the data collection.

4.6.3.2 Generalising the Findings from Case Study Research

Borg and Gall (1983), commenting on case study suggest that many case studies are based on the premise that one case can be considered to be typical of many other cases. It is assumed that once such a case has been located, then in-depth observations of this single case will be able to provide insights into the class of events from which the case has been drawn. Borg and Gall point out that there is no way of knowing just how typical the selected case may be, and suggest that it would be unwise to draw general conclusions from a single case study.

The case study outlined in this study concentrates on the science department of one school. Whilst it is accepted that it would be hazardous to draw too many general conclusions, the researcher agrees with Hamilton and Delamont (1974), that whilst individual classrooms display a diversity, they also share many characteristics. Hamilton and Delamont suggest that by studying a particular context it is still possible to clarify relationships, pinpoint critical processes and identify common phenomena. This view is supported by other researchers, eg. Walker (1972) and Robinson (1974).

4.6.3.3 The Problem of the Missing Null Hypothesis and the Absence of Replication

This study attempts to provide a number of insights into the reasons for the children's increased motivation and self confidence

and that these insights could well be of value to educators in other schools, as well as those responsible for the training of teachers. Several kinds of case study can be found in the behavioural science literature, including: historical case studies of organisations, observational case studies, oral histories, situational analysis, clinical case study. This study draws on the methodology of action research, observational case study and situational analysis where observations and the views of various participants are elicited to provide a deeper understanding of the event being studied.

Stake (1978), defines case study as; '*the study of a bounded system, emphasising the unity and wholeness of that system, but confining the attention to those aspects that are relevant to the research problem at the time.*' Some critics of case study methods state that good research requires sceptical thinking and systematic replication. This is not excluded from case study research. Some case study workers are good at both - eg. Becker and Smith. It is also said that a built in cautiousness, such as statistical testing of the null hypothesis is missing from case study research. The researcher would argue (with Stake 1978), that seeking confirmation from a variety of sources (triangulation) has some of the effects of replication. It has also been said, by some, that the case study lacks validity. This is considered to be an oversimplification. No study has inherent validity and it is appropriate to ask "valid for what?" A given case study might be valid for some purposes and totally invalid for others. Triangulation has been used to increase the validity of the study, and in answer to the critics who might challenge the findings because they feel that case study research is subjective, arbitrary, non-representative and inconclusive then whilst this might be true, the study is not therefore invalidated. An attempt has been made to produce a valid

study by providing a description of the methodological and conceptual reasoning that took place including the efforts at verification and disconfirmation.

4.6.4 Action Research

4.6.4.1 Action Research as Teacher Researcher

Werdelin (1981) suggests that action-related research is defined by the fact that the research plan is systematically changed during the research activity as a result of what consequences this activity has. Borg (1981) describes the goal of action research as the gathering of evidence that can help the teacher (or administrator) make decisions about the local school. He suggests that the practising educator is not interested in generalising his results beyond the local school district or even the single school or classroom. Kelly (1985) outlines what she considers to be the two main strands of educational action research in Britain. One strand is that of 'experimental social administration' exemplified by the Educational Priority Areas, the other strand is the teacher-researcher model, stemming from the curriculum development work of Lawrence Stenhouse and his colleagues in East Anglia. This study is concerned with the second strand, that of the teacher-researcher where the research is essentially teacher-based. This is in complete contrast to the 'experimental social administration' action research type projects where it is not uncommon for the research workers to maintain their role as 'outsiders' in the situation under study. Elliot (1983) argues that teacher-based action research should be practitioner-based and characterised by an absence of a division of labour between practitioners and researchers. Ebbutt (1985) suggests that educational action research is '*the systematic study of attempts to improve educational practice by groups of participants by means of their own practical actions and by means of their own reflections upon the*

effects of those actions.' (p. 156). It was this desire to improve educational practice as described above which drove the development of the science department under consideration forward. Some commentators suggest that the aim of action research is to inform the participants only, and not to add to the general body of knowledge. Whilst this sentiment is understood, this study attempts not only to improve the educational practice of the science department under consideration, but to add to the general body of educational knowledge as well. The researcher agrees with Rapoport (1970) who suggests that action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework. Hult and Lennung (1980) have added further refinements. In their view

Action Research

- 1 simultaneously assists in practical problem solving and expands scientific knowledge;
- 2 enhances the competencies of the respective factors;
- 3 is performed collaboratively;
- 4 is performed in an immediate situation;
- 5 uses data feedback in a cyclical process;
- 6 aims at an increased understanding of a given social situation;
- 7 is primarily applicable for the understanding of change processes in social systems;
- 8 is undertaken within a mutually acceptable ethical framework.

Kelly (1985) commenting on this view feels that this '*combines a strong research component with a respect for participants' knowledge and understanding. Action and research are integrated and proceed*

simultaneously.' (p. 132). It was felt that this approach would enable the department to work towards educational change as well as make a contribution to knowledge. This is what has been attempted in this study.

4.6.4.2 Action Research and the Whole Science Department

It is also worth stressing that this study has not just been undertaken by one teacher. The whole science department at the school was involved. Everyone contributed to the debate, wrote and taught the materials, evaluated the materials and methods used, refined them etc. This is important because the action research very much involved the whole department. Without this involvement, the department may not have moved forward. The people were interested in the approaches under discussion and saw that they 'worked' in their classrooms with their pupils. This success lead to further development, refinement etc. This is stressed because this aspect of the research seems to add to its objectivity. It is not the view of one person which is portrayed here, but the results of a whole department involved in action research. It is also felt that approaching the research 'from within' has a number of advantages, which far outweigh the disadvantages discussed earlier.

These include:

1. An intimate knowledge of the context,
2. A knowledge of contextual features and events,
3. Being in a position to view both the obvious links between situations and events and an understanding of the more subtle or diffuse links, and
4. Being in a position to assess the implications of following particular avenues of enquiry.

4.6.4.3 Action Research and Individual Teachers' Professional Development

The position of teacher-researcher is unique and the benefits which may be accrued can be extremely valuable, not only to the teacher, but also to his or her colleagues, pupils, school and the research community in general. It is not just the 'results' of the study which may be valuable, but the development of the teachers' own professional expertise and improved practice. If the researcher's colleagues have been involved fully in the study, then this applies to them, as well as the teacher undertaking the study, and hence could add to the expertise of the wider school community. This is discussed later in the thesis but, for now, the detail of the research design is addressed.

CHAPTER V
RESEARCH DESIGN

5.1 Introduction

The research design involved three methodological stages:- the exploratory, field operational and explanatory search. Owing to the nature of action research, there was an element of overlap between the stages and further details can be found on page six.

5.2 The Exploratory

It appears that during the undertaking of this study, significant progress was made with adapting the approach to science teaching at the school in question. Science has been seen to be successful in a number of ways:

1. Examination success at GCSE
2. Numbers of children opting for the dual award science
3. Comments made by children about their science, eg. to staff and on their records of achievement.

The research has explored a particular approach - 'Responsive Teaching' and the apparent success of the methodology seemed to be of particular interest for this study. If children were choosing the Double Award course and were achieving excellent examination results (above the averages expected from these pupils), then it was possible that the teachers were enabling the pupils to focus their minds on the conceptual area of interest during science teaching. The department therefore appeared to be particularly suitable for study.

The exploratory stage is itself divided into a number of phases, which are:

- * Initial lesson observations.
- * Analysis of pupil profiles.
- * Interviews with Science Staff and Special Needs Coordinator.

The above, together with the background theory, was used to develop an observation schedule for a more detailed investigation of the factors and strategies which enable children to focus their minds on the conceptual issue being taught and how it might be possible to build and maintain the children's self confidence.

5.2.1 Interviewing

Wragg's (1978) cautionary note that interviewing is the oldest and yet sometimes the most ill-used research technique in the world, was felt to be pertinent. He lists many pitfalls, but three sorts of bias are of particular interest. That of the interviewer, of the respondents and the conversation act itself.

5.2.1.1 Interviewer Bias

Millband (1984), commenting on these biases suggests that more often than not a teacher is more used to asking questions (consciously or unconsciously) which cue children into giving answers which direct them towards building a framework of ideas. The teaching methodology under scrutiny here has at its very core the use of questioning which tries not to cue children into giving the answer the teacher wanted. These skills were developed with the teachers over the duration of the project and has been commented upon by teachers in the interviews. The researcher trusts that the transcripts show that this bias has been eliminated, as far as possible.

5.2.1.2 Respondent Bias

With regard to respondent bias, under interview conditions, answers can be given (although not always) which are thought to please the interviewer. This is, to some extent, connected with the bias discussed above. The climate within the science department was such that this was felt unlikely to happen. The climate was felt to be open. However, to attempt to eliminate any potential bias, a number of strategies were used.

Staff and pupils were nurtured into spilling out information, in any way the person chose to do so, and in their own time. Only a few questions were asked and these were open questions. The respondents were also given advance warning of the interviews. They were assured that no 'testing' was involved and that their answers were not only for the purposes of research but also so that we could use the ideas to aid our future development. Verbal questionnaires were not used.

No-one refused to give an interview. The climate, as mentioned above, was supportive and open, both with and between staff and children. The success of the department in recent years, and hence the department's high standing within the school seemed to suggest that the staff were very willing to continue the improvement process. They seemed to feel that it was in their own best interest to be honest.

5.2.1.3 The Seating Arrangements

The interviews were 'face to face' interviews, not written conversations. Stenhouse (1975) advocates interviewer and interviewee sitting side by side, rather than face to face, as if to symbolise the fact that the interviewer and interviewee together face a common task. The researcher had found that this can cause communication difficulties and that it can be difficult to read non verbal signals. A compromise was found which proved to be effective, where interviewer and interviewee

wee are placed at 90 degrees to each other. This seemed to provide a perception of common approach without connotations of confrontation and also allowed non verbal signals to be seen.

5.2.1.4 Use of Tape Recorder and Notes

The interviews were recorded so that a permanent record was available, and brief notes were taken to enable the researcher to focus his thoughts as the interview progressed. MacDonald and Sanger (1982) have given a comprehensive account of the advantages and disadvantages of note taking and tape recording. The combination was chosen so that the brief notes would enable the interviewee's stumbles, irrelevances and incoherences, to be omitted, whilst keeping a professional control of the record. This enabled points to be summarised as the interview progressed to verify the researcher's perceptions with those of the interviewee. If there was a mismatch, then supplementary questions were asked to cross-check. The summaries were particularly useful when processing the data.

It is recognised, however, that note taking is not without its problems as it can constrain natural discourse and reduce non-verbal contact. Also, it is possible to miss points altogether and little raw data survives. This means that there is a lack of objective evidence to substantiate analysis and an increased risk of interviewer error/bias in generation. The latter can be compounded at an advanced processing stage. For these reasons, the interviews were also recorded. This enabled the personalised relationship and conversational style to remain since it was not necessary to take notes at all times. It was thus possible to listen; the raw data, being preserved in verifiable form. This proved very helpful at the data processing stage since it was found, on transcribing the tapes, that some apposite comments had been missed.

In summary, therefore, the tapes were found useful for verification and the knowledge that when it was necessary to listen particularly carefully during the interview, note taking could be suspended. The notes were useful because they speeded up the transcription and processing whilst enabling the researcher to summarise during the interview to check perceptions with those of the interviewee.

5.2.1.5 Further Comments on the Nature of the Interviewing Process

Tripp (1983) has argued that the interview ought to provide more coherence for the subject. He says that it should attempt to understand, take on board and explore what the interviewee's questions are as well as pursuing the interviewer's agenda. Tripp suggests that an attempt to record what someone thinks on a particular question must also include the attempt to discover how that question and its relevant features is placed in the world view of the interviewee, that is in the interviewee's rather than the interviewer's terms. In this regard it seems that it must be equally important for the interviewer to learn what questions are important to the interviewee, as it is to learn what questions are important to him or herself. One way of achieving this, suggests Tripp, is to allow the interviewee joint responsibility for structuring the interview in terms of the progress of questions, in content, kind, sequence and number. It appears that one is dealing with questions of power: the extent to which power is equally shared, or in this case, the symmetry of the communication.

Walker (1985) suggests that for the interviewer to be alert to the issue discussed above, it is not difficult to frame the interview in ways that at least provide opportunity for reflection and processing within the interview itself. The tactics used to attempt to enable this were: pausing at intervals, giving the interviewee time to think, offering summaries and asking for an assessment of the researcher's

understanding as the interview progressed. The intention of the interview was made quite clear, and as has been commented earlier, the results were, in part, to enable the improvement process of the successful science department to continue which was to everyone's benefit.

Adreski (1972) suggests that the act of conversational interviewing does not need to sink to the level of mechanicalness. It can be a graceful and joyful act, enjoyed by both sides and suffered by neither. What is more, Adreski contends that unless it becomes such an act, it will only fail in it's main function. It is recognised that one cannot conduct an interview by bombarding one's victim with a barrage of questions, which is only tiresome and tiring for both sides. Adreski suggests that the only way to make an interview an enjoyable, social act, both for the interviewer and for the respondent, is to enable two way traffic. In this way, the respondent might feel less a victim and more a true partner, a true conversationalist.'

It is hoped that the respondents felt, at least fairly closely, that they were true partners. The researcher is satisfied, as fas as is possible, that true feelings and perceptions were not hidden.

One of the main reasons for choosing conversational interviewing over other forms, was, as Allport (1942) suggests, we should ask people if we want to know how they feel, what they experience and what they remember, what their emotions and motives are like, and the reasons for acting as they do.

Millband (1984) suggests another advantage and the researcher agrees that conversations also provided time for watching as well as for listening and talking. Gestures and facial expressions gave additional information as to what was happening in his or her mind and hence helped to identify when further probing was necessary. The interviews were transcribed, and then stored for future analysis.

5.2.2 Pupil Profiles

5.2.2.1 The Manner in which the Profiles were Completed

The profiles were completed by all the children in year Eight.

An example is given in appendix two. The method used in its completion was:

1. The pupil was asked to write, in rough, their thoughts about their science. Where they thought they had done well and where they thought they needed to improve. The reason for writing the statement in rough was so that the spelling could be checked, or the teacher could help a child to articulate their thoughts. A few children knew what they wanted to say but could not put it into writing - a familiar problem to the staff with respect to scientific ideas.
2. As this was happening, the children completed the pupil box 'Assessment of Attitude and Approach', using a scale of 1 to 4.
3. The children copied their statements onto the form after they were checked.
4. The teacher then sat down with each boy in turn and completed the teacher boxes: the teacher's assessment of attitude and approach together with the assessment of attainment and the teacher comments. The levels are relatively arbitrary and refer to criteria drawn up by the science department. They do not in any way relate to the National Curriculum. Generally, for each skill, level one indicates it can only be achieved with lots of teacher help whereas level five indicates it can be achieved by the pupil without any help.

The pupil comments were particularly interesting. The profiles were completed as part of the normal reporting process within the school and not specifically for this research. Profiles of a similar nature were

being completed by the boys in all their subjects and they were used to commenting on their progress and perceived areas for improvement. It is important to stress that the boys were not guided towards any particular response.

5.2.2.2 Profile Analysis

165 profiles were completed and all of the pupil comments were analysed. The attainment boxes were ignored for this study. An example of the profile can be found in appendix I (page 301). The comments below refer to the way in which the comments were classified, and examples can also be found in appendix I (pages 302 to 307):

- (a) Page 302: Some children like the 'academic', they like to learn things or they have a particular career intention, e.g. to be a doctor.
- (b) Page 303: Some children like the practical work - being "active".
- (c) Page 304: Science is enjoyed for various reasons. One boy felt that he did well when he tried, another liked talking about his work to the class and another found a topic interesting because he already knew a lot about the subject. This seemed to give him self confidence, as it did teacher 1 - recorded in the interviews with staff.
- (d) Page 305: Some children were motivated by external factors; getting on well with classmates and teacher, rewarded with a commendation (his first one was for science), liking the teacher and having some credits, rewarded for work completed using the computer, enjoyment following an improvement in comprehension and presentation.
- (e) Pages 306 and 307: These comments are pertinent because the

children have highlighted some areas of concern. These areas would seem to diminish children's self confidence and so are as pertinent as the motivators. There were problems with: time to complete practical work, recording experimental work, expressing ideas in writing even though thinking was sound, handwriting and spelling, not enough experimental work, a dislike of copying from the blackboard, words which were not understood.

Analysis also shows that:

- 114 said that they 'enjoyed' their science.
- 79 particularly mentioned practical, investigations, experiments, problem solving.
- 27 said that they had done well in science.
- 42 said that they had problems with presentation, write-ups or spelling.

Closer analysis reveals other interesting factors. Because each profile was signed by the teacher it was possible to look at the positive and negative comments with respect to the teachers. For confidentiality the teachers names are not used. They are referred to as teacher 1,2,3 etc.

Adverse comments towards science appeared against three teachers out of a total of seven. Whether these teachers de-motivated children, or sapped their self-confidence in some way whereas the others built and maintained that self confidence is not clear. What is interesting is that one of the teachers who drew adverse comments also drew 8 positive comments about the topic on 'Processes of Life'. This was the topic where teacher 1 had worked with the SENASS advisor to produce an exemplar module. It seems as though this had been successful and further analysis is documented in chapter six. Also of interest is that teacher 4 drew 14 positive comments, with respect to the modules on Air

and Weather. This teacher had not taught 'Processes of Life' using the modified module. The 'Air and Weather' module had been taught in a particular way. The children were able to express their ideas and the children used these ideas in the design of their own experiments. This topic was highly conceptual, but this did not appear to deter the pupils. It was very open ended and the children planned their own work and build pieces of equipment which they subsequently used. This teacher was well liked and appeared to have a natural style which seemed to enhance the children's self confidence. This teacher was included in the next phase of the research, where the strategies used are analysed.

5.2.3 Pilot Observation of Lessons

The data from the above proved most useful. With these comments in mind a further number of lessons were observed, although no formal observation schedule was used. One could not be found which was thought to be appropriate. The purpose of the observations was to enable the researcher to focus more clearly on the data to attempt to design an observation schedule which could be used with a number of more formal observations. Field notes were written and it was felt that this experience helped with the practice of recording data during the observations.

These initial observations were very useful and highlighted a number of possible factors. For example, the general atmosphere; the quality of the questioning used by the teacher; the way in which the teacher accepted, or otherwise the pupils' ideas; the use of praise and encouragement; the way in which the teacher responded, or ignored pupils; the strategies used by the teacher in structuring the work and the non-verbal signals displayed by the teacher.

5.2.4 Four Characteristics of Work in Successful Classrooms

On observing a number of lessons, it became apparent that the lesson appeared to contain a number of characteristics which were interrelated, and the success, or otherwise of the lesson, seemed to depend on the teacher's skill at managing these factors successfully.

Firstly, the group social behaviour of the class appeared to be a major characteristic; different classes behaved in different ways, and the dynamics of the groups within the classes varied. Some classes contained many pupils who arrived at their science lesson ready for work, were quiet and were well equipped in terms of pencils, rulers, and pens. Other classes contained groups of pupils who arrived noisily, did not line up but 'swarmed' around the door, waiting for the teacher. Some classes contained pupils with learning difficulties and / or pupils with behavioural difficulties. Pupils also came from a variety of cultural and social backgrounds. It seemed that each class typically consisted of a number of sub-groups, or cliques which rejected or supported particular types of behaviour. This was evident both inside and outside the lesson. It was quite clear, from the lesson observations that some teachers managed the group social behaviour of their classes successfully and others found this more difficult.

The second major characteristic seemed to be the nature of the interpersonal relations within the classroom, both between pupil and teacher, and between pupils. It appeared that it was the nature of the interpersonal relations within the classroom which contributed towards the success, or otherwise, of the lessons observed. It was felt that successful learning happened when the teacher was able to manoeuvre the pupils through the activities, attending to individual pupils' conceptual understanding, whilst also paying particular attention to the nature of the relationships within the classroom. In a sense, it appeared to be the nature of the interpersonal relations which enabled,

or otherwise, successful learning to take place. It seemed that the successful teachers were able to navigate through the cognitive dimension, and the group social behaviour of the class, by using positive interpersonal relations.

It is therefore felt that the third major characteristic is the pupils' conceptual understanding.

It was also apparent, that successful lessons happened when the teachers attended to the above three factors in their planning. It seems that teachers have access to, and control of, the planning, whereas the other factors mentioned above are rather more elusive. It seemed that the quality of the planning was a major factor in the success, or otherwise of the lessons observed, and this has therefore been identified as the fourth major characteristic of work in successful classrooms. As a starting point, therefore, It was felt that the four main characteristics worthy of further analysis were the group social behaviour of the class, the interpersonal relations, the individual pupils' conceptual understanding and the teachers' planning.

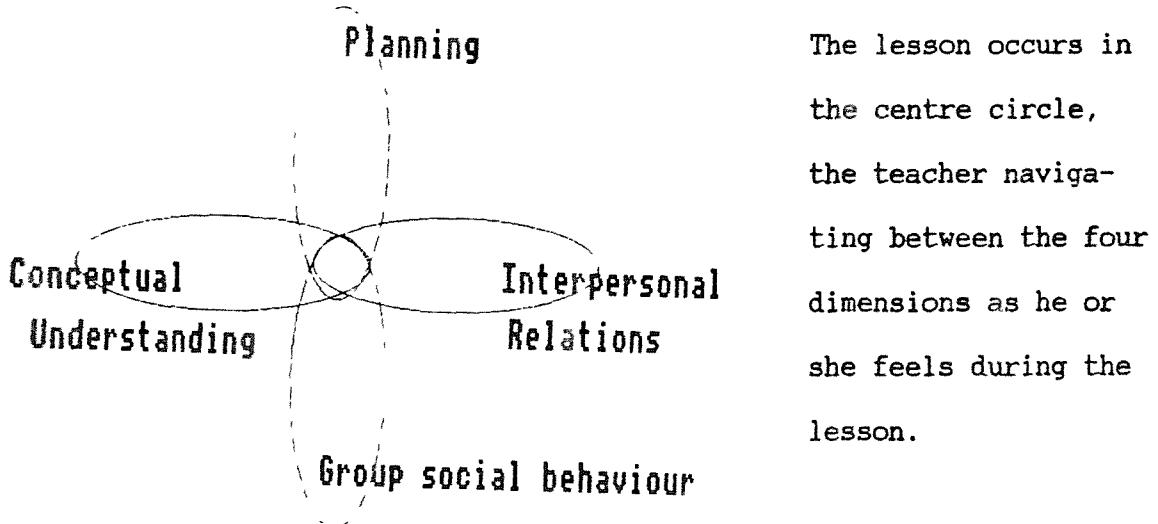


Fig (5.1) Four characteristics of work in classrooms

5.2.5 The Development of an Observation Schedule

Armed with the information from the field notes, and bearing in mind the discussion above, it was now possible to design an observation

schedule for the field operational stage of the research.

5.2.5.1 Verbal Interaction

It is very easy to use observation schedules to 'decide' the nature of the interaction between teacher-pupil and pupil-pupil. Many such schedules exist (e.g. Eggleston, Galton and Jones 1976). It is suggested here that the quality of the verbal interaction between teacher-child and child-child could be important if children are to increase their confidence at articulating their ideas. There are three descriptive systems in particular, which attend to the linguistic data; Barnes (1969), Bellack et al (1966) and Flanders (1967). The problem is that these schedules all assume that talking is the important fact in the classroom whereas the researcher feels that non-verbal signals are as important as the verbal interaction. Talking is important, however, and it is worth investigating methods of analysis.

Barnes has two main educational tenets. That pupils should be encouraged to participate and draw on their own knowledge and experience as much as possible; and that teachers' questioning should be more concerned with stimulating thinking than eliciting factual information. The descriptive system he proposes concentrates on two aspects of the interaction:

- (a) pupil participation and the way the teacher handles the turn-taking system and guides the development of the topic.
- (b) teachers' questioning:
 - factual.
 - reasoning (open and closed).
 - other open questions (not requiring reasoning).
 - social.

Barnes notes that pupils' participation is too low; they ask too few questions and when they are willing to contribute, their contribu-

tions are not built upon.

Bellack et al (1966) suggests that all interactions can be described in terms of four moves.

- * structuring - setting the context.
- * soliciting - moves intended to elicit an active verbal cognitive or physical response.
- * responding - to fulfil the expectations of soliciting moves.
- * reacting - to modify and/or to rate what has been said previously.

Probably the best known of these systems is that devised originally by Flanders (in Amidon and Hough 1967). His early ten point scale is given overleaf:

Mainly talk coming from	Category	Type of behaviour	Examples of talk in the category
Teacher talk, having the effect of indirectly influencing behaviours.	1	Accepts feelings	Teacher accepts or clarifies the feelings of pupils (quite rare, usually concern is more for ideas).
	2	Praises or encourages	Often a single word -'Good!' 'Maybe,'I see, yes, well go on then.'
	3	Accepts or uses ideas of pupils.	'That's fine, now if we do that...' Often finishes using his own ideas.
	4	Asks questions	Does so with the intent that pupil will answer. Not rhetorical, e.g. 'What do you think you are up to John'
	5	Gives information	Gives facts or opinions; expresses own ideas. Characteristically, the most frequently used category!
	6	Gives direction	Commands or orders with which pupils are expected to comply, e.g. 'Now light your bunsen burners'.
	7	Criticises: justifies authority	'You will do as I tell you.' All teacher talk aimed at changing behaviour to acceptable pattern.
	8	Teacher-initiated pupil talk	Any talk by children in direct response to teacher, most frequently the answer to a direct question.
	9	Pupil-initiated pupil talk	Pupils want to talk, and do so of their own free will; typically they ask a question of the teacher.
	10	Silence or confusion	Children working quietly on their own, or informally where much talk makes it impossible for observer to interpret correct category.

Table (5.1) Flander's Ten Point Scale

There have been criticisms of these crude measures (e.g. Edwards and Furlong 1978), but some significant findings have emerged from the approach. The 'rule of two thirds' states that someone is talking in the average classroom for about two thirds of the time. For two thirds of the time the person talking is likely to be the teacher and for two

thirds of the time the teacher is speaking, the talk is likely to be concerned with the giving of information. Reid and Hodson (1989) comment that the one third of classroom talk not allocated to teacher talk is not necessarily allocated to talking by all, or even a majority of the pupils. They suggest that it may be given to individual pupil talk in the public arena as the result of teacher questioning. It seems that in a class of 25 pupils, the opportunity for any one child to talk meaningfully about science could be very short.

It seems, then, that we have one criterion for evaluating what is happening in the classroom: the quantification of verbal interaction patterns. The way in which the teacher asks questions, accepts children's feelings and ideas and uses praise and encouragement seems to be central to the building and maintenance of the pupils' self confidence.

5.2.5.1.1 Open and Closed Questionning

It is worth looking at questioning in more detail. Millband (1984) discusses question types and suggests that open/synthetic questions relate to an inferential style of teaching and closed/analytical relate to an expository style of teaching. She derives a continuum for two models, the 'closed-open' of Kerry (1982), and the 'analysis-synthesis' of Turney (1977), (based upon Bloom et al, 1956). These are explained:

Closed-Open Model

Closed questions- those which require a single word or very brief response, for which there is a single correct answer and the answer has been predetermined by the questioner.

Open questions- those which require an answer running to a sentence or more, where a variety of responses could be acceptable to the questions and where they may have no correct answer.'

Analysis-Synthesis Model

Analysis questions- asks pupils to break down the subject matter into parts and to study the nature of those parts and the relationship between them.'

Synthesis question- asks pupils to build up a new idea, plan or experiment.'

Millband united these into one system, shown below, and it is to these categories that reference is made when using the terms 'open' and 'closed' for the Teacher-talk questions.

Closed - Analytical

Question Catagory	Explanations
<u>Factual</u>	include those requiring pupils to give information or name phenomena. These embody both (a) factual naming and (b) factual information.
<u>Recall</u>	asks pupils to remember information they have previously learned, without putting the information to use.
<u>Pseudo</u>	the teacher elicits information he already knows, i.e. the question is constructed to appear that the teacher will accept more than one response, but in fact the teacher requires a specific response.
<u>Reasoning Closed</u>	asks pupils to construct or reconstruct from memory a logical organised sequence applied to the subject matter. This catagory includes observations which may ask pupils to describe what they see without attempting to explain.

Open - Synthesis

Question Catagory	Explanations
<u>Reasoning Open</u>	asks pupils to give reasons why certain things do or do not happen, encourage 'thinking aloud' and the exploratory approaches to tasks - the intuitive 'leap'.
<u>Speculative or hypothesis generating</u>	asks pupils to speculate about the outcome of a hypothetical situation.
<u>Person response</u>	allows pupils to say exactly how they themselves feel about something without pressure to conform to the teacher's or the group's viewpoint.
<u>Problem solving</u>	asks pupils to construct ways of finding out answers to questions.

Table (5.2) Categories of Open and Closed Questioning, as defined by Millband (1984)

It will be necessary to differentiate between these in the observation schedule. It is difficult to determine whether a question is open or closed; it depends on the recipient. One way of determining this is to listen to the answer. It is with this in mind that reference is made to 'Questions perceived as open' and 'Questions perceived as closed' in the schedule. It is not so much the question as the answer which gives the clue.

5.2.5.1.2 Other Categories of Verbal Interaction

Lecturing and Demonstration have also been included under the

category of 'teacher talk'.

Earlier discussions impressed the importance of the affective dimension and the category of "Social" has also been included. This covers any talk outside the realm of that required by the purely cognitive dimension of the lesson. Hidi (1990) presents evidence that both individual and text-bound interest have a profound effect on cognitive functioning and the facilitation of learning. It was suggested in chapter three that the phraseology used by the teacher with the children could have an impact on their potential interest in the area under discussion and their confidence in tackling new work. It seems reasonable to suggest that there will be occasions when social talk could help a child to concentrate on the conceptual issue being taught. One example is where the teacher took time to talk to a pupil whose father was suffering from cancer. This boy was undertaking many of the father's roles at home including collecting football money three evenings a week, helping with younger siblings and constant visiting in hospital. The emotional and mental stress suffered by this boy was enormous. However, the teacher took time, whilst the rest of the class were working, to ask the boy how his father was and to listen. He also encouraged the boy to do well in his GCSEs as this could help his parents. This 'social' talk encouraged the child and the increased motivation and concentration over the next few weeks was noticeable. The boy asked many more questions than normal, caught up on course-work and generally worked harder. The teacher also gave the boy an extension as to when the course-work should be completed, showing understanding and empathy.

Continuing with the quantification of verbal interaction patterns, It was suggested earlier that the quality of the discussion between pupils and teacher could be a useful indicator of the climate within

the classroom. If all the discussion is initiated by the teacher, then the climate could be very different where the discussion was initiated by the pupils, or even between pupils. It was therefore felt necessary to distinguish between discussion between pupils, (pupil-pupil); discussion with pupils initiated by the teacher, (Teacher - pupil) and discussion with the teacher initiated by a pupil, (Pupil - Teacher). These categories therefore appear in the observation schedule under the heading of 'Discussion'.

5.2.5.2 Practical Work

Another aspect of the science classroom is the use of practical work. When this is happening, it could be in groups or individually. It is, of course, possible for some children to be working individually even though many of the class are working in groups.

5.2.5.3 Teacher Direction

During the course of a lesson, the teacher will undoubtedly give instructions, either to individuals, groups, or the whole class. It is felt that it could be useful to distinguish between instruction in response to a pupil request (R) and those purely initiated by the teacher (T). This could give some indication as to the nature of the relationship within the classroom.

5.2.5.4 Motivation

Chapter three outlined the importance of motivation if the children are to focus their minds on the conceptual issue being taught. This heading has been subdivided into 'positive' and 'negative'. Positive motivation concerns actions taken by the teacher which appear to increase motivation in the classroom. This includes: 'Reduces Tension', perhaps by a joke, a smile, or non-verbal language; the acceptance of pupils' own ideas; and the praising and encouraging of the pupils - the importance of which was discussed in chapter three and

corroborated in the initial lesson observations and interviews.

There are many ways in which a teacher can have a detrimental effect on motivation. One significant way is simply to ignore pupils or their requests. This was highlighted in the observations. The other demotivating factors have been brought together under the heading of 'unnecessary and excessive authority'. Whilst it is realised that this view is rather subjective, it was felt that the researcher's 14 years teaching experience would enable a decision to be made as to whether the authority evident was necessary or not.

5.2.5.5 Other Categories

Science teachers seem to leave the room at times, possibly to fetch a piece of equipment. The pilot study revealed not only how important the teacher's presence was for some groups, but also the importance of the placing of the teacher within the room. Perhaps a highly motivated class would not require the teacher to be present at all times; hence the column. In common with Flanders, the categories of Silence and Confusion are included. Silence when the class was working quietly, and Confusion when the observer could not determine what was happening.

A quantification of the 'feeling' within the classroom is clearly difficult; rather like determining the 'ethos' of a school. Despite the difficulty of defining it, one feels it instinctively. The category of feeling is therefore included and is marked on a scale from very positive through neutral to very negative.

5.2.5.6 Use of Field Notes

During the pilot study, the use of free notes proved a valuable way to collect data. Any other aspects could be recorded, including non-verbal signals and hence the category 'Other Activities'. The

second page of the schedule enabled comments to be written in prose and helped place the identified categories in context. These comments were sequenced by time, corresponding to the time intervals in the schedule. It was therefore possible to compare the field notes with the observation schedule. This was found to be particularly helpful when interpreting the results of the observations. If children were interviewed after the lesson, these interviews were included here as well. In this way it was possible to aid the interpretation of the dynamics within the lesson. A copy of the schedule, together with the field notes for one of the observed lesson can be found in appendix II (pages 308 to 310). These are discussed later in the thesis.

5.3 The Field Operational Stage

5.3.1 Introduction

The field operational stage involved two main phases:

- * A detailed investigation of one teacher's work with a member from the Special Needs Advisory and Support Service (SENASS). This is of particular interest and is detailed first.
- * Systematic lesson observations using the observation schedule developed during the exploratory stage of the research.

5.3.2 The Work with SENASS

Teacher 1 was the teacher who worked very closely with the SENASS (Special Educational Needs Advisory and Support Services) advisory teacher. It was hoped that this analysis would enable the findings from the interviews and lesson observations to be confirmed, or otherwise. It was also felt that the partnership between the teacher, SENASS, and the school's own special needs coordinator might enable further factors and strategies to be identified. Teacher 1 was asked to keep a diary of his feelings / perceptions of how things were going with the children (Some pages can be found in appendix VII). He was asked to particularly mention areas of success or where improvement was thought

necessary. This was intended to provide valuable information for the other members of the department when planning further modules. This, together with the lesson materials and field notes from the exercise were to be used during the explanatory search phase of the study.

Teacher 1 was chosen for this activity because he had had most difficulty in implementing the ideas associated with the responsive teaching methodology. It should also be made clear that discussions had taken place with the SENASS advisor and teacher 1 before teaching was to take place, on the module 'Processes of Life'. The aim was to provide an exemplar module which more closely matched the Responsive Teaching model, as well as being valuable in-service training for this teacher. It was the role of the advisor to help plan the appropriate extension and overlearning activities and then to take part in the lessons to monitor their success (or otherwise), helping to amend the activities in the light of experience and discussion. This was outlined briefly in chapter two. The school's special needs co-ordinator was involved because it was hoped that he would be able to help with the preparation of materials and also be able to use the experience to develop further the work of the Special Needs department. It was hoped that the work would be beneficial to the Special Needs staff in helping children in all departmental areas. The SENASS advisor would only be with us for a relatively short time and then our own special needs co-ordinator would help and advise. It was therefore essential that he took part in the planning and lessons as much as possible. This was agreed with all concerned and as mentioned earlier, it was seen as valuable in-service training. The Special Needs teacher was interviewed as part of the research, and it was felt that his involvement could be of benefit to the school and possibly provide valuable insights for the research project itself. These discussions will be found later in this

thesis. Before discussing this work, it is useful to consider the lesson observations undertaken as part of this research.

5.3.3 Lesson Observations

The observation schedule, developed in the previous chapter was used in each of the six lessons to be analysed in detail. The teachers were chosen carefully because they were all of a similar age (early forties) and teaching experience. They had all taught at the school for at least five years and were fully established, both in terms of their knowledge of the school's systems and in terms of their relationships with pupils, teachers and parents. This was considered to be important because for meaningful comparisons to be made, it was felt to be necessary that the teachers did not differ significantly in age, experience as teachers, or length of service in the school. It was also felt that newly qualified teachers, or experienced teachers who had joined the school recently would bring different issues to bear and the researcher wanted to avoid these complications as much as possible.

The lessons were chosen so that each of the teachers was observed once, and the teacher who was deemed to be one of the most successful teachers in the school was observed three times. It was widely accepted that this teacher (Teacher 4) was extremely popular with the children and he had achieved excellent GCSE examination results with pupils of all abilities. It was ensured that two of these lessons were practically based and one was theory based.

It was not considered necessary to observe a large number of lessons for four main reasons.

Firstly, the findings of the Ph.D. thesis by Millband (1984) were particularly interesting. She found that teachers tended not to change their teaching style in recognition of the type of topic being taught. This has been discussed in more detail in chapter two, but this finding

is particularly pertinent here.

Secondly, It must be remembered that the researcher was a participant observer; a true member of the department and had known the staff over a four year period. The teachers had been observed teaching hundreds of times, both formally and informally. It was felt that the findings of Millband were justified and that the teachers chosen for observation did indeed have a personal style, to which they adhered no matter which class or topic they were teaching. It was considered acceptable therefore, that a relatively small number of observations would suffice. The researcher was, however, ready to undertake more observations, if the lessons appeared to be 'out of character' but in the event, this was not the case. An attempt was made to probe into each lesson in as much detail as possible, rather than attempt to justify certain traits or categories by analysing a large number of lessons by quantitative means. The researcher wanted to use the unique position of participant observer to the full. As mentioned earlier, it was considered that it might be more useful to other teachers to try not only to identify the factors and strategies which proved to be successful, but to attempt to see what lay beneath them and what it was that enabled teachers to use them successfully - or not as the case may be.

Thirdly, this sentiment is shared by other researchers. Hammersley (1986) feels that it is not surprising that some quantitative classroom researchers find precisely what they are looking for because their theories pre-determine the findings. He suggests that an alternative practice is provided by ethnographic research where the ethnographer studies a single situation, rather than a large number of classrooms as systematic observation usually demands. Hamilton and Delamont (1974); Walker (1972) and Robinson (1974) also suggest that there is a virtue in studying one particular context in detail, because although indivi-

dual classrooms differ, they also share many characteristics and it might well be possible to pinpoint critical processes, clarify relationships and identify common phenomena.

The fourth reason was practical. The nature of the small scale study undertaken here rather limits the number of lessons which it is possible to investigate in depth. If the researcher had had access to a team of research assistants, then it might have been possible to observe and analyse a much larger number of lessons. This was not the case, but for the reasons outlined above, it is not felt that the study is invalidated owing to this limitation.

5.3.4 Comments Concerning the Field Notes

During each of the lesson observations, field notes were written in addition to the completion of the observation schedule. These field notes amplified the points considered to be pertinent at the time, and enabled a more detailed analysis to be undertaken during the analysis of the data. Comments included details of off task behaviour, comments made by the teacher, or pupils, non-verbal signals used by the teacher and comments on the content of the lesson. The researcher's feelings were also noted during the lesson, both on the observation schedule itself, and also in the field notes where it was possible to amplify the reasons for these feelings. In addition to these notes, a sketch was kept of where the teacher was, in the classroom, during the lesson. This did not prove difficult to do and yet was particularly useful during the analysis of the data.

Each lesson was documented, ready for analysis, in the following way:

1. The lesson observation schedule.
2. The teacher movement charts. These showed the teacher's movements during each three minute interval during the lesson, the room layout in

terms of pupil benches and demonstration benches and where access doors were situated. The charts were annotated to show where particular pupils, or groups of pupils were sitting and where the teacher had called across the room to children. The direction of movement of the teacher was distinguished from the direction in which the teacher called to a pupil or pupils. The movement diagrams were annotated to attempt to explain the relationship between the comments and the location of particular groups in the classroom in relation to other groups and the teacher.

3. The field notes for the lesson contained a brief overview of the topic and the class being taught together with the comments, documented within the same three minute time units used on the observation schedule. If a pupil was interviewed after the lesson, then a transcript, or the notes written immediately after the interview followed.

Attention is now turned to the explanatory search stage of the study.

CHAPTER VI

EXPLANATORY SEARCH

6.1 The Analysis of Qualitative Data

McCracken (1988) comments that the analysis of qualitative data is perhaps the most demanding and yet least examined aspect of the qualitative research process. Issues relating to the analysis of qualitative data have been documented earlier; in this chapter, attention has been turned to the analysis of the data itself. McCracken describes a scheme which is mechanistic and yet which leaves the precise route from data to observations and conclusions in the hands of the researcher.

This technique has been applied to the interview data. To enable this process to be undertaken, the interviews were taped and a transcript was produced. McCracken suggests that the interviewer should appoint a typist to undertake the transcription to eliminate the possibility of the researcher becoming too familiar with the data. In fact, the researcher undertook the transcription. Owing to the pressure of work, there was a time interval of some months between transcription and analysis. This had an advantage because this enabled a distance to be put between the data and the researcher without becoming either overfamiliar or having lost touch.

Before undertaking the analysis, an appreciation was gained of what the literature said should be there, a sense of the various issues under consideration and a sense of what took place in the interview itself. Although the background material was used as a guide to what might exist in the data, the researcher was prepared to set all this aside to attempt to elicit ideas and themes which had not been anticipated. It was important to be prepared to reconstruct a view of the world which might bear no resemblance to the one evident in the literature.

6.2 The Five Stages of the Analysis

The analysis undertook five distinct phases, each of them representing a higher level of generality. The first phase treated each utterance in isolation, without any reference to the rest of the transcript. Each utterance created an observation, which was recorded next to the utterance which occasioned it. The self was used as an instrument, and consideration was given to what was in the data and what the data 'set off' within the researcher. Attending to the self, as carefully as the data itself, was a vital part of the process, because on occasions the stream of utterances set off a stream of associations. A recognition took place, not only in terms of personal experience, but also in one's imagination, glimpsing the possibility of alien meanings. Berreman (1966) considers this 'intuition' to be the most powerful (if most obscure) of the analytic devices at our disposal. This is not to say that the analysis depended solely on intuition, because this was also where the matches from the literature and cultural reviews undertaken earlier in the research process were considered. In this rather less obscure undertaking, the findings from the academic literature were used as templates to search out the systematic properties of the interview data. On occasions certain avenues appeared to go right to the heart of the matter and associations seemed to 'pour' onto the page. At these points, the temptation to follow up these associations and neglect other possibilities was resisted. The dangers of closing prematurely were appreciated and generalities were postponed until a later stage in the analysis.

The second stage took each of these observations and developed them further; firstly, by themselves, secondly with respect to the evidence in the transcript and thirdly with respect to the previous background. Some utterances now had clusters of observations surround-

ding them. The third stage consisted of taking each of these clusters in turn, looking for interconnections, once again referencing previous literature reviews. The focus of attention had now moved away from the interview and towards the observations themselves. It was useful to develop the 'clusters' of observations by summarising them on a separate piece of paper, in the order in which they appeared. Whilst writing, it was found that they led to further impressions which added to the comments. Progressing through the observations in turn, later ideas complemented those made earlier and these further impressions were written next to the original ones. In this way, a series of perceptions about each issue which had been identified was documented. The fourth stage took each of these and subjected them to collective scrutiny. This was a time of judgement. Some of the clusters of thoughts had developed considerably and many comments had developed comments of their own as described above. At this stage each cluster was analysed, searching for identifiable themes. Once this had been completed, all the themes were considered to attempt to identify a small number of themes under which the others could be subsumed. Whilst undertaking this, it was necessary to re-group and re-classify some initial ideas. This was an important process, and helped to clarify the analysis of the interview itself. This process was undertaken for each of the interviews and the fifth stage considered the fourth stage conclusions from all the interviews. These fourth stage conclusions were brought together to elicit general themes which could help give an insight to the general thoughts of the community under investigation. At this fifth stage, the data had now moved away from the original transcripts and it was felt that the world was no longer being considered as the respondent saw it, but as it appeared to me, the analyst, after considering the background work which had been undertaken earlier. The general themes identified were consistent with

the themes identified from the initial analysis of the observational data, ie. Planning, Conceptual Understanding and Interpersonal Relations. These general themes have therefore been used as the main headings for the analysis of the interview data and the findings have been documented under these broad headings.

The process can be represented diagrammatically, and McCracken's diagram is shown below:

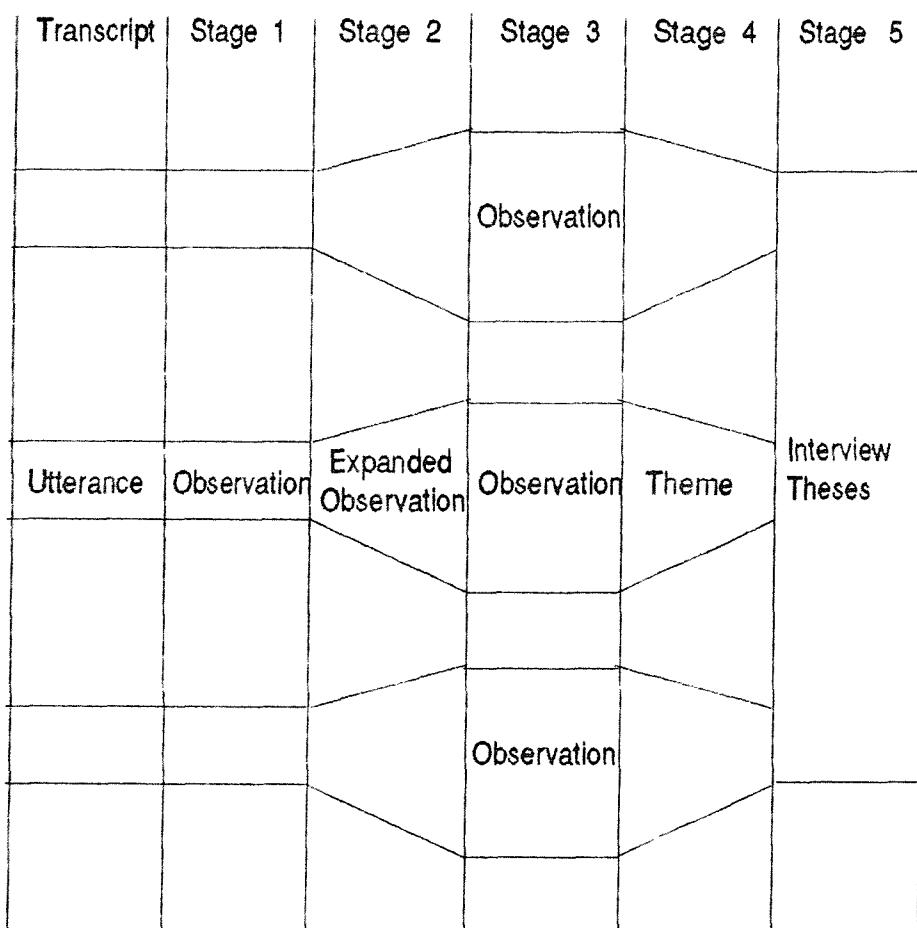


Fig (6.1) The Long Interview: Stages of Analysis

McCracken (1988) (p. 43)

The pictorial representation shows a movement from the particular to the general. At first, the investigator is embedded in the fine detail of the interview transcript, and with each successive stage, moves to more general observations. It is worth noting that this process has the advantage of creating a record of the processes and reflections of the researcher and such a record has been identified by

Kirk and Miller (1986), as a condition of the qualitative reliability check.

6.3 The Findings from the Interviews

The findings have been categorised into a number of themes and sub-themes which are detailed below. Space limits the amount of data which can be included within the thesis, but an extract from the interview with teacher 3 has been included in appendix III (pp. 311ff)

6.3.1 The Teachers' Planning

6.3.1.1 The Importance of Teamwork within a Supportive Atmosphere

(a) The first aspect of planning seems to concern the role of the Head of Department. Dialogue between the departmental team appears to be essential to enable the department to develop and grow. Despite the personal characteristics and idiosyncrasies of individual teachers a common culture was apparent:

* There was agreement about the methods of teaching (in addition to the content which should be taught) within which individual teachers could have their own styles. All the science teachers had contributed to the scheme of work and teacher 4 commented on the importance of this joint planning; "*Writing the programmes is important, although it's been heavy work. It also gets you involved in what's going on.*" Within this scheme of work, it was clear that individual teachers were able to adapt the methodology to suit their personal style. Teacher 3 commented that he preferred to base his work on a written text; "*It's a relief getting back to some basic structure, having a text book in front of you.*" (page 312), whereas teacher 4 felt that pupils should be more involved in using their own ideas; "*..they do it themselves - they create it themselves.*". The lesson observations, documented later in this chapter, confirm the view that individual teachers retained their own style within the common culture.

- * There appeared to be a shared view of how children learn. (This is documented under Conceptual Understanding.)
- * The findings show that planning was undertaken jointly in the department, and that all staff felt involved and valued. There was a sense of security in that even though there was a common culture, individual teachers could retain their independence. This idea has been mentioned above.
- * Reaching a consensus on the above takes time, and within this common culture the teachers felt confident to take risks and try 'new' ideas and methods. A supportive environment seemed to be instrumental in enabling this to happen. For example, Teacher 4 commented "*everyone in this department seems comfortable about not understanding certain things and talks to other people. There's not much hiding and I think that's very important.*"

6.3.1.2 Responding to Diverse Pupil Groups

(b) The second aspect concerned responding to diverse pupil groups. Here, this is being considered in the context of planning. This is discussed in greater detail later, but it is worth commenting that this aspect of planning appeared to be particularly important. For example; if some pupils in the group have learning difficulties, and have a reading age significantly lower than that of the majority, then they will probably need additional support. It is possible that these pupils will not only need the worksheets to be written with words and language that they are able to understand, but will also need different types of activity to be planned for them. This could include sentence completion, rearranging diagrams by cutting and pasting, and diagram completion. Teacher 1, commenting on the difficulties some pupils had experienced with a particular worksheet said; "*....if it had been one lesson, they would have got nothing from it at all, because the words*

baffled them....". This teacher amplified these points in his diary, which is discussed in section 6.8. The concentration span of the children was also pertinent, as would be expected. Teacher 1 commented; "*if they start to get fed up, or bored or whatever, then you start to get problems.*". When writing worksheets for use by a class, it seemed that the teachers felt that planning a variety of approaches, with attention to the reproduction quality of the materials, in addition to the context and readability of them could help enable children to engage in the activities and hence increase their concentration span on the scientific issue under discussion. Knowing the children was considered important. Teacher 1, commenting on the worksheets and materials which were designed and written within the Science department said; "*..it has been designed specifically for them, which no text book has.*". The interviews suggested that some pupils require more structure than others and that the worksheets, texts or activities should reflect this. For example, teacher 3 commented "*Some need more structure, more support. The open approach works very well with the most able kids, I'm not so sure it works as well with the least able - they need more reassurance, they need something in front of them.*" (p. 312). It is possible that particularly bright pupils might need to be challenged at a higher level and may need different, more challenging activities, rather than more activities of a similar nature. Teacher 3 commented; "*In terms of stretching the brighter ones you tend to make it more technical, by setting them extended problems, making them think through the concepts*" (p. 313). These aspects of overlearning and extension work are a central feature in the Responsive Teaching model and it was apparent that teachers not only appreciated that many concepts could be understood at different levels, but that the nature of the activities appropriate for pupils with differing needs had significant implications for planning. Teachers perceived the following to be pertinent:

- * The Scheme of work should be written such that conceptual development is planned. This was inferred in the interviews, and was a significant factor in the discussions within the science department throughout the researcher's four years at the school as the Head of Faculty.
- * Resources should be planned so that they are available when needed. This is not only to enable the teacher to follow the programme which had been written, but also to enable the teacher to respond to the children's ideas appropriately as the lesson proceeded. For example, teacher 1 commented on the scheme of work; "*The very fact that we have got work schemes makes a difference because the whole thing is geared up, there is equipment around. Going back to what we were saying, they can proceed with their ideas, because we knew it (resources) was going to be needed, it was thought about before.*" This feeling of anticipating where the teacher might need to respond to different children in differing ways was amplified by the other teachers. For example, teacher 3 suggested that overlearning and extension work should also be planned and resourced, and that potential problems should be anticipated. He commented; "*Our own course, mix and match as it is, with that (identified extension work, resources) on top of it, with remedial (work) to cover the less able would be much better than anything published*". Similarly, teacher 1 commenting on the planning, suggested that it was the planning which had enabled him to respond to pupils of differing ability.
- * A range of teaching styles should be incorporated into the scheme of work.

* A range of approaches must be planned into the scheme of work.

Teacher 4 commented; "*we're drawing from different areas so we've got a variety of activities - I think that's important.. so variety is good and also; we all get bored.*".

* The curriculum material needs to be accessible in terms of level of understanding, readability and presentation - but this does not mean that the content must necessarily be within the pupils' realm of experience. This latter aspect was not highlighted by the interviews documented in the study, but it was inferred from my many informal discussions with the science teachers as a member of the science staff.

* It was felt that whilst work should be planned to challenge pupils, it should aim to increase their self confidence. Teacher 4 felt this very strongly. Teacher 5 also commented "*I think the major thing is the confidence you give the kids.*". If pupils find the work too easy, teachers thought that boredom could set in. This is an aspect where dialogue within the department was felt to be important in order to 'get it right'. For example, Teacher 1 commented that "*the first few things were not on the spot*", but then goes on to discuss the work which was undertaken as part of the team and commented how the activities which were developed subsequently were found to be much more appropriate at meeting the needs of the diverse pupil groups.

* When examinations are approaching, pupils should be prepared for them; not only in terms of knowledge, but also in terms of presentation skills, methods of approaching questions, use of language etc. This could help increase the childrens' confidence by helping to make the process, question style, examination expectations etc. familiar to them. The department had developed its own revision scheme, to help children become familiar with these factors and teacher 4 commented; "*One thing is the revision schemes. I think especially the ones we wrote. The kids came back and gave us feedback on that. They centred*

their revision on those books rather than the notes".

6.3.1.3 Planning the Methodology

(c) The third aspect seems to concern the planning of the methodology in addition to the content. For example, teacher 3 commented; "*Hand in hand with this has gone what we've tried to do, changing methodology, from a more didactic style to a more open style, a more investigative style, a more pupil centred style.*" (p. 311).

* The findings suggest that teachers should build time into the lessons so that the teacher, and the pupils, have opportunities to think. It was felt that the teacher required space to monitor and review as the lesson progressed and the children required time to think about the activity being undertaken. Teacher 1 commented on the children needing time; "*these sort of worksheets also give them some time, a breather, a space to think what they're doing.*" and "*they needed time to realise they could do it*". This planning for time to think was considered to be significant. The other science teachers agreed with this sentiment, and although this was not raised during their interviews, it was very evident from my informal discussions with the teachers during the development of the science department.

* The data suggests that time should be planned to provide opportunities for the teacher to talk to the pupils and listen to their answers. This dialogue, was felt to be particularly important by all the teachers in the study. For example, teacher 5 commented; "*..talking to the boy you have to get some idea of what he's thinking and by your questions you've got to lead him a certain way; or use the questions to*

find out what he's thinking.", and teacher 3 commented; "*there's an awful lot of chat involved in these lessons.*" (p. 312).

* Teachers considered that planning should include activities to teach pupils how to develop their understanding, plan, problem solve, write up work, and research, not only to enable the pupils to undertake these methods of working for their own sake, but also to attempt to build their self confidence. If this could be achieved, then it is possible that these methods of working could be used by the pupils, independently, to enhance their conceptual understanding of an aspect of the topic under consideration. This could be quite a powerful tool where the teacher's time for individual interaction is limited in the course of a lesson. Teacher 5 suggested; "*The actual individual contact is important, but you have to build up an atmosphere where the others can work on their own.*" The teacher then referred to the manner in which the planning could enable this. It was recognised, however, that these activities need to be resourced.

* The findings also suggested that teachers should plan to use the class as a learning structure, in addition to using individual and small group work for its own sake. The teachers did not talk in these terms during the interviews, but it was inferred. For example, teacher 1 commented; "*That's the main thing, trying to round something off before we go on.*" It is pertinent to note, that teachers did use the class as a learning structure in practice but it seems as though this was done unknowingly, and was part of their general practice.

6.3.2 Individual Pupils' Conceptual Understanding

Most commentators would agree that pupils are in school to learn and whilst it is true that children learn many things during their school career, this study is concerned with children's conceptual understanding of science in particular. An appreciation of the proces-

ses at work could have a significant impact on the children's attainment at public examination, (as suggested by this study) and to help clarify the analysis, the main categories have been separated. The interviews suggested that teachers perceived the following to be significant:

- * Although the teachers did vary in their personal ideas, a common view was revealed in the interviews. Most striking was the view that children need to express their own ideas, and that these ideas should be valued by the teacher; for example, teacher 5 commented; "*There's a lot of scope for lads giving their own ideas,*" and "*I think their ideas are respected, I think that's an important thing*". Teacher 4 commented that "*..they do it themselves - they create it themselves.*" and "*The first thing for me is valuing the kid himself and to know it's a big thing for him to be wrong, in front of me as an audience and in front of the kids as an audience.*"
- * For lessons to be successful, teachers require a good understanding of the content to be taught and should be confident with it. Teacher 4 commented on the tension he felt between the requirement to teach the knowledge demanded by the syllabus and the desire to develop the children's understanding; "*..it gets a bit confusing sometimes ... you get a lack of confidence because there is such a volume of content as well in them*".
- * An appreciation of how ideas build from certain core concepts was inferred in the data. It is possible to understand concepts at different levels and it was felt that this should be appreciated by the teacher if he or she was to enable children from diverse pupil groups to learn meaningfully. This has commented upon earlier.

- * The teachers' understanding of a topic should be such that he or she can question effectively, to elicit the pupils' understanding and to help lead pupils' thoughts, from the pupil's perspective to the more scientifically acceptable view. This was mentioned in section 6.3.1.3 in the context of planning.
- * In order to comprehend the child's understanding and be able to appreciate what should be attempted next, successful teachers were able to question effectively and listen intelligently to what children were saying (there is an interpersonal dimension here which is discussed later). For example, teacher 5 commented; "*It depends on the skill of the teacher in understanding...where he's (the pupil) at, if you like, at the time, by talking to the boy you have to get some some idea of what he's thinking and by your questions you've got to lead him a certain way, or use the questions to find out what he's thinking*".
- * Teachers should appreciate that pupils' have their own preferred learning styles. Teacher 4 commented on this; "*...we've got a variety of approaches - I think that's important because certain people are inclined to want their education in a certain way*". This might, in part, be related to the earlier discussion where it was suggested that planning might take place most effectively when working as part of a team. This team planning could encourage dialogue, thus enabling teachers to learn from the experiences of others in addition to the individual teacher's experiences. It might, then, be possible to plan work which could appeal to pupils with different learning styles and hence encourage a deeper conceptual understanding of the topic in hand. Teacher 4 outlines the dialogue which had been taking place in the department concerning the emphases between using problem solving approaches to aid the children's conceptual development and the teaching of knowledge; "*..I think it's a balance....when I first came into teaching everyone was talking about GCSE and getting rid of*

content....and I think a lot of people, as you do when you get change, threw a lot of this content overboard and started to disbelief in it."

* Teachers require an appreciation of their own teaching style, and be perceptive to know when and how to adapt it. This aspect of using a variety of styles was a theme which was revealed in many of the interviews in addition to the informal discussions with the teachers. Teacher 4 commented on the need for the teacher to take an active part in the learning and not just deliver content to the children. Similarly, teacher 3 commented that he had moved towards a more open style of teaching, but that he felt the children (and the teacher) needed to "touch base" on occasions and that he should respond to this need (p 312). Teacher 3 suggested that using Warwickshire Process Science for a year helped teachers to become more aware of their teaching style and re-evaluate it; "*It was good as far as the staff are concerned in re-thinking our teaching style, in re-thinking our approach. It was a good stepping stone.*" Interestingly, teacher 4 commented on being "*self aware*", and suggested that by being "*self aware..other things come out of it. You're not always right, but if you're aware of the kid's situation and you don't want to hurt him...you'll readdress it, re-evaluate it and think it through again instead of just putting it in tablets of stone.*" This aspect of the teacher reflecting on his practice, being sensitive to the needs of individual pupils and having a willingness to adapt and respond appropriately to the children, is a theme which emerges through the data in this study. Once again, dialogue might encourage this process; as might mutual observation, which is an interesting issue where appraisal is under consideration.

* Successful lessons were associated with teachers understanding how different types of activities might aid learning in different circumstances. Teacher 1 suggested that some pupils prefer to be told what to do on occasions and teacher 4 commented that teachers need to be able to re-evaluate their approaches at times, depending on the response from the children.

* Learning was felt to be effective when children were encouraged to express and develop their own ideas. This was revealed in each of the interviews and was felt by the teachers to be a central feature of the success of the department in recent years. For example, teacher 5 commented "*There's a lot of scope for lads giving their own ideas,*" and teacher 1 commented on the work undertaken with the advisor from SENASS; "*One point (name) says is to get them to discuss*". This seems to require an appropriate understanding of the topic by the teacher him/herself. Also, there appears to be a significant interpersonal relations dimension here, as mentioned earlier in this section, and which will now be discussed.

6.3.3 Interpersonal Relations

Much of the above could be considered to be issues related to teaching rather than the act of teaching itself. To put the above into practice involves interacting with people and it is pertinent to note that the interviewees all commented on the practice of teaching, in addition to the issues identified earlier. Factors identified from the analysis included:

6.3.3.1 Valuing the Children

(a) The first aspect concerned how the teachers viewed the children themselves. It was very evident from the interviews that the teachers valued the children highly and had high expectations of them. There appeared to be a feeling of wanting to be with the children and a

seeking of ways to enable the children to gain in knowledge, understanding and confidence. There was a feeling of sensitivity and empathy on the part of the teacher. The following factors seemed to be particularly significant:

- * There was a need for a supportive atmosphere, where children felt that it was 'ok' to give a wrong answer.
- * Mutual respect was considered to be important by the teachers who were interviewed. Teacher 5, commenting on his observations of various science lessons said; *I think the crucial thing is showing kids you have an interest in them.*" Teacher 4 agreed with the interviewer when asked; "*So you're not giving the children the image of the teacher as the 'knower' of all facts. More a partner*". These comments highlight a general feeling revealed by the interviews that the teachers valued the children and their ideas.
- * The findings suggest that successful teachers had high expectations and communicated these clearly to children. Teacher 4 commented on the process of predicting GCSE grades where he felt it was pertinent that although some teachers were uncomfortable with predicting grades at first, this helped to raise expectations: "*a lot of people were uncomfortable with this at first - projecting grades and predicting high.*" Similarly, teacher 5 suggested that the science teachers encouraged children to succeed and had high expectations of them; "*The difference I see is that kids are encouraged, their ideas are given praise, they're given confidence, they are told that they do understand, they can do this, they can do that, they're told that they can understand, that they can make progress, that they have got good*

ideas...I think that's a major factor." Once again, this appears to be concerned with caring and valuing the children.

* Teachers must be able to talk to children and feel at ease with them. Teacher 5 expressed the view that teachers should be able to talk to children as equals; "*Talking to them rather than at them, then by implication you are respecting their ideas. You're not talking down to them, but talking with them. That's what I've seen happening is, sort of, conversations...where they haven't felt 'silly idea, try again'.*"

6.3.3.2 Verbal and Non Verbal Cues

(b) Whilst the above concerns a feeling of wanting to be teaching the children, it was also recognised that pupils react, sometimes in subtle ways, to the messages teachers give to them. Although these factors were not discussed during the interviews, the teachers did consider them to be pertinent, as was revealed by my many discussions with the science teachers in my role as Head of Faculty:

* Teachers understood the importance of being able to 'give the right messages', both verbally and non verbally , such as: tone of voice, appearance (wearing 'normal' clothes), posture, facial expressions, and the ability to smile and joke. This was apparent from the informal discussions but was not mentioned during the interviews.

* Teachers 'presence' in the classroom was pertinent. Teachers should be able to 'navigate' around the room, guiding the activities. This is an interesting category and is discussed more fully later, where the findings from the field notes are presented.

6.3.3.3 The Affective Dimension of Questioning

(c) Effective questioning was discussed in the section concerned with conceptual understanding. It is mentioned here, because the teachers believed that whilst they must be able to question effectively from a conceptual point of view, it was also important that they were able to use questioning such that the children felt that they wanted to answer the questions - from an interpersonal relations perspective. The lesson observations suggested that children can be encouraged to answer questions by using an appropriate tone of voice and phraseology alongside positive non-verbal cues in addition to the skilful use of open and closed questions. It is interesting to note that teacher 5 found this difficult to articulate. When asked "*What sort of skills would the teacher have to have to be able to do this?*", he responded; "*I think I've got better at this myself by being in science lessons....and watching you and other people.*" It appears that this interpersonal relations dimension of questioning is something which teachers feel is important but do not particularly consider consciously. The lesson observations (discussed later in this chapter) confirmed the view that this was a significant factor in enabling children to build their self confidence.

6.3.3.4 Teachers' Responses to Difficulties

(d) The teacher's response to the unexpected, was pertinent. It is possible that the pupils expect the teacher to be able to remain calm, whatever the circumstances, and to be able to provide a lead. This could provide the pupils with a degree of security if they know their teacher will react calmly in the face of a difficulty. It was also apparent, that teachers can anticipate some potential difficulties and that they could plan strategies for dealing with them in advance. The findings suggest that where lessons were successful:

- * Problems were anticipated wherever possible, and strategies for dealing with them had been considered. It was also felt that teachers should be able to put the strategies into practice effectively. This aspect of anticipation has been discussed under planning, above.
- * Teachers were able to respond appropriately to the unexpected, such as illness, accident, a pupil outburst, or another teacher entering the room. This was not evident in the interview data, but emerged from the observational data discussed later in this chapter in addition to the informal conversations with the teachers.

6.3.3.5 Teachers' Sensitivity to the Group Social Behaviour

(e) Lastly, it appears that whilst the interviewees perceived cognitive factors to be important, teachers should also be sensitive to the group social behaviour of the class.

* Lessons were successful where teachers were able to appreciate the social culture and group dynamics of the class, and were able to manage it appropriately. This aspect of responding to children was inferred in the interview data and seems to be related to the sensitivity and empathy of the teachers towards the children. This also appeared to be related to the manner in which pupils were reprimanded. Teacher 5 commented that being sensitive to pupils and encouraging them to develop and use their own ideas meant that teachers should be 'tougher' on the pupils than when a more traditional approach is used. "*..if you set them to work on their own, and they agree that they are to do something, and they indicate that they enjoy that responsibility, then if they don't produce, you have to come down hard on them.*" This toughness was not an overt toughness however, but was concerned with not allowing things to slip. This teacher commented that the teacher should be more vigilant in following up poor, or incomplete work than in a more traditional setting. He also suggested that this is concerned

with valuing children and having high, but realistic expectations of them. Teacher 4 agreed with this view and suggested that "*when he poorly achieves, use that as coaching, not to be negative and to say how bad he is.*" It appears that the teachers were aware that some pupils could need more cajoling than others to encourage them to engage with the activities, but the interesting finding is that this was not considered negatively, but as an opportunity for coaching or counselling.

6.4 Quality Control

Before discussing the analysis of the field notes, it might be pertinent to pause and consider the validity of the findings from a qualitative enquiry. Questions which have been of concern in this research are:

- * how does the investigator ensure the quality of his or her own research, and
- * how does the user of the research treat it with confidence?

McCracken (1988), comments on these issues and presents an adaptation of a scheme proposed by Bunge (1961). The adaptation attempts to enable the scheme to be used for the evaluation of explanation instead of theory, and qualitative instead of quantitative enquiry. He suggests that an explanation of qualitative data must exhibit the following conditions or, as Bunge calls them 'symptoms of truth':

1. It must be exact, so that no unnecessary ambiguity exists,
2. It must be economical, so that it forces us to make the minimum number of assumptions and still explain the data,
3. It must be mutually consistent, so that no assertion contradicts another.
4. It must be externally consistent, so that it conforms to what we independently know about the subject matter. (But this does not

suggest that innovative thought has no place. As Kuhn (1962) suggests, it is the data that refuses to submit to our guiding paradigms that offer the hope of important theoretical advances. What is being suggested is that external consistency needs to be used judiciously.)

5. It must be unified, so that assertions are organised in a manner that subsumes the specific within the general, unifying where possible, discriminating where necessary.
6. It must be powerful, so that it explains as much of the data as possible without sacrificing accuracy.
7. It must be fertile, so that it suggests new ideas, opportunities for insight.

It should be appreciated that Bunge's original scheme of twenty 'assaying criteria' was designed for the assessment of natural scientific theory and not social science explanation. The categories have, however, been very useful and the researcher agrees with McCracken that what the categories lack in philosophical rigour, they appear to make up in usefulness.

The standards have been outlined here because it is necessary to attempt to demonstrate the validity of the research to others where there is no realistic opportunity for the replication and confirmation that exists in the natural sciences. The criteria, developed by Smith (1978), to judge the validity of a study in which participant observation is used have been discussed in chapter four and this, together with the standards above, may help to clarify how an attempt has been made to produce a valid thesis. The field notes, which were written during the lesson observations, are now discussed.

6.5 The Field Note Analysis

It is not possible to include all the field notes in this body of work, but the field notes, together with the completed observation schedule from one of the observed lessons (lesson 4) are given in appendix II, (pages 308 - 310).

The procedure outlined in the first part of this chapter was used to analyse the field notes, written during the lesson observations. It was felt that this would enable the analysis of this qualitative data to be undertaken in the same manner as the interview transcripts. The procedure, outlined earlier in this chapter, was found to be a sensitive research tool with which to analyse the field notes, bearing in mind the earlier comments concerning the validity of the methodology.

As an initial stage to the analysis, the data from the stage four analyses were brought into one data file, using a word processing package. This enabled each of the three main categories to be considered individually, drawing together the themes and sub themes from the individual lesson observations.

The main themes from the interview analysis have been retained, and whilst drawing the data together, the researcher was fully prepared to identify alternative, or sub themes which became apparent. Whilst this categorization aided analysis, it should be appreciated that the findings suggest that it is the manner in which these factors are orchestrated by the teacher that seems to create the successful lesson. This will be discussed in greater detail later.

6.5.1 The Teachers' Planning

6.5.1.1 The Importance of Teamwork in Planning

(a) The first aspect of planning seems to be related to the teacher being a member of a team. It was clear from the observations that the

teachers were following a particular methodology which had been discussed over a period of time. There was agreement concerning the teaching methods, though individual teachers had adapted the methodology in the light of their own experiences:

* Where planning was effective, it had been undertaken as part of a team, not only to share the work load, but also to try to ensure that the work and methodology were coherent across the department. This was evident in that all the lessons observed conformed to the scheme of work.

* Where lessons were successful, the teachers had put the agreed methodology into practice, even if individual teachers had adapted it to suit their personal style. These teachers believed in the methodology and were actively striving to respond to the children. One teacher had followed the scheme of work, but did not fully appreciate the implications of the methodology he was using. This mismatch between what the teacher believed and what he was attempting to do resulted in less successful lessons, and stresses the importance of continual dialogue within the department. This was particularly noticeable in lesson 1, where the pupils were studying ecology. Telgrun funnels had been set up earlier and the pupils were attempting to identify what had been found. Many pupils had found nothing but the teacher had not planned for this eventuality. One boy, who was sent out of the classroom for poor behaviour was questioned by the researcher after the lesson and when asked what the problem was, answered; "*Didn't find anything*". He then commented enthusiastically about a previous experiment involving pitfall traps where he had found a mosquito and then went on to say; "*I didn't find anything today and got bored. I talked to others and then got told off*". It was as though this teacher had taken the investigative nature of the work to the extreme and had not appreciated the importance of enabling the pupils

to engage in the lesson when planning the work. It was clear that teacher 2 preferred a more didactic approach. He demonstrated the practical work from the front of the classroom and the pupils did not engage in group work until 36 minutes into the lesson. When the pupils were working in groups, he did, however, move from the front of the classroom and engaged in discussions with pupils in small groups. It was in this latter part of the lesson that the teacher responded most effectively to the children. Lesson 4 had also been planned carefully; the required equipment was available, and the pupils were able to engage with the activities. In this lesson the teacher used many opportunities to speak to the children, and used questioning very effectively. For example; "*Teacher continues to move from group to group, pausing to quiz the children.*" (p. 310 at 27 minutes). The planning had enabled the children to engage with the activities and had created opportunities for dialogue to take place. This aspect of planning is considered to be significant and is discussed in more detail later in this chapter.

* The findings suggest that planning should enable the individual teacher to become familiar and confident with the content, methodology, texts and worksheets used, the location of equipment and room layout. It was noticeable that if an individual teacher was not confident with the materials, or inadequate planning had meant that something required was not available then this could make the teacher uneasy, leading to the children receiving negative verbal and non-verbal cues to which they may respond. It is also possible that the teacher, under stress, might react inappropriately to incidents within the classroom, affecting the atmosphere and hence the quality of the interpersonal relations. The stress caused could affect both the experienced and inexperienced teacher alike. It is also worth considering this from the

pupils' perspective. Problems associated with poor planning, such as the equipment not being available could also cause pupil stress. This might then affect the way in which individual children might react, or behave in the classroom, exacerbating the problem. This was particularly evident during two of the lessons observed. For example, Lesson 4 did not start well. The field notes comment; "*The fact that the apparatus had not appeared threw the teacher for a while...The slight confusion probably accounts for the slightly negative feeling documented. The pupils could tell that something was not right.*" This teacher was a very experienced and well respected teacher, but during this lesson, two incidences of 'Excessive and unnecessary authority', and three incidences of 'Negative non-verbal cues' were recorded. This is considered to be out of character and amplifies the discussion above. During earlier discussions concerned with children's conceptual understanding of some science topics, a significant emphasis was placed on the ideas which children brought with them to the lesson. It is worth considering at this point, that children also bring aspects of the emotional dimension into school. A pupil might have been bereaved recently, be the victim of bullying, be suffering from girl/boy friend difficulties and so on. Whilst it is not possible to plan for the possibility of emotional trauma, it is possible that poor planning could aggravate the situation. In some circumstances, the additional stress of a poorly managed lesson might affect the children's behaviour and learning.

* Where lessons were successful, the relevant resources, materials and books were available at the appropriate time. Where resources were not available when required, there was a marked increase in teacher and pupil stress. In the example mentioned above, this clearly resulted in the teacher reacting inappropriately to a class and the quality of the interpersonal relations decreased despite the fact that this particular

teacher was viewed as one of the best liked, and most effective in the school. This has implications for advanced planning and might involve the deployment of a technician. The teacher could be teaching one lesson after another, without a break, and technician help in clearing one set of resources and setting up another could be an important factor. This is an example where team planning might help reduce the problems associated with competition between classes for resources and/or technician time. This corporate planning might help alleviate some of the causes of teacher and pupil stress in the classroom, and hence enable more effective learning to take place.

6.5.1.2 Responding to Diverse Pupil Groups

(b) The second aspect concerns planning with respect to diverse pupil groups. Each class contained a range of pupils, and it was apparent that where lessons were successful, this had been considered an important factor during the planning of the lesson:

* From the findings, successful lessons were associated with children being enabled to gain in confidence. It appears that successful teachers were able to anticipate difficulties and had planned to alleviate them. For example, teacher 3 had ensured that all the equipment and text books required for the lesson were available before the pupils entered the room. They were ready when the teacher wanted to use them. The texts were clear, contained diagrams and a variety of typefaces, were well presented, and the language and readability of the books was appropriate for the age and ability of the class. The teacher was familiar with the texts and where apparatus was stored in the room. This appeared to enhance the teacher's confidence (eg. the language used by the teacher demonstrated that he was confident with the class and the work being undertaken) which might then have enabled him to respond appropriately during the course of the lesson. Another example

of how teachers can plan to enable children from diverse pupil groups to grow in confidence concerns the nature of worksheets used. Appendix VIII shows some of the worksheets developed when teacher 1 worked alongside the advisor from SENASS. They include, for example, diagrams which children are asked to put into the correct order (p.325). This helps alleviate the problem of children who might lose confidence when asked to draw diagrams in science. Examples of sentence completion exercises are also shown (p.326). This could help some pupils to structure their work and record the important features of an experiment or task. Sometimes, the words to be used are listed for the pupils. An example of a chart, which the children complete as they undertake the practical work is also given (p.324). Once again, the chart itself could help some children to record their results coherently, whilst the 'possible reasons' given could help others to document their reasons with increased confidence.

Planning for the above requires a certain experience and this can be shared in a team. This could be particularly pertinent if the department contained students or newly qualified teachers, or where the nature of the curriculum was subject to external change. Teachers of science in particular have experienced this external change with the introduction and subsequent rewriting of the National Curriculum programme of study. With the introduction of the new arrangements for initial teacher training in which schools now play a very significant part, the consideration of students within the departmental team takes on a particularly urgent significance.

* In the context of planning, it is interesting to note that the findings highlight the manner in which the individual teacher was able to adjust the team planning to the needs of his or her individual classes. It is interesting to compare the manner in which teachers 2 and 3 attempted the work on acids and alkalis with parallel groups.

These are documented on pages 197 to 202, and concern lessons 2 and 3.

Teacher 2 was demonstrating the work which the class had attempted unsuccessfully the previous lesson and comment has already been made on this teacher's preferred style on page 155. Teacher 3 was approaching the same work, with the same materials in a different manner. He was less didactic, and was willing to allow the pupils to attempt the work much earlier in the lesson than teacher 2. It appears that rather than spend a significant amount of time ensuring all the pupils understood what to do, he spent approximately 10 minutes outlining the task, and questioned the pupils to ensure they were clear in their own minds. He then started the practical work, but called the class back together, for a quick demonstration, when he felt that this was necessary to correct a misunderstanding. He also pulled the class back together at the end of the lesson for to discuss the findings of the work. The graphs representing the cognitive and interpersonal responsiveness of the teacher, together with the division between class and individual work can be found on page 202. It is interesting to note that lesson 3 was considered to have been more successful than lesson 2, and this is discussed in greater detail later in this chapter. It is worth highlighting, however, the manner in which different teachers had amended the scheme of work to suit their own preferred styles.

* It appeared that sudden conceptual jumps, or inappropriate work could be the source of a problem within the lesson. Successful lessons had been planned to develop understanding and the teacher had a clear idea of the pathway through the topic in general, and each lesson in particular. It is interesting to note that although lesson 6 had been planned carefully, the teacher suddenly started questioning the pupils about elements (which had not been planned), although the topic under consideration was the characteristics of living things. The teacher asked the class which two elements make up water, and when the response

from a pupil was "blood", the teacher suddenly stopped the lesson with "Wooh!". The field notes comment; "*I wonder if the sudden conceptual jump from biological discussions concerning living things to elements confused the pupil*". A few minutes later the class was becoming restless and the teacher resorted to silent work.

Lesson 4, however, was a lesson conducted by the same teacher and there were no such sudden conceptual jumps. The teacher adhered to his original plan and the lesson was much more successful. It recorded the highest rating for both interpersonal and cognitive response on the part of the teacher. (p. 203 ff). It appears that whilst it might be appropriate for teachers to respond to the perceived needs of the pupils during the lesson, care should be taken when diverting from the planned work to ensure that inadvertent conceptual jumps do not occur.

* The findings suggest that to enable pupils to gain in confidence, teachers should have a number of alternative strategies and activities available. This proved most successful where they had been planned; eg: use of text book, class discussion, group work, practicals etc. This was undertaken most successfully where teachers had taken account of the social behaviour of the group. (Examples of this occurred with the work undertaken by a teacher and the advisor from SENASS, which is discussed later). This could depend on the day or even the time of day together with the subject, teacher, or activity the children had experienced before their science lesson. The researcher had noticed that the same class could arrive at their science lesson, on different days, in completely different moods, depending on the activities which had occurred prior to the science lesson.

* Successful lessons demonstrated that planning had taken account of time. Even though sufficient pace had been planned, and pupils were pushed through the activities, sufficient time had been available for

pupils to complete tasks successfully. (Lessons 3, 4 and 5 are particularly good examples). Monitoring the use of time during the lesson is also discussed under Interpersonal Relations.

6.5.1.3 Room Layout

(c) The physical layout of the room was found to be important and this could also have implications for planning:

* The school in this study had fixed benching and it was clear that this hindered the teacher's access to the children at times. In one case, there was insufficient room to walk between two long, fixed benches and the children who sat along these benches could only be addressed by the teacher when he or she was leaning over the bench from the opposite side. When children sat in these positions, the teacher's access to the pupils on the opposite side was restricted further. The findings suggest that where lessons were successful, the teacher was able, on occasions, to sit next to pupils and talk to them. The fact that this was sometimes impossible had a detrimental effect on the interpersonal relations within the classroom. It was also found that the teacher can use his or her position to deter off task behaviour; the field notes record: "*The teacher moves over to group Y who then get back on task.*"), and this was difficult to effect where accessibility was a problem. In some cases the teacher used his or her line of sight to deter off task behaviour, even though close proximity was impossible, (for example; during lesson 6, the field notes record: "*Two pupils at the back of the classroom were talking. The teacher noticed this and moved himself so that they were more clearly in his field of vision. He looked at them and said 'Sh!', looking sternly. This was sufficient for them to stop talking and to return to the task.*"). It was also found that some children can find accessible objects a distraction, and fiddle, or play with them. Alternatively, a planned

wall display was found to encourage pupils to focus their minds on the conceptual issue of interest, particularly where the display consisted of the same pupils' work from earlier lessons. A particularly effective strategy concerned using the pupils' display to demonstrate their progress and changing ideas by comparing their current ideas with the views held previously. This was not evident during the observations for this study, but it was observed during the work with the department as Head of Faculty.

6.5.2 Individual Pupils' Conceptual Understanding

This theme has been subdivided into a number of sub-themes. It appears that whilst this is concerned primarily with learning, the issues of 'diagnosis' and confidence in the learning process were seen to be very important.

6.5.2.1 The Teachers' Confidence

(a) The first aspect concerns the teacher's confidence and successful lessons tended to occur when the teacher was confident with the methodology in addition to the content.

6.5.2.2 The Pupils' Confidence

(b) The second aspect concerns the pupils' confidence:

* The findings suggest that closed questions can be used to build confidence, eg: where teachers asked questions in which the pupils clearly knew the answer, the confidence of the pupils appeared to increase. This was evident with both the academic content and the act of answering questions publicly and privately.

* It was also evident that taking account of pupils' questions, and interests, helped build success and confidence. It seems that where pupils asked questions and expressed their own thoughts and ideas they tended to boost their confidence in articulating these ideas, in

addition to building their conceptual understanding. There is an interpersonal relations dimension here, detailed later.

* It was apparent that where lessons were successful the teacher introduced scientific terminology in a non threatening way and encouraged its use in subsequent work. This appeared to build pupils' confidence in the terminology itself, its use, and the pupils' accessibility to other related scientific literature. Teacher 4 used colloquial English to increase accessibility. He used these colloquialisms to introduce new words in a non-threatening manner and built the issue under discussion on previous ideas. Correct terminology was integrated into the colloquialisms and it appeared to be particularly effective.

* It was noticeable that each laboratory had a spelling list, in fairly large letters, displayed in a prominent position. The department had considered which words had caused the greatest problems with children and it was clear that pupils referred to the list whilst writing up their work. It seemed that this encouraged pupils to document their work because they knew they were using the correct words and the correct spelling. It was interesting to note that a discussion with one of the teachers highlighted the importance of the spelling list. He suggested that whilst it was used by pupils, where the words referred to items of science equipment, the word alone appeared to be insufficient. In some cases, the pupils had not known the name of the piece of apparatus, and hence the spelling list had not been particularly helpful. He suggested that pictures should accompany these words and that this might improve the accessibility of the list further. This conversation not only highlighted the use of such spelling lists, but also demonstrated the manner in which this member of staff was reflecting on his current practice, and was considering how to further improve the tactics and strategies used within the department. Observa-

tions which were undertaken as Head of Faculty, rather than researcher, also showed that the spelling list encouraged the children to work independently of the teacher since they could refer to it unaided. This independent working was found to be significant and will be discussed later.

* It seems that making continuity and progression explicit was significant in helping build the pupils' confidence. All the teachers referred to previous work (although this was not recorded in the field notes as it was not considered significant at the time) and it seems that the teachers felt that the children needed to be reminded that they were making progress - encouraging success and building confidence to tackle new work. It is possible that this 'progress made explicit' could be particularly pertinent when teaching adolescents who are possibly grappling with the uncertain transition from childhood to adulthood.

* The findings suggested that the self confidence of the pupils could be increased not only by using materials within the pupils' experience, but also by introducing new material in a structured manner. For example, electrolysis (Lesson 4, pp 308 - 310)) was not within the pupils' experience, but the pupils were familiar with the teacher, equipment, text book used, method of working, layout of laboratory, where things were kept and some of the ideas from previous work. Even though the material was not from within the pupils' own immediate experience, it proved to be a particularly effective lesson.

6.5.2.3 Teachers' Use of Questioning

(c) The third aspect concerns the use of questioning by the teacher as a means of eliciting the pupils' understanding:

* Questioning was used to elicit pupils' understanding of a concept to attempt to make the understanding explicit to the pupil in addition to the teacher. Lessons appeared to be successful where teachers were able to use the information in a diagnostic manner. For example, teacher 4 in lesson 4 used questioning very positively. Similarly, questioning was used when negotiating understanding, where the teacher was probing to gain a better understanding of the pupils' position, helping to lead the pupil towards the accepted scientific view.

* Small group work appeared to enable the teacher to ask more focused questions, providing more detailed feedback on pupils' understanding. Opportunity was also taken to use this questioning to encourage, challenge and praise pupils. (See also Interpersonal Relations).

* Some teachers constantly checked pupils' understanding, monitoring and pushing the work forward, both in terms of understanding and progress. For example, the field notes record; "*Teacher continues to move from group to group, pausing to quiz the children. As each child answers, teacher with hand to mouth, obviously listening and receptive.*", (p. 310 at 27 minutes). This feedback was important because it was clear that the teacher used it, not only in terms of framing the next question, but also in terms of directing the pupil to an alternative activity. Successful teachers appeared to have a 'cognitive perception'.

* Closed questions were used by the teacher to check pupils' understanding, to help build pupils' confidence where the answer was known, and to check that they were paying attention. For example, Teacher 3 asked a pupil how many tests could be undertaken at a time,

to make the pupil aware that he had made a simple mistake. Also, during the same lesson, the teacher asked pupils to feed back to the class what they had found out and the pupils responded readily. This appeared to provide valuable feedback to the teacher, which he or she could use to act upon.

6.5.2.4 Challenge and Pace

(d) The fourth aspect concerns the challenge and pace of the lesson:

* It was clear from the findings that work should not only be accessible to enable pupils to engage with the activity, but that it should also challenge the pupils at an appropriate level. It was found that work requiring little thought, or which was too difficult could lead to boredom and off task behaviour. Lesson 1 is a good example where pupils became bored, and lesson 6 is an example of where pupils found the discussions difficult. In both cases, off task behaviour was recorded.

6.5.3 Interpersonal Relations

It is clear that interpersonal relationships (whether they be pupil-pupil or pupil-teacher) are an important factor in any lesson. What is interesting from these findings is how central a feature this may have been.

6.5.3.1 Group Social Behaviour of the Class

(a) The first category concerns the teacher's awareness of the group social behaviour of the class. The influence of the group on the behaviour of individuals has been well documented elsewhere (eg: Schachter (1951), Krech, Crutchfield and Ballachey (1962), Asch (1951), Crutchfield (1955) and Milgram (1958), amongst others). In the role as Head of Faculty, it was noticed that individuals could indeed behave and act very differently when in a group compared to when they

were not under the group's influence. When pupils moved around the secondary school, it was also pertinent to note that the same individuals could well be members of different groups at different times during the school day, whether this was as members of different classes, or groups which meet outside the classroom. It appeared that the same individuals sometimes behaved in different ways, depending on the group to which they belonged at that moment. It was also apparent that this could occur in the same science classroom when certain members of the class were absent. It was possible that this could change the dynamics within certain groups, or even alter the group to which a particular individual chose to belong. What is pertinent to this study is that successful teachers were aware of factors such as these, and considered them, not only in the planning of the lessons, but also during the lessons themselves:

- * The findings suggest that lessons were successful where teachers were aware of the dynamics at work in the classroom and were able to select appropriate strategies to tackle any potential problems. This had the effect of attempting to avoid problems in addition to using the dynamics within the class to positive affect. It appeared that for lessons to be successful, the teacher required a sensitivity to the social behaviour of the group and an ability to act appropriately if a problem was thought to be threatening the progress of the lesson.
- * Where lessons were successful, the teacher was vigilant, scanned constantly, monitored the pace, mood of the class, conceptual development, and the timing of activities.
- * Whole class discussions were useful, as documented earlier, but it was clear that successful lessons were associated with the teacher being sensitive to how effective these might be, or how long they should last, depending on the social behaviour of the group. This sensitivity and awareness also applied to the other strategies. The

field notes comment; "*The class becomes restless ('fizzy') and the teacher notices this. He refers back to the text book....this seems to concentrate the minds of the pupils and they are brought gently back on task*".

* During successful lessons, the teacher involved all the pupils. In group work, the teacher had many, even if brief, contacts with pupils and there was much movement of the teacher around the classroom. The teacher constantly checked on pupil progress and understanding, praising and encouraging where thought appropriate.

6.5.3.2 Sensitivity and Empathy Towards the Children

(b) The second aspect seems to concern the empathy and sensitivity of the teacher towards the children. The observations highlighted the importance of the way in which the teacher treated the children. Lessons appeared to be more successful where the teacher appeared to want to be with the children and where a positive atmosphere had been fostered. This was evident in a number of ways:

* The teacher gave verbal cues to the children, not only in what was said, but also in the manner in which it was said; for example: positive cues included praise, being openly welcoming, joking, using humour (p. 309 at 12 minutes), using colloquialisms, talking to pupils as equals in the learning process, being polite, and in more than one case; singing or chanting at the start of the lesson (eg. p.309 at 0-3 minutes). Negative cues included shouting, denigrating pupils, expressing low expectations and using sarcasm. It was interesting to note that the nature of the language used by the teacher was reflected in the mode of the language used by the pupils between each other. This was thought to be significant because this was used by the teacher to help foster positive interpersonal relations between the pupils. This appeared to have a positive effect on the success of the lesson, both

in terms of the relationships within the classroom and the conceptual development of the pupils.

* What was clear from the observations was that non-verbal cues were seen to be as important as the verbal cues. All the teachers gave non-verbal cues to the children, whether they were aware of them or not; positive cues included smiling, eye-contact, posture, head nodding, lowering the body or sitting with pupils when discussing issues, being relaxed with the children, overtly listening to pupils. There are many examples in lessons 3,4,5 and 6. Negative cues included ignoring pupils, bored / disinterested look, raising eyes to the ceiling, and sighing. Examples were found particularly, although not exclusively, in lessons 1 and 2.

* The findings suggested that at times, the teacher ensured that questions and praise were heard by many pupils, giving cues that trying and effort will be rewarded. For example, teacher 4, in response to a wrong answer says; "*No, but you were thinking positively weren't you*", which was heard by the whole class (p. 310 at 51 minutes).

* Where lessons were successful, the teacher ensured that pupils were not ignored, even if it meant not following up a pupil request or

idea immediately.

* The findings suggest that where lessons were successful, the teacher gave quiet, individual reprimands - and did not shout at pupils across the classroom. For example, the field notes for lesson 4 (p. 310 at 27 minutes) note that the teacher quietly asked a pupil "*who is going to look after your experiment?*" when the pupil was about to walk off and leave the bunsen burner on. However, it also seemed that it might have been pertinent to allow others to hear the reprimand at times, but that it should not interrupt the flow of the lesson.

* Quiet pupils were not made to come to the front of the class, or to answer questions out loud if it was felt that this could cause embarrassment. Similarly, such pupils were given quiet praise and encouragement, (For example, Lesson 4; p. 310 at 36 minutes)

* New pupils were sensitively integrated into the class and not left to fend for themselves. For example, on one occasion a group of pupils was asked to explain the practical to a new boy joining the class, and on another occasion, a group was asked to explain what was happening to a pupil returning from an absence (Lesson 4: p. 309 at 12 minutes). This had the effect of releasing the teacher from giving what could be felt to be a disproportionate amount of time to one pupil, at the expense of the rest of the class, in addition to engaging the pupil with other pupils in the class. It also appeared to have the effect of building the confidence of the pupils who were explaining to the returner/new pupil.

* Using pupils' names seemed to be particularly effective. Many pupils have commented that they like their name to be written when the teacher is marking their exercise books - eg: 'Well done John'. The observations demonstrated the effectiveness of using pupils' names in

the classroom. In the school observed it was customary practice for teachers to use pupils' first names. In the researcher's own experience, this also seems to be pertinent if the customary practice is to use surnames. In one school, the researcher noticed that where the practice was to use surnames, the pupils themselves used their surnames between each other. It appears that, whatever the convention used within the school, the use of pupils' names could be used to help foster positive relationships.

* The observations showed that one teacher in particular had built up a positive relationship with at least one class over a period of time. This was evident because the teacher was willing to admit a mistake and apologise to a pupil. It is not suggested that a teacher new to a group, or to a school, could necessarily use this as a strategy to foster positive relationships, but it is pertinent to note that it was effective in this case where positive relationships had already been established.

6.5.3.3 Using the Class as a Learning Structure

(c) The third aspect concerned the way in which the teacher used the class as a learning structure, where consideration had been given to the overall activity and movement in the classroom in addition to individual student contacts. This management of the class appeared to be particularly effective, not only in terms of clearing up misunderstandings, but also in terms of sensing the mood of the class and being able to react appropriately. This could be allied to the knowledge structures and comprehension processes a teacher uses to interpret classrooms and whether an individual teacher considers the class to consist of a group (or number of sub groups) of children, or a collection of individuals. This management of group dynamics appeared to be particularly significant:

- * Successful teachers defined clear boundaries between activities where each section was clearly delineated (For example, p. 202 for lesson 3). Also, where lessons were successful, teachers ensured a smooth transition between activities.
- * Where lessons were successful, the class was brought together for a discussion, during the lesson, if the teacher noticed that there was a general need (eg, a prevalent misconception or a general 'fizz'). Examples can be found on pages 200 to 210 for lessons 3, 4 and 5 respectively.
- * The findings suggest that where lessons were successful, the class were brought together at the end of the lesson to summarise, share ideas and round off the lesson. (The examples mentioned above are particularly pertinent). Closed questions appeared to be effective in reinforcing, checking understanding, and enhancing pupil confidence, in addition to providing a coherent completion to the lesson.
- * The teacher ensured that all were listening if he/she wished to explain something to the whole class.
- * The teacher quickly regained control if pupils appeared to be gaining the initiative.

6.5.3.4 Some Comments Concerning the Teachers' Use of Control Techniques

- (d) The fourth aspect concerned the way in which successful teachers remained in control of the class, navigating through the learning activity. It appeared that this could be concerned, in part at least, with the socialising process. The pupils under consideration came from diverse social and cultural groups, and it seems reasonable to assume

that this is true for many, if not most, comprehensive schools. There is a considerable body of evidence to suggest that as children grow older they may need to go outside the family, not just to learn the social skills that he or she may need as an adult, but also to fulfil the psychological needs that come with adolescence. It is possible that groups of adolescents have, or quickly evolve, codes of values and behaviour of their own which might be very different to those of the family or the school. This could lead to conflict. One of the attitudes involved in this conflict is that towards authority. It does not seem reasonable to expect adolescents, necessarily, to be readily obedient. The ease, or otherwise, with which an individual teacher can 'control' a class could depend, in part, on the cultural view of authority held by the children. In terms of the ways in which the teachers thought about the children, there was a striking similarity between the teachers in the study. This has been highlighted earlier, when the interviews were discussed, but it was also apparent from the study that the teachers took time to build relationships according to a personal style which seemed to be based on a collective view. This was evident in a number of ways:

- * Where lessons were successful, instructions given were clear and unambiguous. For example, in terms of whole class management, some teachers had obviously explained that if they shouted 'freeze', then all the class should immediately stop and pay attention to the teacher. This had been taught to all the classes previously, mainly as a response to an emergency, but it was also used to call the whole class to a halt very quickly. The researcher also considered this significant in terms of individual pupil management in terms of safety, in addition to procedure. Unclear instructions were not helpful. For example; where the teacher shouted "*Get something down in your exercise books*) the researcher did not notice any pupils respond positively to this unclear

instruction.

- * The findings suggest that expectations should be made clear and unambiguous. One teacher referred to an incident outside the classroom, emphasising his expectation of behaviour both inside and outside the classroom.
- * It appeared to be necessary for the teacher to have 'presence' in the classroom. This is difficult to define, but seems to be concerned with a number of factors, including the verbal and non-verbal cues given to the children by the teacher, in addition to the awareness of the teacher of what was happening in the classroom. In one case, not noted during the field work, but in the role as Head of Faculty, the teacher referred to an off task pupil by name even though the teacher had his back to the class. This had the effect of almost startling the pupil and brought him back on task.
- * Where lessons were successful the teachers responded appropriately to incidents within the classroom: for example; pupil humour, off task behaviour, disruption, accident, interruption by another member of staff. The findings suggest that there was a collective view, between teachers, between pupils, and between pupils and teacher, of what was, and was not, acceptable, together with the manner in which teachers were expected to respond.
- * The teacher politely and pleasantly did not 'pick up' on pupils' ideas which are 'off target'. For example 'We'll look at that later.'
- * The teacher monitored the use of time and expressed clear time deadlines. This has been discussed earlier where the significance of setting clear boundaries between activities was discussed.
- * The teacher used the text book, or worksheets to re-focus pupils' minds on the conceptual issue under consideration, when felt to be appropriate.

6.6 Further Discussion on the Manner in which Teachers Responded

Cognitively and Interpersonally During Science Lessons

The above analysis proved most enlightening. It was surprising how central a feature the dimension of interpersonal relations might have been and it was thought pertinent to use the above information to delve further into the lesson observations themselves. The relationship between the manner in which the teacher responded to children cognitively and the factors contributing towards the interpersonal relations in the classroom were of particular interest. An attempt has been made to expand the categories which were originally used in the observation schedule to enable the data to be represented graphically. It was hoped that this might generate fresh insights into the factors at work.

The idea that there are four main factors at work in the classroom has already been discussed. These are considered to be: the group social behaviour of the class, the planning of the teacher, the conceptual understanding of the children, and the interpersonal relations. This section is concentrating on conceptual understanding and interpersonal relations whereas the influence of planning will be discussed later.

The researcher is considering, here, how teachers respond to children, cognitively and interpersonally and has attempted to identify the main factors associated with these categories using the data from the lesson observations and interviews.

The sub headings below are followed by the abbreviations used to identify the various categories in the charts which follow.

6.6.1 Cognitive Response

Accepts and Uses the ideas of pupils: (Acc.)

If the teacher is to be able to respond cognitively to children,

it is important that he/she is able to elicit the children's ideas. In this way, it might be possible for the teacher to encourage the children to use their own language to clarify their own conceptual position and be able to take the discussion further, or to direct the child towards a particular activity. The aim will be to enable the child to develop his/her thinking and provide a focus for discussion with the teacher. It appears that the teacher must be willing to negotiate with the pupils and encourage the pupils to negotiate with others. This might not be possible if the teacher cannot accept and use the pupils' own ideas.

Discussion: (Dis.)

As mentioned above, it is important that the teacher is able to discuss the work in hand with pupils. This discussion could be initiated by the teacher or the pupil (as was identified in the original observation schedule). The category of pupil-pupil discussion has been omitted because the emphasis here is on how the teacher may help children to focus their minds on the conceptual issue of interest.

Open and Closed Questioning: (Op. for Open questioning, and Cl.

for Closed questioning.)

The two categories discussed above will require questions to be asked of the children. This category was not used when compiling the graphs because it was felt that even though the teacher might be responding to pupils cognitively by questioning them, this would be subsumed into the categories of 'Discussion' and 'Accepts and Uses pupils' ideas'. The response was taken to be the determining characteristic, rather than the stimulus.

Directs pupil: (Dir.)

If the teacher is responding to pupils, it might well be necessary

to direct them to particular activities, whether to provide further challenge, or to help enable the child to integrate the 'new' knowledge with his or her existing ideas. This category was taken to indicate that the teacher had thought about what the child should now attempt, and was directing the pupil in response to the negotiation.

Progress made explicit: (Prog)

This category was identified during stage five of the observation analysis. It was felt at the time that the teacher could be responding to pupils by making continuity and progression explicit. Whilst this could well be important it was taken to be subsumed into the other categories detailed above.

6.6.2 Interpersonal Response

The analysis so far suggests that the interpersonal response to the child could be either positive or negative. The following have been considered to be the factors associated with this positive and negative interpersonal response.

6.6.2.1 Positive Interpersonal Response

Reduces Tension: (Red.)

It was evident from the observations that the ability of the teacher to reduce tension in the classroom was an important factor in enabling pupils to gain in confidence. This has been discussed earlier in this study, but a particularly effective strategy was observed where two of the teachers started some of their lessons by either singing, or chanting to the children. The children responded in a similar manner and this had an immediate effect of reducing any tension which might have been present. This was a particularly extreme example and demonstrated the nature of the interpersonal relations in these classrooms. Another example included an incident where the teacher

reprimanded a pupil in such a way that tension was reduced. The pupil had spoken out of turn, and the teacher had heard the word 'red' mentioned. The teacher responded "*You'll see red in a moment - splat against the wall.*" The field notes comment: "*This reduced the tension in the classroom*". All the teachers in the study reduced tension to some degree, at various times, and this has been recorded under this category.

Praises and encourages pupils: (Pr)

This category was also discussed in the original observation schedule, and its importance is amplified by retaining it here.

Verbal Cues: (Ver.)

In addition to the above, it became apparent that teachers responded positively to pupils by using verbal cues such as:

- * closed questions to draw pupils into the lesson,
- * social chat,
- * using non-threatening language, eg, slang,
- * admitting mistakes,
- * politely postponing a response to a pupil's idea, answer, or request.

Non-verbal Cues: (Nv)

It was also apparent that teachers responded to pupils in subtle ways. On occasions, these cues were given unknowingly eg:

- * smiling,
- * posture (eg lowering body to reduce height),
- * gesturing with the hands, eg; thumbs up,
- * head nodding whilst listening,
- * sitting beside pupils whilst discussing an issue,
- * overtly listening to pupils' talking.

Teacher's position in the Classroom: (Pon.)

The teacher sometimes moved towards a pupil who was off task, and gave no other cue at all. This proximity was sometimes quite conscious and had the effect of bringing an off task pupil back on task.

Similarly, positioning sometimes enabled children to have access to the teacher.

Individual attention: (Ind)

It was also apparent, that teachers sometimes responded to pupils quietly and individually, eg. to help a new pupil integrate into a group, or to give a quiet reprimand.

Ignoring pupils: (Ign.)

This last category of responding positively to pupils concerned the way in which the teacher ignored a pupil who was off task to enable the lesson to flow without interruption. This category has been included under the positive heading because it appeared to be helpful to the other pupils. In this case, the teacher would often acknowledge the pupil's desire to speak, but would sensitively postpone the opportunity.

6.6.2.2 Negative Interpersonal Response

Excessive Authority: (Exc.)

This was discussed earlier, when the original observation schedule was designed, and concerns the over, or inappropriate use of authority.

Ignoring pupils: (Ign.)

This concerns the accidental, or purposeful ignoring of pupils where the effect is deemed to be negative, rather than the positive effect documented in the previous section.

Verbal cues: (Ver.)

The data suggested the following, amongst others;

- * using sarcasm,
- * embarrassing pupils,
- * putting pupils down,
- * expressing exasperation.

Non-verbal cues: (Nv)

These include;

- * sighing,
- * raising eyes to ceiling,
- * looking bored or disinterested,
- * posture.

Ambiguous Instructions: (Amb.)

The data suggested that giving clear and unambiguous instructions can help children to focus their minds on the conceptual issue of interest. It was noticed that ambiguous instructions not only confuse, but could also lead to off task behaviour in pupils. This category has therefore been included as a negative aspect of interpersonal relations.

Not Noticing off task Behaviour: (Nn)

It appears that it is one thing to ignore off task behaviour purposefully, but that it is quite another for the teacher to be oblivious to the fact that it is happening. Deliberately ignoring mild off task behaviour was observed to be effective at protecting the flow of the activities, and is deemed to be an appropriate response to some situations. For example, the field notes record an incident where the teacher ignored a boy who was chatting quietly as another pupil was answering a question publicly. The teacher waited until the pupil

answering the question had finished, accepted the answer, and then leant over to the boy who continued to chat to tell him, quietly, to stop - which he did. The field notes record another occasion where the teacher did not notice two boys playing with bosses and clamps at the back of the classroom. Within two to three minutes, the 'playing' had degenerated into play fighting: "*The group at the back continue to mess around. One boy had the other in a half nelson.*" The teacher did not notice this, and the notes record; "*One boy was 'strangling' another.*" At this point the teacher noticed and intervened. It seems that poor behaviour which is simply not noticed can lead the offender to even more outrageous behaviour, in addition to the distraction of others. It has therefore been included here as a negative factor.

6.6.3 Further Consideration of the Significance of the Cognitive and Interpersonal Response

The categories described above have been used to plot '*Responding Cognitively*' and '*Interpersonal Relations*' against time. In both cases, positive attributes are plotted vertically upwards and in the case of interpersonal relation, negative attributes are plotted vertically downwards. The manner in which a teacher could respond 'cognitively' in a negative manner was originally considered. This could occur where the teacher confused the child, or gave incorrect information, but neither of these were observed in the study and they have therefore been omitted from the chart. The third graph concerns the nature of the interaction. That is, whether the teacher is teaching the class as a whole (CLASS), or whether the pupils are working individually or in groups where the teacher is interacting with individuals or small groups of pupils (INDIVIDUAL). The relationship between the previous two categories and the manner in which the teacher used the class as a learning structure was considered to be worthy of further investiga-

tion. The charts can be found with the discussions of the lessons, on pages 194 to 214.

6.6.3.1 A Quantitative Analysis

Before looking at the charts in detail a simple quantitative analysis might be useful. In each case, the vertical axis represents one incident. The final 'score' has been tabulated for the two categories plotted, together with the 'feelings' rating from the initial observations, as described in chapter six. To clarify the origin of the final 'scores', they have been drawn on the right hand side of the charts on pages 196 to 214.

Lesson No.	Cog. Score	Inter Pers. Score	Feelings
1	+ 9	-11	-11
2	+16	+ 4	+ 6
3	+22	+24	+30
4	+29	+56	+33
5	+18	+20	+ 9
6	+16	+22	+ 4

Table (6.1) Cognitive, Interpersonal Relations and Feelings Scores for the Observed Lessons.

This table is shown below, rearranged, so that the 'Feelings' column is displayed in ascending order of score:

Lesson No.	Cog. Score	Inter Pers. Score	Feelings
1	+ 9	-11	-11
6	+16	+22	+ 4
2	+16	+ 4	+ 6
5	+18	+20	+ 9
3	+22	+24	+30
4	+29	+56	+33

Table (6.2) Cognitive, Interpersonal Relations and Feelings Scores Arranged in Order of Feelings.

Whilst it would be foolish to draw major conclusions from such a limited set of data, the tables appear to raise a number of points for further consideration.

As the rating for 'feelings' increases, so does the cognitive score. This is also broadly true for the score for Interpersonal Relations, but with a notable exception - lesson 2. It is interesting to note that this teacher was well known in the school for keeping his emotions to himself. He rarely smiled and was feared by many pupils (and a few staff!). He was also a strict disciplinarian. His main subject was Physical Education, Science being his subsidiary. During the PE lessons, pupils undertook their activities in what appeared to be strict military order. The pupils were always well presented, and waited in silence, in straight lines, for their turn to use a particular piece of apparatus. Pupils would change from one piece of equipment to another without fuss, when the teacher blew a whistle. The pupils were taught how to do something, and then practised it to get it right. It is not, therefore, considered surprising that this teacher did not score highly for Interpersonal Relations. It is interesting to note, however, that he did respond cognitively, in the science classroom, particularly in the latter part of the lesson. It is pertinent to note that when this teacher was responding cognitively, he also responded positively with respect to interpersonal relations.

Lesson 6 is also interesting. The rating for 'Feelings' is relatively low - just above neutral, but the rating for interpersonal relations is quite high (+22). This teacher was considered to be one of the most effective in the school, and lessons 4 and 5 were taken by this teacher. Lesson 6 started well, and the graphs curve upwards quite steeply, showing the teacher responding cognitively and interpersonally. However, the social behaviour of the class was such that the teacher grew irritated by the pupils. It should also be noted that this

was a 'theory' lesson and was dominated by the teacher at the front of the classroom. The class was also a lower ability band class. The findings suggest that the teacher, in his planning, had not taken sufficient account of the group social behaviour of the class. Many of the pupils were not engaged in what they were doing and this appeared to lead to off task behaviour, to which the teacher responded. He appeared to be trying his best but resorted to silent work. At this point, the teacher ceased responding at all and the 'scores' were therefore pegged. It is pertinent to note that the pupils did not try to speak and did what they were told.

The low 'Feelings' score, and fairly high Interpersonal Relations score is, in itself quite interesting. The lesson only had two negative interpersonal incidents. It appears that one negative response could have a much greater effect in the classroom than one positive response and this will be considered when analysing the other lessons.

Table (6.3), which follows, compares the level of positive and negative Interpersonal Relations for each lesson and details concerning the calculations can be found in appendix IV (pp. 314 - 315).

Lesson Number	Ratio of +ve:-ve Interpers. Rels.	Percentage +ve		Percentage +ve		Percentage -ve		Percentage -ve	
		Interp. Rels.	IR / time unit						
	Whole Lesson	Class	Small Gps						
1	1:12	0.0%	100.0%	0.0%	7.1%	0.0%	100.0%	0.0%	7.1%
2	8: 4	25.0%	75.0%	2.3%	15.0%	100.0%	0.0%	9.1%	0.0%
3	25: 1	36.0%	64.0%	4.5%	10.7%	100.0%	0.0%	12.5%	0.0%
4	56: 0	28.6%	71.4%	4.7%	6.5%	0.0%	0.0%	0.0%	0.0%
5	22: 6	45.5%	54.5%	3.8%	13.6%	83.3%	16.7%	6.9%	4.2%
6	24: 2	100.0%	-----	6.5%	-----	100.0%	-----	6.3%	-----

Table (6.3) Relationship between the Interpersonal Relationship Scores for Whole Class and Small Group Activities in the Observed Lessons.

A similar analysis was performed for the conceptual understanding dimension of the lesson (see table 6.4). In the above case, it was the relationship between the manner in which the teacher responded positively and negatively which was being considered. The analysis which follows attempts to gain an impression of the intensity with which the teacher responded cognitively during whole class and small group work. Details of the calculations can be found in appendix V (pages 316 - 317).

Lesson No.	Percentage of Cognitive Resp.		Questioning		Questioning	
	Whole Lesson	Class	Small Gps	Whole Lesson	Class	Small Gps
1	18.8%	0.0%	21.4%	12.5%	0.0%	14.3%
2	35.4%	9.1%	93.3%	40.6%	22.7%	80.0%
3	48.8%	33.3%	72.2%	43.3%	50.0%	33.3%
4	56.9%	33.3%	69.7%	85.3%	66.7%	95.5%
5	37.5%	25.0%	75.0%	46.9%	41.7%	62.5%
6	31.1%	-----	-----	56.6%	56.6%	-----

Table (6.4) Relationship between Cognitive Response for whole class and small group activities for the observed lessons.

6.6.3.2 Discussion

The above charts will be discussed, in turn, considering the overall patterns which were evident in the data. Attention will then turn to each of the individual lessons where these patterns will be considered.

Taking each of the above two charts in turn:

1: Interpersonal Relations: The Interpersonal Relations table, has been rearranged, such that the lessons are placed in ascending order of the ratio of positive to negative Interpersonal relations observed:

Lesson	Ratio of +ve:-ve	Percentage +ve	Percentage +ve	Percentage -ve	Percentage -ve
Number	Interpers. Rels.	Interp. Rels.	IR / time unit	Interp. Rels.	IR / time unit
	Whole Lesson	Class	Small Gps	Class	Small Gps
1	1:12	0.0%	100.0%	0.0%	7.1%
2	8: 4	25.0%	75.0%	2.3%	15.0%
5	22: 6	45.5%	54.5%	3.8%	13.6%
6	24: 2	100.0%	-----	6.5%	100.0%
3	25: 1	36.0%	64.0%	4.5%	10.7%
4	56: 0	28.6%	71.4%	4.7%	6.5%

Table (6.5) Table (6.3) Rearranged in Order of the Ratio of Positive to Negative Interpersonal Relations.

Considering the earlier table and comparing the final cognitive and interpersonal final 'scores' for each lesson, this table has been rearranged such that the lessons are in the same order as the table above.

Lesson No.	Cog. Score	Inter Pers. Score	Feelings
1	+ 9	-11	-11
2	+16	+ 4	+ 6
5	+18	+20	+ 9
6	+16	+22	+ 4
3	+22	+24	+30
4	+29	+56	+33

Table (6.6) Table (6.1) Rearranged in Order of the Ratio of Positive to Negative Interpersonal Relations, According to Table (6.5).

As would be expected, the interpersonal scores are also in ascending order. However, what is interesting to note is the trend for the cognitive score to increase with the Interpersonal Score. The nature of the observation schedule, however, where events are recorded only once in each time period, suggests that the scores should be treated with caution. It is not felt that a difference of two points is particularly significant and the cognitive scores for lessons 2, 5 and 6 above are of similar magnitude. It does seem, however, that an increasing interpersonal response from the teacher is associated with an increased cognitive response.

Another interesting relationship concerns the manner in which the teacher responded to the children when they were being taught as a whole class, or were undertaking work in small groups. The second column in Table (6.3) shows clearly that (except for lesson 6, which did not involve small group work) most of the positive responding, in terms of interpersonal relations occurred when the class was working in small groups. It is also clear, from the third major column, that a

higher intensity (in terms of the percentage positive response per time period) of positive interpersonal relations also occurred during small group work. The reverse also appears to be true for the incidences of negative interpersonal relations. Most of the negative responding, in terms of interpersonal relations occurred when the teacher was teaching the class as a whole. Looking at this more closely, Table 6.7, below, shows the ratio of positive interpersonal response whilst teaching in small groups:whole class, for both the overall percentage, and the percentage per time period, as discussed above. Details of the calculations can be found in appendix VI (page 318).

Lesson	Ratio of small-group:whole class +ve IR.	Ratio of small-group:whole class +ve IR / time unit
1	--whole class teaching insignificant--	
2	3.00:1	6.52:1
5	1.20:1	3.58:1
6	---Class not taught in small groups---	
3	1.78:1	2.38:1
4	2.50:1	1.38:1

Table (6.7) Ratio of Positive Interpersonal Response for Small Group to Whole Class Activities in the Observed Lessons, in Order of Ratio of Positive to Negative Interpersonal Relations.

6.6.3.2.1 Relationship between Cognitive and Interpersonal Response

It is worth commenting on the apparent pattern which can be observed in the last column of Table 6.7. It appears that as the ratio of positive to negative interpersonal response increases, the ratio of positive interpersonal relationships per time period for small group to whole class teaching decreases. Whilst this is true, it must be remembered that this is likely to happen because the teacher responded positively more often during small group and whole class work during these more successful lessons, and the table is arranged in order of increasing ratio of positive to negative interpersonal relations. What is pertinent, is the finding that most of the positive responding in terms of interpersonal relations occurred during small group work, and almost all the negative responding took place during whole class work. Section 6.6.3.1 also highlights the finding that a positive cognitive response is associated with a positive interpersonal response. It could be concluded, therefore, that science lessons might be most successful where the children work exclusively in small groups. This success could be seen in terms of enhanced interpersonal relationships within the classroom which could lead to an enhanced cognitive response and hence more effective learning. Extreme caution is required, however, because whilst the whole-class work seems to be difficult, it appears to be essential in enabling the small group work to function effectively. The findings suggest that whole class work should not be disregarded for a number of reasons, which are now discussed.

6.6.3.2.2 Whole Class Teaching and Small Group Work

Section 6.5.3.3 considered the manner in which the teacher used the class as a learning structure. The strategies outlined there seem to be associated with the teacher managing the class as a group, rather than as a collection of individuals. As discussed earlier in chapter four, it seems that the success of a lesson depends on the ability of the teacher to respond to the children in terms of their conceptual development and social behaviour, in addition to the enabling of positive interpersonal relations with, and between, pupils in the classroom. It appears to be the manner in which the teacher responds to the needs of the situation which is important, and this response seems to be a fusion of conceptual development and group social behaviour, where the vehicle for the interaction is related to the interpersonal relationships within the classroom. Returning to the data for further reflection, the interviews suggested that the teacher should use a range of teaching styles, and a range of approaches in order to enable a range of pupil types to participate meaningfully (Section 6.3.1.2). A range of styles might be difficult to achieve if the class only work in small groups. The field work also suggested that individual teachers have their preferred teaching style, and it could be that some teachers are very effective at, and prefer whole class rather than small group work. Also, teachers in the study called the class together to discuss findings and to share ideas (page 159). This sharing would be very time consuming if all the work was undertaken in small groups, and it could be difficult for pupils from different groups to share ideas unless a mechanism exists for the pupils to feedback to the whole

class. This 'feeding back' to the class was found to be particularly effective on occasions. Small group work excludes pupils from the experience of speaking to a large group and it could be argued that this is a skill which all pupils should be encouraged to acquire, bearing in mind the need for sympathy and empathy as discussed earlier in this study. It also seems that some pupils respond well to this type of activity, and should therefore be given relevant opportunities. The field work agrees with the interview data in that pupils require a variety of approaches, not simply to enable the teacher to respond to a diverse pupil types, but also to aid motivation by providing variety (page 160). Some teachers brought the children together to focus their minds on a particular passage in the text when it was thought that the class was becoming restless and off task (page 168). This was concerned with the manner in which the teacher was able to be vigilant and could respond appropriately to the mood and social behaviour of the class, providing appropriate pace and timing of the activities (page 167), navigating through the activities, remaining in control of the class (section 6.5.3.4).

It seems that whole class teaching, whilst potentially difficult, has an important role to play in the enabling of the small group work, in terms of creating an atmosphere where pupils can work on their own, without the constant direction of the teacher.

Another, seemingly trivial, reason for not dismissing whole class teaching concerns the accommodation. The school in this study had fixed benching and it was clear that this hindered the teacher's access to the children at times. This study suggests that small group work requires the teacher to gain close physical access to the pupils if it is to be effective. It is necessary for the teacher to question pupils and to discuss ideas, as partners in the learning process. If the school has fixed benching in addition to overcrowded classrooms then this proximity could be impossible to achieve, and small group work might become less effective. The teacher might have no alternative but to resort to whole class teaching for most of the time.

6.6.3.2.3 Comments on the 'Feelings' Recorded During the Observations

Returning to Table (6.6), the apparent disagreement between the 'Interpersonal Relations' and 'Feelings' scores for lessons 5 and 6 also deserves comment. It is interesting to note that these two lessons both scored similar, relatively high Interpersonal Relations scores, but the score for 'Feelings' was quite low. These two lessons both contained a number of negative interpersonal responses and it might be pertinent to consider a negative interpersonal response having a greater effect on the pupils than a positive interpersonal response. If a positive interpersonal response is considered to be 'worth' one unit, then a negative interpersonal response seems to be 'worth' more than one unit. This idea has not been pursued here, but it might be worthy of further investigation by another researcher.

6.6.3.2.4 Summary

Attention is drawn to the apparent importance of positive interpersonal relations in the classroom, as the findings suggest a positive correlation between this and a positive cognitive response by the teacher. It also seems that the teacher is more likely to respond in a positive manner, both interpersonally and cognitively when the pupils are working in small groups, rather than as a whole class, (amplifying the above discussion concerning whole class and small group work). In some way, this is not surprising, because it is when pupils are working in small groups in the science laboratory that the teacher is free to talk to individuals and small groups of children. To enable the teacher to create opportunities to respond to the children and their scientific ideas, it seems, therefore, that he or she should plan opportunities for small group work, but the importance of whole class teaching should not be ignored.

6.7 Comments on the Individual Lessons

Turning now to the individual lessons, in the light of the above discussion.

6.7.1 Discussion of Lesson 1

This lesson did not work well. Consideration had not been given to the confidence of the children and, as mentioned earlier, the children found nothing in their traps. The teacher had not considered this, either by having alternative activities for the children to attempt, or by 'fiddling' the experiment by placing living things in the traps before the children arrived for the lesson.

The teacher appeared to feel that the lesson should be practically based and that he should be responding to the pupils, working in small groups. However, the lack of detailed planning meant that it simply did not work, despite the attempts at responding cognitively during the second half of the lesson. Too many children had nothing to do, and the social behaviour of the group was such that they could not cope with the failure easily. The children clearly needed direction. It is interesting to note that this lesson appears to be a good example of how not to use small group work. It might have been appropriate for the teacher, having failed to ensure pupil engagement in the tasks, to call the class together early in the lesson to discuss findings and to set alternative work. It appears that this teacher did not appreciate the importance of managing the class as a group or of navigating the children through the activities. The instructions given at the start of the lesson were unclear, and the teacher did not ensure that all the pupils were listening. This early confusion was exacerbated by the lack of animals in many of the Telgrun funnels, as discussed above.

LESSON 1

	Cognitive Response					Positive Interpersonal Relations					Negative Interp. Relations									
	Acc.	Dis.	Op.	Cl.	Dir.	Prog.	Red.	Acc.	Pr	Ver.	Nv	Pon.	Ind	Ign.	Exc.	Ign.	Ver.	Nv	Amb.	Mn
3																				
6																				
9	✓																		✓	
12	✓																		✓	
15		✓	✓															✓	✓	✓
18		✓																✓		✓
21																				
24	✓	✓																✓		
27	✓																			
30	✓																		✓	
33	✓																	✓	✓	
36	✓																			
39	✓																			
42	✓																	✓		
45																				
48																				
51																				

Figure (6.2) Quantification of cognitive and Interpersonal Response
for lesson 1

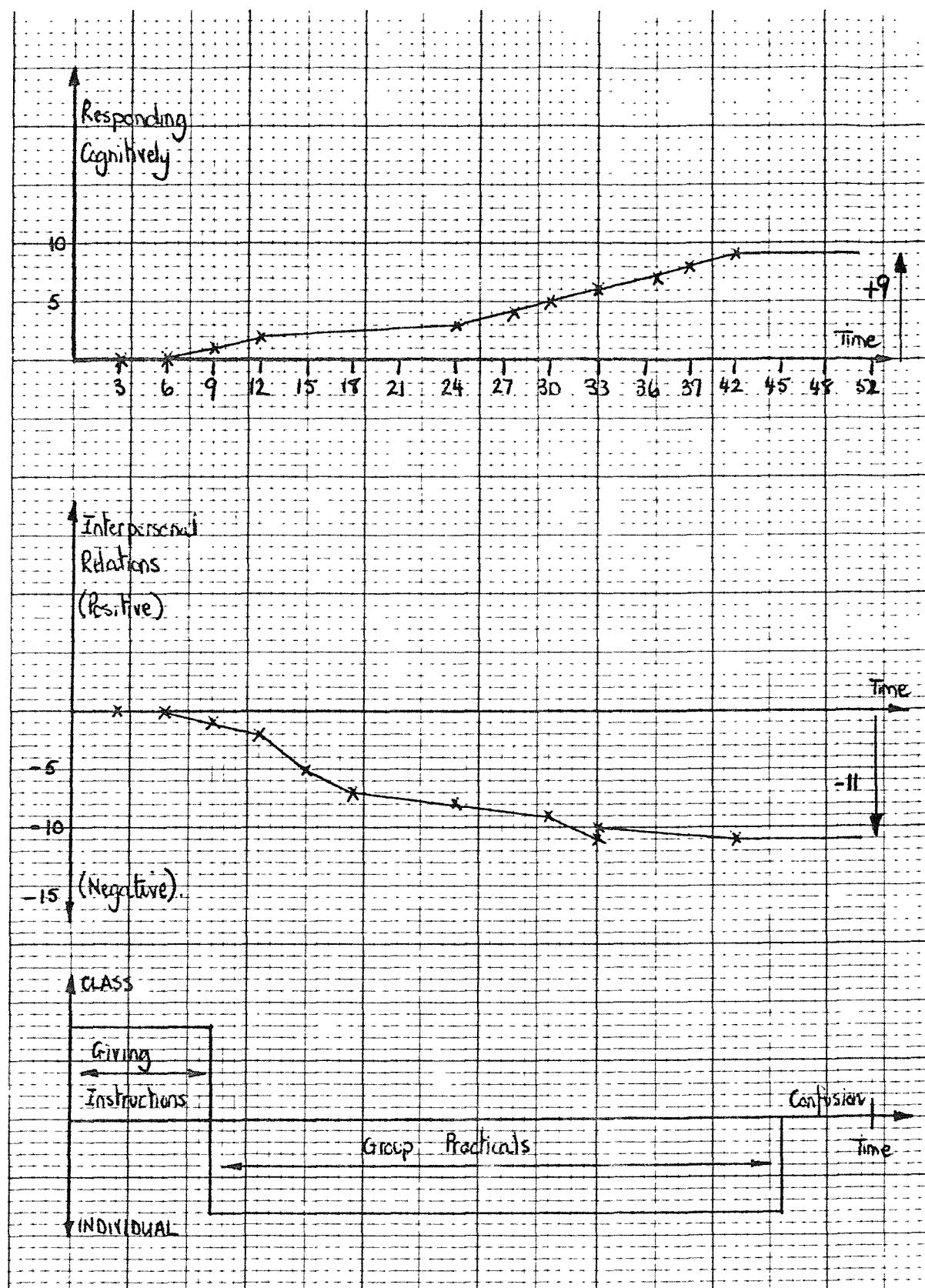


Figure (6.3) Graphical Representations for Lesson 1

6.7.2 Discussion of Lesson 2

During the initial part of the lesson, the teacher did little to respond to the children. Interpersonal relations were mainly negative, until 30 minutes into the lesson. Just before this, the teacher had started to respond cognitively, and as the practical started, the rate of cognitive response increased. This followed an increase in interpersonal response which continued as the practical progressed. This matching of cognitive and interpersonal response agrees with the analysis discussed earlier. It is interesting to note that the early demonstration did enable the children to undertake the practical work confidently and the increase in cognitive and interpersonal response occurred during the small group work, in agreement with the earlier discussion. It could be argued that the early, teacher directed, whole class work was too long and that it might have been more appropriate to have started the practical work earlier.

LESSON 2

	Cognitive Response						Positive Interpersonal Relations						Negative Interp. Relations							
	Acc.	Dis.	Op.	Cl.	Dir.	Prog.	Red.	Acc.	Pr	Ver.	Mv	Pon.	Ind	Ign.	Exc.	Ign.	Ver.	Mv	Amb.	Mn
13																				
16																				
19																				
12																				
15																				
18																				
21																				
24	✓																			
27	✓																			
30	✓																			
33																				
36	✓	✓	✓	✓	✓											✓	✓			
39	✓	✓																		
42	✓	✓	✓	✓	✓	✓										✓	✓	✓		
45	✓	✓	✓	✓	✓	✓										✓				
48	✓	✓	✓	✓	✓	✓														
51																				

Figure (6.4) Quantification of cognitive and Interpersonal Response
for lesson 2

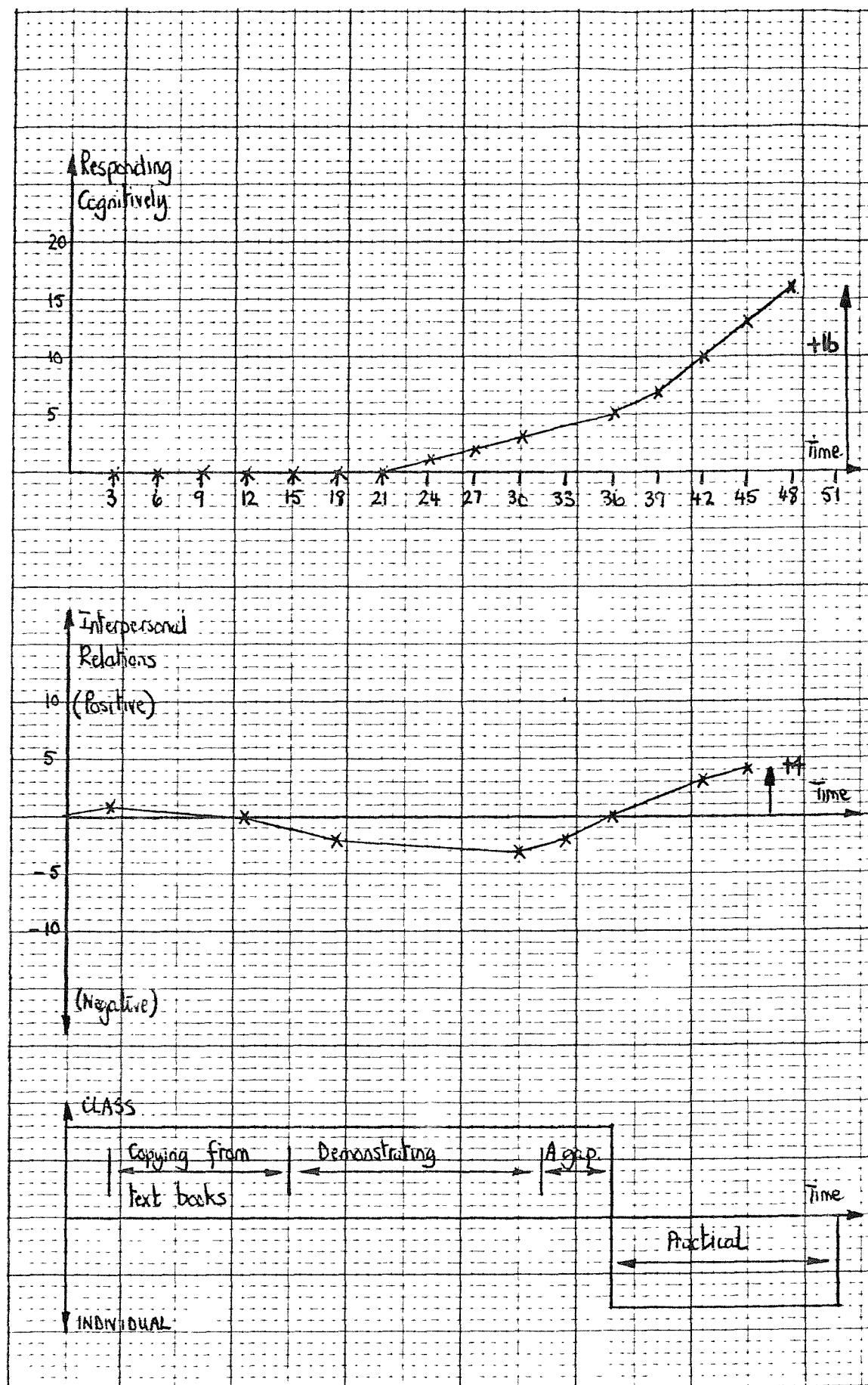


Figure (6.5) Graphical Representations for Lesson 2

6.7.3 Discussion of Lesson 3

The rate of increase of cognitive and interpersonal response was very marked. There was one incident of negative interpersonal response, but the teacher followed this positively and it did not appear to have had an adverse effect on the lesson. The teacher apologised to the individual concerned later in the lesson showing that he knew he had embarrassed a pupil and that it had not been helpful. It is pertinent to note that the teacher used the class as a learning structure. He gave clear instructions and then allowed pupils to work in small groups, on their practical work. When there was a problem which the teacher felt might threaten the progress of the work, he stopped the class and discussed the misunderstanding with the whole class. It is also interesting to note that the teacher used only closed questions during this discussion, ensuring the pupils understood what they had to do. This appeared to increase their confidence at the same time. The teacher ensured the pupils continued with their group practicals as quickly as possible. As discussed above, the teacher used the small group work to provide opportunities to respond to the pupils both cognitively and interpersonally. At the end of the lesson, the teacher brought the class together to draw the work to a close and to share ideas. It is relevant to note that the rate of increase of both the cognitive response and interpersonal response (as shown by the increased slope of the lines on the graphs) occurred during the small group work. This agrees with the earlier discussion concerning the apparent relationship between small group and whole class work (pages 190 ff).

LESSON 3

	Cognitive Response					Positive Interpersonal Relations						Negative Interp. Relations								
	Acc.	Dis.	Op.	Cl.	Dir.	Prog	Red.	Acc.	Pr	Ver.	Nv	Pon.	Ind	Ign.	Exc.	Ign.	Ver.	Nv	Amb.	Mn
3																				
6																				
9								✓			✓	✓								
12	✓	✓	✓								✓		✓							
15		✓	✓	✓	✓			✓					✓							
18											✓	✓	✓	✓						
21	✓	✓	✓	✓		✓								✓	✓					
24	✓	✓	✓	✓	✓						✓	✓	✓	✓						
27								✓	✓											
30								✓	✓										✓	
33	✓							✓	✓											
36	✓							✓				✓								
39	✓	✓	✓					✓			✓				✓					
42	✓														✓					
45		✓	✓	✓	✓															
48			✓									✓								
51																				

Figure (6.6) Quantification of cognitive and Interpersonal Response
for lesson 3

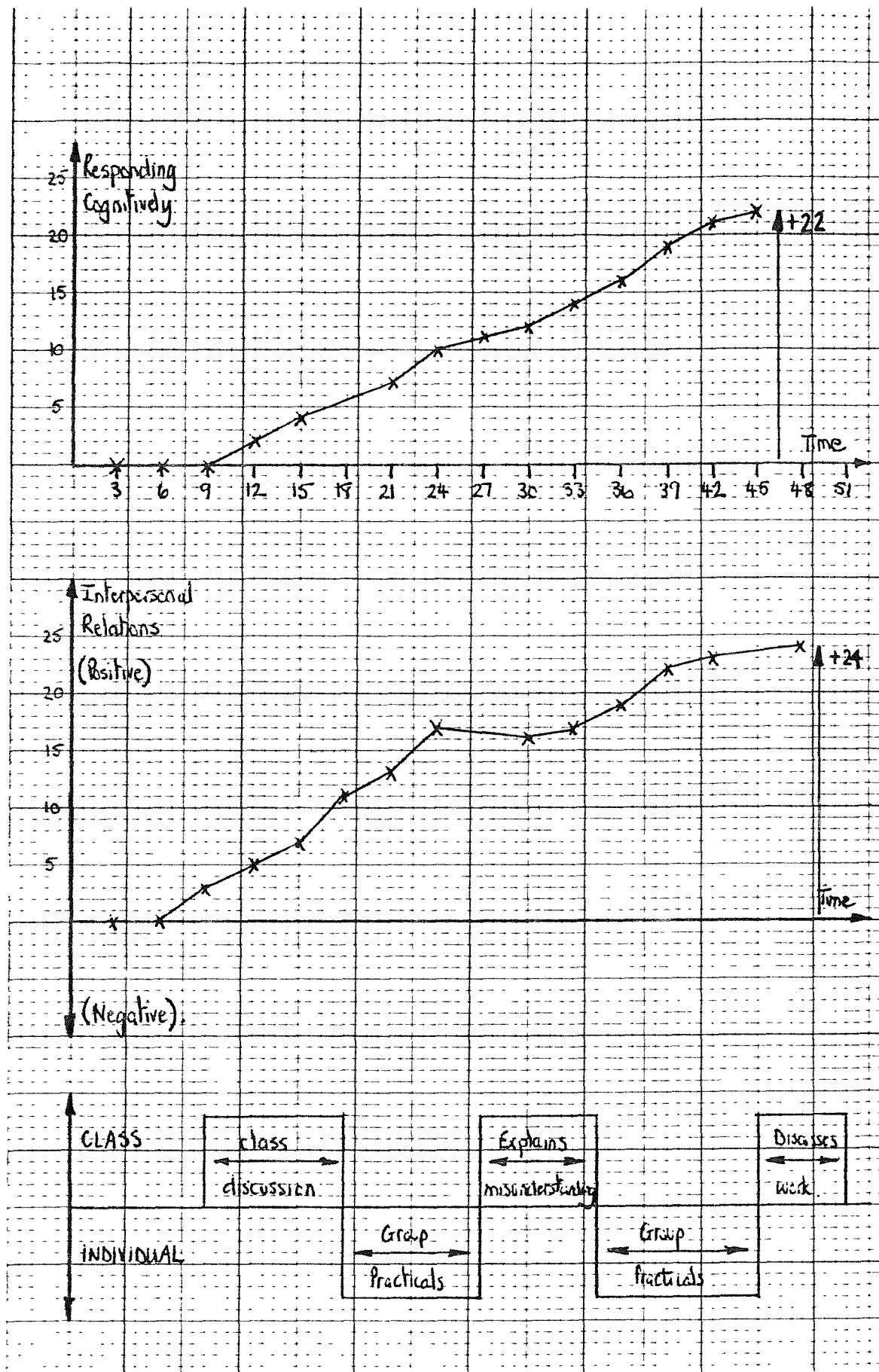


Figure (6.7) Graphical Representations for Lesson 3

6.7.4 Discussion of Lesson 4

This was probably the most successful lesson observed. It is worth noting the rate of increase of cognitive and interpersonal response displayed in the graphs for this lesson. The rate at which the teacher responds to the children interpersonally is very pronounced indeed. This steep slope is accompanied by a relatively steep slope for cognitive response, again agreeing with the previous discussion concerning the relationship between the interpersonal and cognitive responsiveness of the teacher. This teacher also used the class as a learning structure. He, like the previous teacher, started the lesson by introducing the work, and ensured the pupils understood what they had to do. The pupils worked in groups, and whilst this was happening, the teacher used the opportunity to talk to individuals and small groups. The teacher responded cognitively and interpersonally throughout this period. It is also apposite to note that when the teacher discovered a problem which was threatening the future success of the lesson he brought the class together and cleared up the problem. The teacher used both open and closed questioning to build the pupils' conceptual understanding. The practical then continued until the pupils packed away. It is worth noting that the teacher continued to respond to the children interpersonally as they packed away (although the graph shows a smaller rate of increase, as might be expected). He did not just sit down and let the children get on with it - he responded, both verbally and non-verbally, ensuring all the apparatus was being put away appropriately. The teacher then brought the class together, using the group as a learning structure, to discuss the results. It is interesting to note that the slope of the graphs increases markedly, for both cognitive and interpersonal response, once the pupils are engaged in small group work. This agrees with the previous discussion concerning the apparent relationship between small group and whole class teaching

(pages 190 ff). It is also relevant to note that apart from the initial whole class work and when the class was packing away, the slope of the interpersonal response graph is relatively constant. This steep slope is maintained throughout the class discussion (33 - 36minutes) and the discussion of the findings (45 - 51 minutes). It appears that whilst the whole class work can enable the effective use of small group work, once effective small group work has been established, the small group work can similarly enable the effectiveness of whole class work.

LESSON 4

	Cognitive Response					Positive Interpersonal Relations				Negative Interp. Relations										
	Acc.	Dis.	Op.	Cl.	Dir.	Prog	Red.	Acc.	Pr	Ver.	Mv	Pon.	Ind	Ign.	Exc.	Ign.	Ver.	Mv	Amb.	Nn
3								✓												
6	✓		✓	✓							✓	✓								
9	✓		✓	✓							✓	✓								
12		✓	✓	✓							✓	✓	✓	✓						
15	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓					
18	✓	✓	✓		✓					✓	✓	✓	✓	✓	✓					
21	✓	✓	✓	✓						✓	✓	✓	✓	✓	✓					
24	✓	✓	✓	✓	✓	✓				✓										
27	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓				
30	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓				
33	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓					
36		✓	✓	✓							✓	✓	✓	✓	✓	✓				
39	✓	✓	✓	✓	✓						✓	✓	✓	✓						
42		✓	✓								✓									
45	✓	✓	✓	✓	✓						✓									
48	✓			✓	✓						✓	✓	✓							
51			✓		✓		✓				✓	✓	✓	✓						

Figure (6.8) Quantification of cognitive and Interpersonal Response
for lesson 4

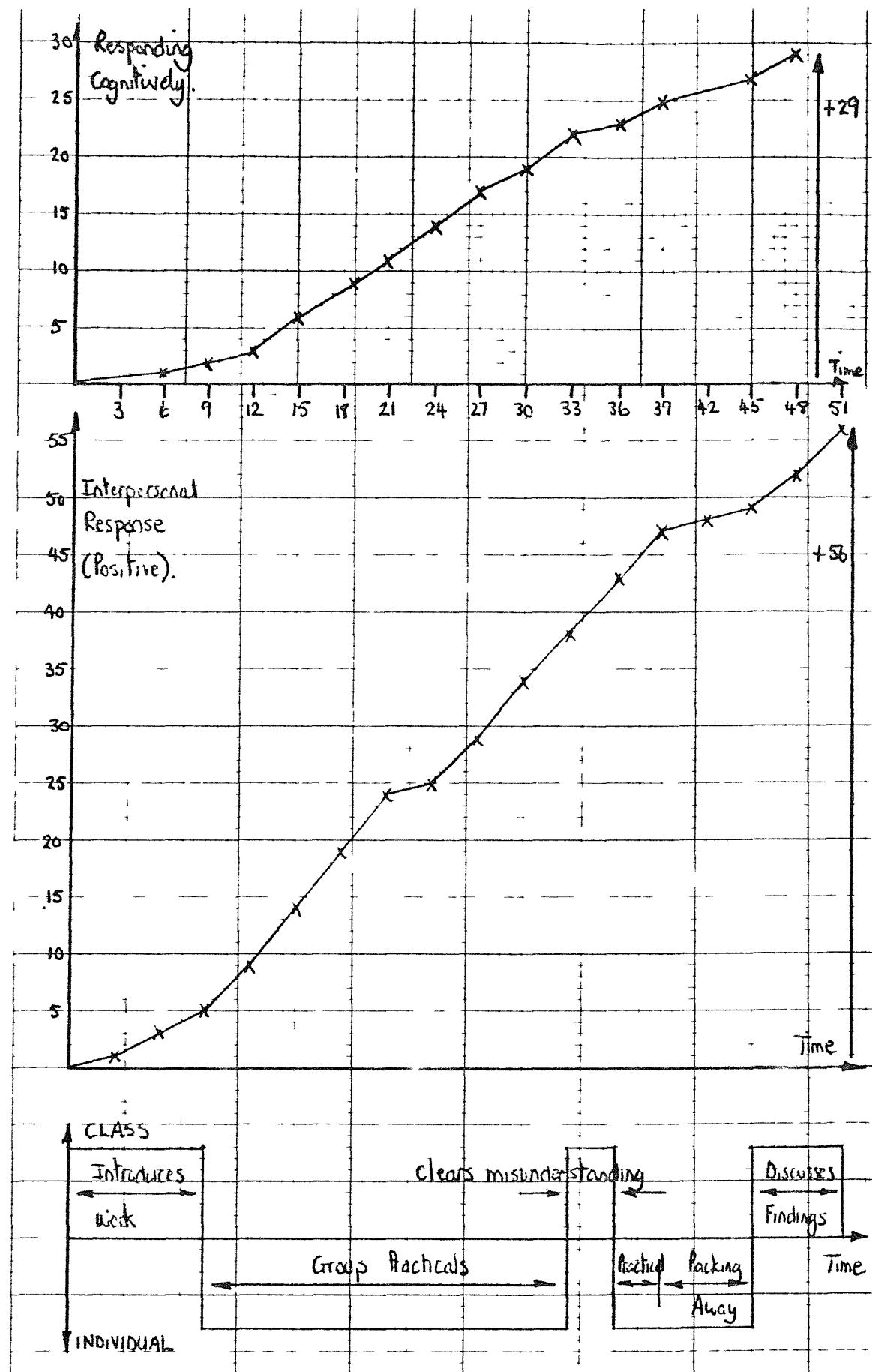


Figure (6.9) Graphical Representations for Lesson 4

6.7.5 Discussion of Lesson 5

This was an interesting lesson, because the teacher was the same teacher as the previous lesson, but with a different group. The teacher here, had a major problem, because part way through the lesson, he realised that he did not have the equipment he needed and the technician had gone home early. What is particularly interesting is that the teacher took some minutes before he realised that the apparatus was not ready. At this point, the teacher responded negatively to mild off task behaviour until he regained his composure. He tried very hard to continue to respond cognitively, but stopped and went to look for the equipment. On realising that it was not going to appear, the teacher again responded negatively, but then told the pupils to use any plastics they had on them. He therefore managed to continue with the planned practical activities. It is interesting to note that it was at this point that the teacher started to respond positively again. This positive interpersonal response occurred whilst the children were engaged in small group work, once again agreeing with the earlier discussions. Also, it was as the teacher was responding interpersonally in a positive manner that he also responded cognitively. Once again, the teacher recognised a problem and called the class together to rectify the problem. The problem concerned the use of the pupils' own equipment and the teacher realised that some of the instructions were not appropriate. He therefore reformulated the practical and the pupils continued. It was at this point that the teacher responded negatively again. This could have been due to the fact that the teacher was once again perturbed by missing the equipment and had had to think quickly to protect the lesson. It was also possible that some pupils sensed the uncertainty in the teacher and reacted accordingly. The teacher, as previously, brought the class together to discuss the findings and to draw the lesson to a close and

during this phase he continued to respond both cognitively and interpersonally. It is pertinent to note that the steepest slope of the graphs for cognitive and interpersonal response occurred during small group work, agreeing with the findings discussed on pages 190 ff where the relationship between whole class and small group is discussed, and the importance of small group work is emphasised.

LESSON 5

	Cognitive Response					Positive Interpersonal Relations					Negative Interp. Relations									
	Acc.	Dis.	Op.	Cl.	Dir.	Prog.	Red.	Acc.	Pr	Ver.	Nv	Pon.	Ind	Ign.	Exc.	Ign.	Ver.	Nv	Amb.	Mn
3																				
6																				
9																				
12	✓		✓	✓	✓	✓													✓	
15	✓	✓	✓	✓							✓				✓			✓		
18	✓	✓	✓							✓				✓						
21									✓	✓										
24																				
27			✓							✓								✓		
30	✓			✓								✓	✓	✓	✓					
33		✓		✓	✓	✓					✓	✓	✓	✓	✓				✓	
36	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓					
39	✓	✓	✓	✓							✓	✓								
42	✓	✓	✓	✓					✓											
45		✓		✓	✓						✓									
48								✓				✓				✓				
51																				

Figure (6.10) Quantification of cognitive and Interpersonal Response

for lesson 5

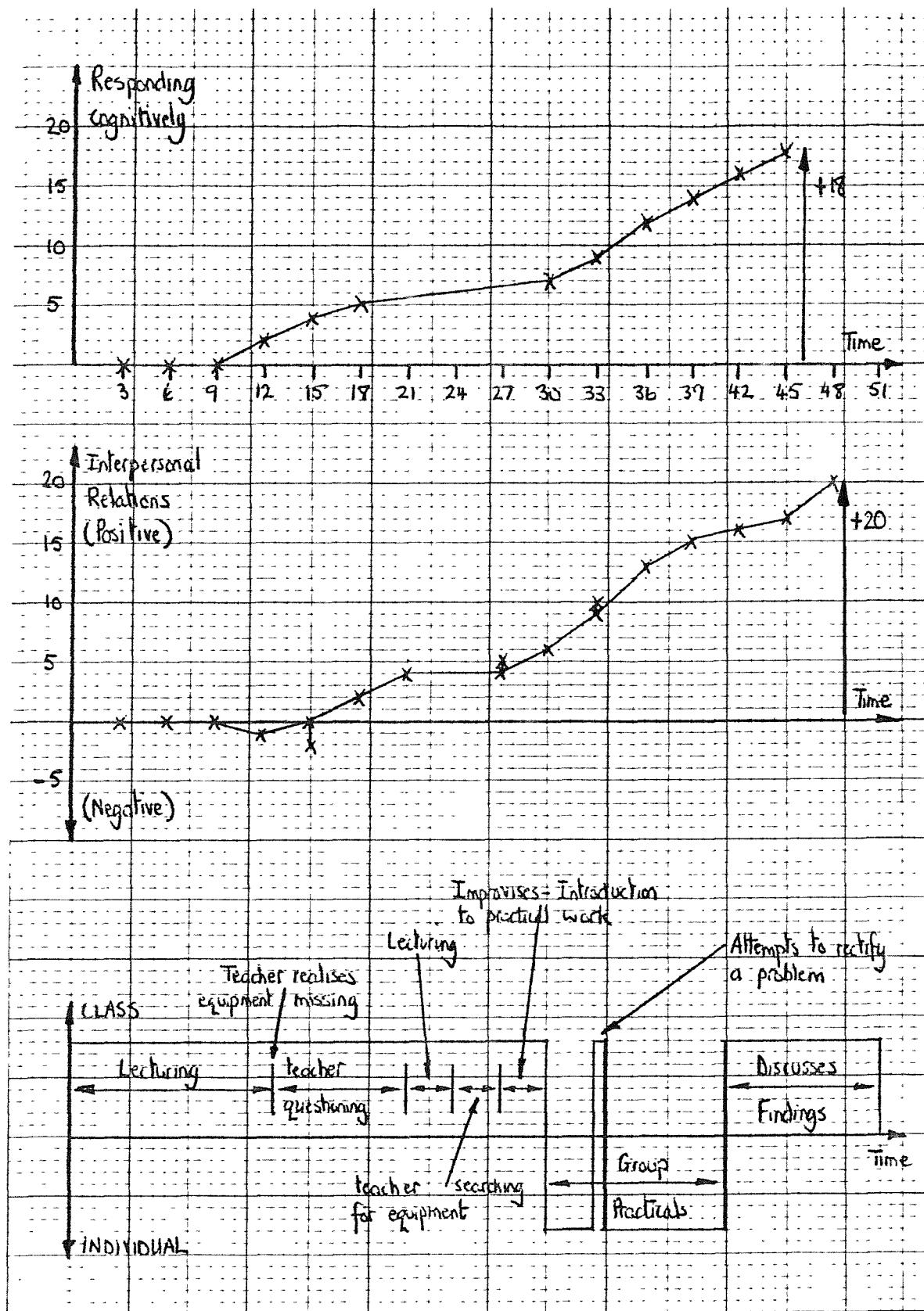


Figure (6.11) Graphical Representations for Lesson 5

6.7.6 Discussion of Lesson 6

This lesson concerned the same teacher again, teaching theory without practical. The lesson started very well, and as before a steep rise in the level of positive interpersonal response was accompanied by a rise in the level of cognitive response. The teacher was listening to the pupils' ideas and was responding accordingly. However, it appeared to work for about 20 minutes, after which the teacher needed to intervene to stop two boys talking. It was as though some of the children had reached their 'saturation point' and were beginning to exhibit off task behaviour. The teacher also ignored a pupil unintentionally. It is pertinent to note that not all the children were actively involved in the lesson and it was the pupils who had not been drawn into the lesson who appeared to be having difficulty. The teacher continued, but again responded negatively. The teacher realised the lesson was threatened and responded by focusing the pupils' minds on the text book. The discussion continued and the teacher continued to respond cognitively. Some pupils did not settle, however, and the teacher resorted to silent work, copying diagrams and notes from the text book. At this point, the teacher ceased to respond at all, and the children worked until the end of the lesson in this manner, without interruption. It appears that the main 'problem' with this lesson was the way in which the planning did not enable all the pupils to participate. The discussion earlier suggested that it is when pupils are engaged in small group work that the teacher is more likely to be able to discuss ideas and respond both cognitively and interpersonally with greatest effect. The fact that the pupils did not engage in this small group work, meant that this opportunity was missing and although the teacher tried to continue responding positively, he gave up. This teacher clearly understood the importance of responding cognitively and interpersonally, and previous observations of this teacher suggest that

if he had built some small group work into the lesson, then he might have been able to continue responding appropriately and the lesson might have been more successful. It is also possible that this might have eased the pressure which led the teacher to respond negatively on two occasions.

LESSON 6

	Cognitive Response				Positive Interpersonal Relations				Negative Interp. Relations												
	Acc.	Dis.	Op.	Cl.	Dir.	Prog	Red.	Acc.	Pr	Ver.	Nv	Pon.	Ind	Ign.	Exc.	Ign.	Ver.	Nv	Amb.	Mn	
3																					
6																					
9																					
12																					
15	✓	✓	✓	✓																	
18	✓	✓	✓	✓																	
21	✓	✓	✓	✓																	
24	✓	✓	✓	✓																	
27	✓	✓	✓	✓																	
30	✓	✓	✓	✓																	
33		✓	✓	✓																	
36			✓																		
39			✓																		
42																					
45																					
48																					
51																					

Figure (6.12) Quantification of cognitive and Interpersonal Response
for lesson 6

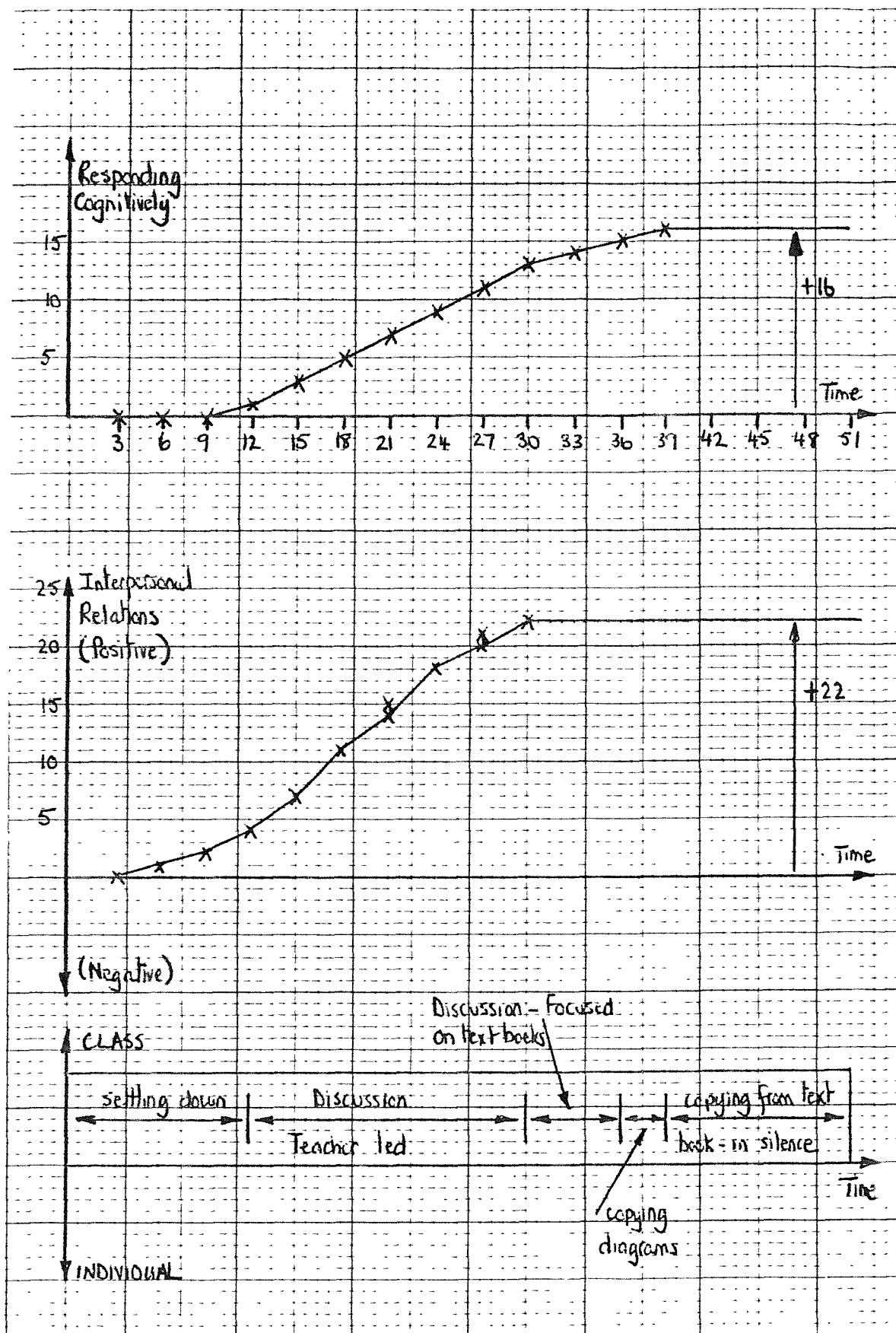


Figure (6.13) Graphical Representations for Lesson 6

6.8 Analysis of the Work Undertaken with SENASS

So far, the discussions have focused upon the interviews and lesson observations. Attention will now be given to the work which was undertaken between one of the teachers, an advisory teacher from SENASS, the school's special needs coordinator and the researcher. The purpose of this work has been outlined in chapter five. This chapter will focus on the main findings from that work and an attempt is made to lay this alongside the findings from the lesson observations and interviews.

6.8.1 Background

The data for analysis consisted of the teacher's diary, written during this phase of the work, the observations undertaken by the researcher, and the curriculum materials which were written by the team. The small team met once per week to discuss how the previous lessons went, what the strengths and weaknesses were thought to be, and what was considered necessary for the following week. The advisor then used her notes from that meeting together with any curriculum materials which were being discussed, to produce new materials. She also advised the team on the approach which she thought might be most appropriate, using her specialist knowledge of responding to the needs of diverse pupil groups. It was fortunate in that the contract agreed with SENASS included this meeting once per week for the half term, together with a one hour lesson observation / assisting and one hour discussion after the observed lesson with the teacher concerned. This pattern of meetings and observations continued for half a term and the materials and ideas were shared both informally, and more formally in departmental meetings. It appeared to be particularly useful for the teacher concerned because, as mentioned earlier, it was this teacher who had had the greatest difficulty in putting the 'new' methodology into

practice. This collaborative work did seem to make a difference in the classroom, as will be discussed. During the implementation of the work, the researcher observed a number of the lessons. This was considered important, not simply because the researcher wanted to try to understand, first hand, which tactics and strategies seemed successful but it was also felt that the presence of the Head of Faculty, on occasions, was important to demonstrate an interest in the venture. It also enabled the teacher concerned to feedback directly to me, or to ask questions, as the work was proceeding. The researcher was, however, sensitive to the teacher's possible perceptions of alternative reasons for his presence (as discussed in chapter four), and observations were limited to two full lessons and a number of 'visits'. On these occasions, criticisms were not made and observations were made from the point of view of researcher. This did, indeed, appear to work successfully; the observations apparently enabling the validity of the teacher's perceptions to be verified. In terms of analysing the data, the Long Interview technique was applied, as described earlier in this chapter, to the diary and curriculum materials. In terms of the main themes, the previously identified themes of planning, conceptual understanding and interpersonal relations were found to be particularly pertinent.

The findings from the analysis of the classroom materials and the diary agreed with the previous analyses of the interviews and lesson observations, highlighting many of the points previously identified.

The broad categories, outlined earlier, were pertinent and seem to reinforce the view that it appears to be the manner in which the teacher orchestrates the four characteristics of; group social behaviour of the pupils, conceptual understanding, planning and interpersonal relations which determines the success, or otherwise of the lesson.

6.8.2 Planning

6.8.2.1 Team Planning

It was clear that the teacher was confident with the methodology and the materials. The diary referred to one of the aims of the project being the refining of the scheme of work including the production of extension and remedial (overlearning) material. The teacher had been instrumental in producing the materials used in the classroom and he appeared confident with them. The teamwork aspect of the project also seemed to be important. The teacher commented: '*I found the exercise very useful. It showed that, given the time, and someone with different ideas, the teaching of any topic can be more varied, more interesting, and hopefully more effective*'.

Perhaps the joint planning enhanced the teacher's ownership of the materials and methodology in addition to its familiarity. The engagement of the teacher in the dialogue and development of the materials also seemed to be important. The planning enabled the teacher to liaise with the laboratory technician to ensure that the materials were requested in time and that any resources which needed photocopying or collating, were ready for the lesson.

6.8.2.2 Some Problems Associated with Insufficient Planning

Even with the rather higher than normal level of planning during this exercise, there were still a few occasions where insufficient planning led to a problem in the lesson itself. During the field work, it became evident that insufficient planning on the part of the teacher could lead to increased pupil and teacher stress. This stress could lower the self confidence of individuals. During the project under discussion, this was observed on a few occasions. The first occurred during lesson two, where the teacher had clearly not given sufficient

attention to the video. He commented:

'The video was not very good on the basics of plant reproduction, being mostly about methods of pollen transfer.' (p. 319 Lesson 2)

The note taking aid clearly focused on the two types of reproduction and this was a potential source of a problem. It was possible that the pupils would be looking for aspects of the points highlighted by the teacher and note taking aid, but find that the video contained a significant proportion of 'irrelevant' information. In the event, the children were happy to watch the video and the potential problem did not materialise. This type of potential problem also occurred during lesson eight, where:

'8 slides were not enough, there were times when pupils were waiting to get hold of one.'

Here the pupils were classifying microscope slides of cells into animal and plant cells. Once again, this could have lead to off task behaviour and/or a feeling of frustration within the children. Once again, however, the potential problem did not manifest itself in terms of difficult behaviour, although the effect on the pupils' self confidence was not known. This also occurred during lesson eleven where the pupils were attempting to observe the increase in number of yeast cells, over a relatively short period of time, on a microscope slide. Only a small number of children managed to produce meaningful results, and the teacher commented in his diary:

'A lot of the Y (lower) band found the experiment so difficult that they gave up! I have tried the experiment myself and it is almost impossible.'

It might have been appropriate to have attempted the experiment

before the children, and in the event of difficulty, investigated an alternative strategy. The lesson observations had demonstrated that this type of problem can lead to a decrease in confidence on the part of the children. These were, however, the only 'failures' during the duration of the project and perhaps the success of the other aspects of the module counterbalanced these negative factors. Problems such as these highlight the need for careful planning on the part of the teacher to attempt to ensure that the activities aim to increase the pupils' self confidence rather than decrease it. These incidents also show, however, that even an experienced teacher could find him/her self 'caught out' if planning has not been carefully undertaken.

6.8.2.3 Some Implications for those with Influence over Curricular Change and the Initial Training of Teachers

In view of the many initiatives and changes to the national curriculum being experienced in schools today, it is possible that the most careful and dedicated of teachers could find themselves in difficulties because they had not been able to plan as effectively as they might have wished. Writing new schemes of work, together with appropriate materials takes time, and it might not be possible to respond to a new programme of study quickly. This could be due to the volume of work required, or the tension which many teachers feel between their roles as class teachers and the many other priorities which demand their time. Experienced teachers who have posts of responsibility could find this particularly difficult as much of their time might be demanded by these other commitments. Teachers such as these might also cause an increased tension in the department where they work whilst the curriculum is undergoing rapid change, owing to the limited amount of time they may be able to contribute to the

development of new resources. The importance of the whole team engaging in dialogue and sharing the work load has been discussed earlier, but this could be difficult where some members of the department feel their main commitments lie elsewhere. It is therefore possible that teachers could find themselves teaching topics with which they are not familiar, or where the resourcing had not been carefully thought through.

Similarly, there are implications for initial teacher training and the induction of new members of staff where these teachers might not have sufficient experience of the scheme of work, the methodology practised in the school, the layout of the laboratories, the location of materials within the teaching spaces, or the social behaviour of the children, to enable them to plan to the degree suggested in this study.

6.8.2.4 Some Examples where Planning Enabled Pupils to Engage with the Activities

Looking at this from the opposite perspective, where planning was effective, it seemed to enable the children to engage in the task and increase their confidence. For example, the cut and paste activity in lesson nine was very successful. It seemed that the activities encouraged the children to engage with the main focus of the lesson - the relationship between the shape and function of various plant and animal cells. The teacher commented:

'This worked very well.....one of the most successful lessons.'

This was one of the lessons observed and it was noted that the pupils were indeed engaged. It was also noticeable that the pupils understood the task without difficulty and that there were sufficient scissors and glue for them to use. No pupil had to wait for others to finish before they could start or go 'hunting' around the room for a

pair of scissors. It was also evident that all the pupils had a piece of work which was very presentable. It is possible that some pupils found the activity more accessible because they did not have to draw the cells themselves. It has been noticed that drawing diagrams can cause some pupils to lose confidence as there can be a feeling that the resulting drawing is poor. This effect was negated here and as mentioned before, it was particularly effective in helping the children focus their minds on the conceptual issue being taught. It was also effective from an interpersonal perspective which will be discussed later.

6.8.2.4.1 Comments on some Wider Implications

Earlier discussions had mentioned the importance of the teacher being able to respond to the needs of diverse pupil groups. The teacher's diary, and the associated curriculum materials refer to a number of tactics and strategies which attempt to cater for these diverse groups. The teacher refers to clear target setting, agreeing assessment criteria with the pupils, introductory group work using the pupils' own ideas, aids for note taking whilst watching a video, giving the pupils a choice of activity, various DARTS activities, rearranging definitions to given words, pre-printing results tables, cutting and pasting activities, and producing work for display. It appeared that whilst this planning did help the children to focus their minds on the conceptual issue being taught, this is only part of the story. The observations suggested that the interpersonal relations aspect of the lessons was an important, possibly central, feature and it is pertinent to note that the teacher made no reference to this in his diary. It was as though this aspect of teaching had been considered unconsciously.

6.8.2.5 Planning and Individual Pupils' Conceptual Understanding

The findings suggest that the teacher did have an understanding of

the topic and the pathway through the topic. The work built on previous work, and there were no observable sudden conceptual jumps. It is interesting to note here, that during the planning of the work, with the advice of the Special Needs coordinator and advisor from SENASS, it was the science teacher who advised on the appropriateness of the activities from a conceptual development perspective. It was surprising, although with hindsight, perhaps it should not have been, that the non-scientists did not appreciate the implications of some of the work which they had provisionally planned. The science teacher, through experience, could predict which activities might work, and which might not, in addition to being able to advise on the suitability of the work from a conceptual development point of view. Once again, there appear to be implications here for initial teacher trainers and for those responsible for newly qualified teachers.

6.8.2.6 Planning the Use of Time in Lessons

It was also apparent that the activities had been planned to take account of time and during the observations and visits, it was clear that the teacher was monitoring the use of time and the progress of the pupils through the activities. The findings also suggest that, to enable the children to gain in confidence, the lesson structure should be planned, in addition to the content to be covered. This included where pupils would be engaged in small group work, individual work, whole class teaching, where pupils would be expected to feedback to their group or to the whole class and the dynamics of the work itself. Once again, however, the findings highlight the importance of the teacher adjusting these factors in the light of the lesson itself, responding to the situation.

6.8.2.7 Some Further Comments on the Teamwork Aspect of Planning

It is also significant to note that the joint planning, which continued throughout the duration of the project, enabled the teacher to feedback the outcomes of the previous work on a regular basis. This permitted the next piece of work to be planned more closely to the needs of the pupils, as perceived by the teacher. This feedback appeared to be particularly important and agrees with the findings from both the interviews and the lesson observations. A scheme of work is clearly essential, but it seems that it might work best when the individual teacher adapts it in the light of his or her own experience with his or her own classes, provided the statutory programme of study is followed. In the context of planning, therefore, successful lessons were associated with the teacher responding to the children in terms of adapting the programme of study, including the methodology, in the light of personal reflection and discussions with colleagues.

6.8.2.8 Comments Concerning the Manner in which some Worksheets Enabled the Pupils to Work Independently of the Teacher

An interesting finding was the manner in which some of the worksheets appeared to enable the children to engage with the activities and work independently of the teacher. It could be suggested that this independent working should be one of the aims of education in general, but it also seemed to have another significant effect. The children, when working independently of the teacher, were not demanding his time and attention. This 'freed' the teacher and enabled him to move around the classroom checking on the progress of pupils, helping briefly where necessary, and initiating discussions with pupils to elicit their understanding of the topic in hand. This seemed to be as a direct result of the activities that were planned for the children and the particular worksheets produced. Activities which enabled the pupils to engage with the conceptual issue being taught, build their concep-

tual understanding and yet also work independently of the teacher included; brainstorming, heads and tails quiz – matching words with their definitions using a glossary, sentence completion exercises, practical work where the pupils were very clear about what they were doing and why they were doing it, recording results from practical work where the teacher had provided a pre-printed results table with suggested alternative statements for the results, and rearranging diagrams. These clearly have a cognitive dimension, but they are mentioned here because it is the planning over which the teacher has control. It seems as though the tactics and strategies which have been identified in this study can be enabled, or otherwise, through the planning of the work. It is pertinent now, however, to turn to the issue of the pupils' conceptual understanding and this aspect of the planning will be discussed further in the summary.

6.8.3 Conceptual Understanding

In earlier discussions, the apparent importance of the teacher's confidence was emphasised, both in terms of the content and the methodology. The data from the teacher's diary emphasises this point and the teacher states that '*I found the exercise very useful*' and goes on to say that he felt that the joint planning and monitoring within the lesson could make '*the teaching of any topic more varied, more interesting and hopefully, more effective.*'. This was also the researcher's perception during the project. This teacher did indeed engage himself in the work of the team and did use his enhanced expertise to contribute to the development of the department as a whole. The observations also suggested that this was the case. Turning to the issue of pupil confidence, a number of tactics and strategies have been discussed earlier in this chapter. The observations of the teacher suggested that he did ask questions of the pupils where the

pupil clearly knew the answer. This appeared to increase the confidence of the pupil in terms of the act of answering questions in addition to reinforcing the content.

6.8.3.1 Comments Concerning the Terminology used by the Teacher and in the Worksheets

In terms of introducing scientific terminology in a non-threatening manner, the scheme of work for this module attempted to enable the children to express their own ideas, in their own language at the start of the module. This appears to have been successful and the diary commented: '*The pupils enjoyed this activity*' (p. 319, Lesson 1). It seems that this activity engaged the pupils and the teacher ensured that the pupils' preferred expressions were accepted, hence valuing their contributions. The manner in which the pupils collated and discussed their ideas in groups, feeding back to the whole class could have increased their confidence in terms of expressing their ideas to the teacher. It is possible that the pupils may have found it less threatening, discussing ideas with fellow pupils, rather than with the teacher.

During the planning, it was appreciated that the terminology might cause problems, and a strategy was devised to enable the pupils to engage with the words and ideas of the unit. One such activity was the Heads and Tails quiz which appeared to be successful, once the children understood what they had to do. The teacher commented: '*The majority of the children found the heads and tail quiz difficult to begin with, but easier when they figured out what to do, and how to make use of the glossary*' (p. 320, Lesson 2). It seems that, whilst an activity might appear to be particularly suitable from the teacher's perspective, it is important that the pupils can also engage with the activity in terms of how to undertake the task, in addition to being able to understand

the terminology or scientific concepts under discussion. It is interesting to note that one pupil 'was completely baffled by the words used' (p. 320, Lesson 2). The readability of the text was an important factor. A handout 'Fertilization' was made available to pupils who wanted it, but the researcher wondered about its usefulness, bearing in mind the previous comments about readability. An analysis of this handout shows that, randomly choosing a passage of 100 words:

Number of Sentences per 100 words: 8.7

Average word length: 4.62 letters
1.46 syllables.

Average sentence length: 11.49 words.

Reading age according to

Gunning's FOG formula 13.5 Years.

It was appreciated that different analyses can give different reading ages and a number of tests were applied to the text in question. The results ranged from a reading age of 10.6 years (Mugford Reading Level) to 15.0 years (Sticht's FORECAST formula). The example quoted above gives the median of five such tests.

It is clear that the readability of this text might not have been appropriate for all the 12 - 13 year olds in this class. Indeed, bearing in mind the school used a banding system¹, it is likely that whilst the pupils in the upper band might have been able to read most of the text, the pupils in the lower band might have had significant difficulties with it. The observations demonstrated that this would certainly not increase their self confidence and might lead to problems

¹ Banding refers to the grouping of pupils by ability. The year group was divided in half, one half containing the brighter pupils (the X-Band), the other half containing the others (the Y-Band).

of engagement within the lesson. In the event, it was the more able pupils who made use of the sheet, but it seems that the readability of texts used with pupils must be considered carefully if the teacher is aiming to increase the pupils' self confidence and encourage the children to engage with the activities to deepen their conceptual understanding of the topic. This also appears to apply to the context and quality of the presentation of the materials.

6.8.3.2 Questioning to Elicit Pupils' Conceptual Understanding

Turning now to questioning, it seems as though this teacher understood the potential effectiveness of questioning, in eliciting the pupils' understanding of a particular topic. In his diary, when discussing a problem with the heads and tails activity where pupils might be able to undertake the task successfully, without understanding the concepts themselves, he records; '*This could be brought out in questioning, if there was time.*' (p. 320, Lesson 3) From the observations, this teacher did use questioning to elicit pupils' understanding, in addition to asking questions to which the teacher felt that the pupil already knew the answer. It must be noted, however, that this teacher did not appear to use questioning as effectively as some of the other teachers in the study. Considering one of the other teachers in particular, it was as though he had a 'cognitive perception', and through questioning, or simply listening to what the pupils were saying, he could appreciate where the child was in terms of the child's conceptual understanding. This was then used to either probe further, to negotiate a more scientific understanding of the topic with the pupil, or to direct the pupil to an activity where he could substantiate, or otherwise, the idea himself. Even though the teacher under discussion did not appear to have this ability to the same degree the structure and content of the materials seemed to enable the children to

engage in this dialogue with themselves as well as the teacher. The teacher had become a facilitator in the process. The teacher commented, about an activity where the materials appeared to 'free' him: '*They worked well and showed interest. It was easier for me to move around and ask questions to see how much had stuck.*'. This 'freeing' of the teacher's time was discussed under the previous section and this, together with the other tactics and strategies under discussion, might be particularly significant. It is pertinent to mention here, however, that the teacher did notice, through questioning, that some pupils were using alternative strategies to complete the cutting and pasting activities. Some pupils were using the size of the 'hole' to judge which cells matched which functions! The teacher noted: '*Some of the brighter ones just used the size of the cut-out to fit it in.*'. Conceptual understanding, it seems, cannot simply be assumed by what the teacher sees the pupil write down. Questioning appears to be a central strategy to help the teacher ascertain where the child is in terms of his or her understanding of a particular topic or concept. Weaver (1980) gives an interesting example of an English exercise where it is possible to produce correct answers to comprehension questions using knowledge of the syntax and semantics of the English language, rather than an understanding of the passage itself. To illustrate, a small section is given:

'Corandic is an emurient grof with many fribs; it granks from corite, an olg which cargs like lange.....'

The first two questions in this exercise are:

1. *What is corandic?*
2. *What does corandic grank from?*

This interesting example highlights the need for dialogue between teacher and pupil if the teacher is to ascertain the pupils' understand-

ding of a topic, or issue. An example from the data concerns the sentence completion exercise from the curriculum materials (Appendix VIII, p.326). It is possible to complete many of the gaps by using a knowledge of the syntax and semantics of the English language and yet not understand the passage as a whole. The researcher had also noticed that it is possible for some pupils to copy their friends' work without the teacher realising and these pupils had a correct version of the text in their exercise books, even though their conceptual understanding of the text was suspect.

6.8.3.3 Summary

With this particular teacher, even though he did not appear to have the 'cognitive perception' of some of the other teachers, the team planning and 'outside' expert help in constructing the materials seems to have had a significant positive effect. The planning had also considered the pace and challenge of the activities and this appeared to support the teacher in the teaching of this module.

6.8.4 Interpersonal Relations

Using the categories which were discussed in the previous section, (and bearing in mind that the categories were discussed in depth at that stage), the first category concerned the teacher's awareness of the social behaviour of the class. During the planning phase, it was clear that this teacher was very aware of the social behaviour of the class and this formed an important part of the discussions with the SENASS advisor during the planning of the work. It was partly due to this advice, that some of the strategies were devised, to attempt to take the social behaviour into consideration and enhance the engagement of the pupils with the tasks. This was not particularly true concerning the dynamics within the classes as the observations suggested that this

teacher did not monitor the pace, and mood of the class as effectively as some of the other teachers. This was evident because, as discussed under Planning, a few activities were not particularly successful, and yet the teacher did not attempt to rectify the situation within the lesson.

6.8.4.1 Comments Concerning the Manner in which the Team Planning seemed to Facilitate the way in which the Class was used as a Learning Structure

What is interesting is that this teacher appeared to use the class as a learning structure because the work had been planned that way. In this teacher's case, it appeared to be the planning that enabled the class to be managed from a group dynamics point of view. The group work, feedback sessions, whole class work, practicals and discussions had been written into the scheme of work. Even though this teacher had participated in the writing of this work, it had been the special needs coordinator and SENASS advisor who had suggested and planned the dynamics of the lessons.

6.8.4.2 Comments Concerning the Manner in which Team Planning seemed to Raise the Confidence of the Teacher

It was felt that this project helped this teacher to develop a number of tactics and strategies which he could use later (as he commented in the summary of his diary), and which the science department could use as it continued to develop the schemes of work. It was also noticeable that the teacher himself appeared to be particularly confident whilst teaching this module and that he had rather more time to interact with the children. The children appeared happy to discuss their ideas with the teacher and he valued these ideas. Chapter five outlined the findings from the exploratory work. In that chapter,

the findings from the profile analysis was discussed (section 5.2.3) and it was found that teacher 1 drew a number of adverse comments from his classes; the same classes which were used during the work with the SENASS advisor. However, it is pertinent to note that eight pupils commented that they particularly liked the module on the Processes of Life; the module developed and taught with the SENASS advisor. As discussed earlier, these comments were not contrived in any way. The profiles were completed at the end of the year. All pupils were completing profiles for each of their subjects and the pupils knew that they should comment on what they had liked and what they had not liked. The fact that some pupils had highlighted this module suggests that it had been enjoyed and had made a positive impact on some pupils.

6.8.4.3 Comments Concerning the Limitations Associated with the Manner in which the Planning can Enable Positive Interpersonal Relations

The findings suggest that whilst the planning can help the teacher, to some degree, to respond to the children it does not seem to be able to help with certain aspects of the interpersonal relations. This finding is all the more important, because the building of positive interpersonal relations within the classroom appears to be a central feature of the lessons which enabled children to gain in confidence. It seems, however, that planning which takes into account the factors which have been identified in this study, might go some way towards helping the teacher respond to the children in a manner which might enable them to focus their minds on the conceptual issue being taught and possibly contribute towards the raising and maintaining of their self confidence. The findings suggest that this emphasis on planning is important, because it is the one factor over which the teacher has control. In a sense, the planning seems to be accessible to

the teacher, whereas the other dimensions identified appear to be rather more elusive. That is not to suggest, however, that the planning can in any way be undertaken in isolation from the other dimensions, but that effective planning which might be able to contribute towards the enabling of the learning process in the classroom should take particular account of them.

6.8.5 Summary

It is possible, that through dialogue, the planning of a scheme of work might be able to take account of the identified factors, where the teachers feel that they own the methodology in addition to the teaching materials. This might contribute towards each individual teacher's self confidence in addition to 'freeing' the teacher from the class during the lesson. This 'freeing' of time, and energy, might enable the teacher to gain access to individual pupils and groups during the lesson, enabling personal contact and discussions about the work in hand. Many of the factors associated with positive interpersonal relations, however, appear to be in the hands of the individual teacher alone. It appears that the planning can help with the factors associated with using the class as a learning structure, but that the manner in which the teacher is able to respond to the social behaviour of the class, the empathy and sensitivity of the teacher towards the children and the manner in which the teacher is able to navigate through the learning activity, responding to the dynamics of the moment, is firmly in the hands of the individual teacher. In this study, an attempt has been made to identify the tactics and strategies which all science teachers can reflect upon, respond to, and put into practice, irrespective of the their background and previous experience.

The findings from the various instruments are now summarised, with reference to the background theory.

CHAPTER SEVEN

SUMMARY AND DISCUSSION OF RESULTS

7.1 Introduction

The purpose of this chapter is to draw together the findings presented in chapter six and to respond to the background theory detailed in the early chapters of this study.

There has been a general feeling amongst science teachers that school science should be made relevant to the children, but it seems that there is a lack of clarity as to what this actually means. This appears to be concerned with increasing the motivation of the children and whilst it is clearly important to facilitate an initial motivation, on the part of the children, towards the area to be studied, the findings from this thesis suggests that this is insufficient. This study suggests that by careful planning, giving due attention to the group social behaviour and conceptual understanding of the pupils, together with the fostering of positive interpersonal relations, that children can indeed be encouraged to focus their minds on their school science and raise their self confidence at articulating their ideas. It should also be stressed that this does not mean that school science need always be focused on ideas which have direct relevance to the wider world, or which originate directly from the pupils' own experiences. It appears that it is the environment in which learning takes place which is significant, and this study attempts to describe the characteristics which have been found to be particularly pertinent in successful classrooms.

In the discussion, attention is given to the two strands which provide the focus for this research; ie. a description of:

- (a) The factors and strategies which enable children to focus their minds on the conceptual issue of interest in science,
- (b) How teachers may build and maintain the pupils' self confidence to enable pupils to access scientific ideas.

7.2 The Choice of School and Pupil Group for this Study

7.2.1 The Choice of School

This study has attempted to explore the issues outlined above by investigating the work of the science department in one school. The school had four main advantages which became clear at this stage in the research.

Firstly, it was the school at which the researcher was the Head of the Faculty of Science and Technology and hence lent itself to close investigation.

The second advantage concerned the manner in which the GCSE examination results and the number of pupils opting to undertake the double award science had improved over a period of two years. The GCSE results, as outlined in chapter one, exceeded the results which may have been expected from the pupils at the school with respect to national averages (p. 39). In view of the focus for this study, it was felt particularly appropriate to investigate a successful department because it was considered that there might be a greater probability of finding successful strategies. It was found that the department improved during the research, and comment will be made on this later in this summary because this is considered significant.

The third advantage for choosing the researcher's own school concerned the stability of the teachers. As discussed in chapter five (p. 128), they had all taught at the school for at least five years

and were fully established, both in terms of their knowledge of the school's systems and in terms of their relationships with pupils, teachers and parents. These teachers had all been intimately involved in the department's successful development and were therefore in a strong position to comment meaningfully.

The fourth advantage for choosing this school was that it was a single sex (boys) school. With the issue of gender removed, which may otherwise have made the research more complex, it was felt that it might be possible to concentrate on the research focus more intently than might otherwise have been possible.

7.2.2 Choice of Pupil Group

The school used cognitive ability tests on entry, and these suggested that the ability spread of the pupils had a normal distribution, with the exception that the top two percent was missing. It was assumed that these 'missing' boys attended the local selective independent school but this was not considered to be significant for this research. The researcher decided to concentrate on pupils in the lower school (Years 8 and 9) for four main reasons.

The first was theoretical. Chapter two outlines the background to the constructivist and Piagetian schools of thought which suggest that there would be less diversification of conceptual development with these pupils (ages 12 to 13) compared to the older pupils in the school. Interestingly, Dearing (1993a) comments in his interim report that the abilities and aspirations of young people entering Key Stage 3 will diversify less than at subsequent years.

The second reason for selecting the lower school concerned the pupils' social development. It has been suggested that the younger pupils will exhibit a greater degree of social stability at this age compared with the later years when adolescence may add to the

complications.

The third reason was strategic. It was felt that it was particularly important to build the self confidence of the pupils in the lower part of the school in order to establish patterns of working and raise their self confidence as soon as possible. It was hoped that this might then have a bearing on the success of the science programmes later in the school. It therefore seemed to be particularly pertinent to find out as much as possible about these initial years of secondary science.

The fourth reason was practical. This was the area of the school where teachers were more willing to risk experimenting with alternative approaches because the public GCSE examinations were a number of years away and end of Key Stage 3 tests were not yet used in schools.

These reasons seem to have been largely justified by carrying out the research.

7.3 Summary of Findings from the Exploratory Phase

7.3.1 Comments concerning the improvement in examination results and the pupil group.

The work from the exploratory phase confirmed the view that the noticeable improvement in GCSE examination results had not been due to a general improvement in GCSE results within the school. Also, It was known that the school attracted pupils from a very wide catchment including diverse social, cultural and economic groups and the exploratory work confirmed this view.

7.3.2 Summary of Findings from the Profiles and the Work with SENASS

The pupil profiles provided further information. 74.5% of the pupils who completed their profiles (114 pupils) commented that they

enjoyed their school science. The pupils were not prompted in any way, and this appeared to be a high figure. The profiles also revealed that one teacher in particular drew negative comments (teacher 1), although it was interesting to note that this teacher drew eight positive comments about the 'Processes of Life' topic. This was the topic developed with the help of the school's special needs coordinator and the SENASS advisor. This was felt to be significant because this teacher came from a physics background and was not, therefore, teaching within his specialism during the work with SENASS.

7.4 Four Characteristics of Successful Classrooms

7.4.1 Introduction

Chapter five (p. 115) introduces the idea that there are four main characteristics of work in the classroom that are pertinent to successful science teaching: the group social behaviour of the children, the individual pupils' conceptual understanding, the interpersonal relations and the teachers' planning. The importance of attention to these aspects of work in classrooms was very evident during the field operational phase of the research. For example; interviews with the teachers (pp 136 to 151), the lesson observations (pp 153 to 175), and the teacher's diary (pp 215 to 232). It is also interesting to note that these characteristics emerged from the findings from the exploratory work and were confirmed during the field operational phase of the study. These characteristics are outlined below and are developed further later in this chapter.

7.4.2 Comments concerning the variation in Individual Pupils' Conceptual Understanding and Group Social Behaviour

The normal distribution of the scores from the cognitive ability tests of the pupils suggested that the pupils would vary in the level of their conceptual understanding of the various scientific issues under consideration. Also, the fact that the school drew its intake from diverse social, cultural and economic groups, in addition to a large number of Middle Schools, suggested that the social behaviour of the children was likely to vary considerably. When these children were put into groups, as they were in tutor and teaching groups, then the behaviour of individuals was likely to vary according to the accepted norms of the various groups to which individuals belong. This has been discussed earlier in chapter six (pp 166 to 167), and supports the view that the group social behaviour of the children is an important factor at work in the classroom.

The above discussion, in terms of conceptual understanding and group social behaviour, suggested that the pupils in the school would vary. This was to be expected and the views expressed by the pupils themselves during the exploratory work supported this idea. For example, the analysis of the profile statements (Chapter 5, pp 112 to 113) show that some pupils liked an academic approach to their work, whilst others preferred a more practical approach. Similarly, pupils commented on their preferences for activities as diverse as problem solving, researching, practical work, talking publicly and explaining ideas.

7.4.3 Interpersonal Relations

The pupil profiles also revealed another interesting finding. It was clear that the quality of the interpersonal relations was also a factor which influenced some children. Comments included, again unprompted, that they liked the teacher, got on well with their classmates, or enjoyed receiving commendations. This also agreed with the findings from the other instruments.

7.4.4 The Teachers' Planning

The fourth characteristic of work in classrooms seems to be the planning of the teacher. Obviously, pre-planning contributes towards success, but this study suggests that it is the manner in which the teacher plans the work and activities which is particularly important.

7.4.5 Summary

This discussion has explored the relationship between the group social behaviour, the individual pupils' conceptual understanding, interpersonal relations and planning as major characteristics of work in the classroom. This is in agreement with the findings of other researchers. For example, chapter two (p. 19) outlines a study undertaken by Shapiro, where different pupils clearly learn and behave in different ways and shows how conceptual development can be considered to be guided by a variety of cognitive, social and personal features which function together in the science classroom. Similarly, the work of Pask, Kelly and Millband (pp 27 ff), suggest that pupils vary in their learning styles, and the work of researchers such as Head (1985), Witkin (1975) and Atkinson and Raynor (1974) (pp 31 ff) suggest that children vary in terms of their personality and motivation. It is interesting to note that I have not found any specific study which has attempted to link the research concerning the cognitive and affective domains to suggest how teachers may best organise and put into practice

their teaching for effective learning. In this study, an attempt has been made to look not only at cognitive factors, but also to consider the affective characteristics to some degree. It should be noted, however, that during the lesson observations, lessons involving strongly emotive content areas (eg. reproduction, inheritance, cancer) were avoided because it was felt that this might have added to the complexity of the study.

The methodology is felt to be particularly significant and it is hoped that, together with the findings from the study, it can help teachers in the future to reflect on their practice with greater understanding, and hence be of use to them in the classroom.

What seems to be particularly pertinent from the findings is the manner in which the teacher can influence, or orchestrate the four characteristics (of group social behaviour, interpersonal relations, conceptual understanding and planning) to enable effective learning to take place.

7.5 Team Planning

Planning will be discussed first because it is this over which the teacher has control. The other characteristics appear to be rather more elusive.

7.5.1 Comments Concerning Teamwork and the Manner in which Teachers Adapted the Agreed Methodology to Suit their Preferred Styles

It was clear from the interviews, lesson observations, the work with SENASS and the researcher's informal discussions with the teachers in the science department that there was a common culture: there was agreement about the content and the methodology (pp 136, 153 and 217). The scheme of work had been planned as a team, and this teamwork is considered to be particularly significant (eg: Page 136 outlines the

importance of the team planning which was revealed during the interviews). Page 154 demonstrates that the agreed methodology was indeed being translated into practice in the classroom, and page 217 highlights the importance of the teamwork aspect of the work undertaken with SENASS.

It is also worth stressing at this point that it was very clear that the planning had been a collaborative venture. The teachers were implementing the methodology because they felt it worked in their classrooms and that their ideas had been shared and valued by the other members of the team. This was evident in the interviews, (for example p. 136), the work with SENASS (p. 217) and the lesson observations (for example p. 154). It was also evident that individual teachers were able to adapt the agreed methodology to suit their own personal style (for example pp. 137, 154). Page 158 gives an example where two teachers were teaching the same topic, to parallel groups and yet had adapted the team planning to the needs of their individual classes. The fact that individual teachers felt confident to adapt the team planning to the needs of their classes is also considered to be significant. Pages 28 ff of this study outlines the work of Millband (1984) and it is relevant to note that she found different types of concept require different teaching approaches yet teachers tended not to change their teaching style in recognition of the type of topic being taught (p. 29). This is important because this suggests that it might not be particularly effective to attempt to coerce teachers into adopting a particular teaching style if it differs significantly from their natural style. Millband's work raises important issues concerning how teachers develop and change the strategies they employ.

7.5.2 Comments Concerning Teamwork and the Fostering of Positive Interpersonal Relations

Another significant reason for not expecting teachers to adopt a style which might be significantly at odds with the individual teacher's preferred style is highlighted in this study. The findings support the view that the type of relationship between pupils, and between pupils and teachers is more significant in enabling pupils to develop their conceptual understanding than has been previously thought by teachers. The observations demonstrate that when teachers are uneasy or unsure of the content, methodology, worksheets, location of equipment or room layout then they can give negative verbal and non-verbal cues to the children, to which the children may respond. This could affect the atmosphere in the classroom and hence the quality of the interpersonal relations (pp. 156 ff). This was found to affect experienced teachers and could lead to a greater incidence of negative interpersonal response on the part of the teacher which could then lead to a lower cognitive response. Lesson five, (p. 207) provides a good example of how an experienced, respected teacher, who taught the most successful lesson observed (Lesson four, p. 203) can respond negatively when under pressure. It is proposed therefore, that if teachers are to be able to adapt their preferred teaching style to suit the demands being placed on the learner, then this might be most effective where it is achieved through dialogue and discussion, in an atmosphere of collaboration and support. The findings suggest that this was the case within the science department under consideration.

7.5.3 Comments concerning the importance of Ownership and Involvement in the Teachers' Planning

The interviews show that the teachers not only felt that the environment was supportive and collaborative, but that this was valued and felt to be important (p. 136). It is possible that teachers might be more likely to experiment, admit mistakes to themselves and share their experiences in this type of supportive environment. It is also possible that this experimentation, reflection and dialogue on the part of the teachers was, in itself, significant in supporting the improvements within the science department during the period of the research. This could have contributed towards the self confidence of the teachers, and the work undertaken with SENASS supports the view that for effective learning, teachers themselves need to be confident with the methodology in addition to the content and the materials. They need to be involved in their development, have a sense of ownership (p. 217), and be able to adapt the team planning in the light of their own experiences. It is also interesting to note that the lesson observations revealed a potential problem. Lesson one (p. 194) highlights the importance of ownership and involvement in the planning process and shows that where the teacher did not fully appreciate the methodology, a partial implementation was not successful.

7.5.4 Summary

The previous section supports the view that when looking at successful classes, there seem to be four issues of significance. This research, whilst considering one science department in particular, has attempted to identify the factors and strategies which all science teachers may find useful in enabling children to focus their minds on the conceptual issue of interest. Similarly, the findings concerning the manner in which the children's self confidence can be built and

maintained appear to be generic and might prove helpful to science teachers in other secondary schools.

The importance of team planning has just been highlighted, together with the necessity for individual teachers to be able to adapt the team planning to meet the needs of their own classes. It is now apposite to consider the nature of the methodology which was planned, because this underpinned the manner in which the schemes of work were written and implemented.

7.6 Responsive Teaching

The background work, outlined in chapter two, develops the Responsive Teaching model (Pages 34 to 40), which attempts to unite, in a small way, the separate research which has taken place in the cognitive and affective domains. Inherent in the model is the notion of the teacher responding to the pupils. This study has identified two aspects to this responding on the part of the teacher, which reflect the cognitive and affective dimensions discussed in chapters two and three. These concern the manner in which the teacher responds to the pupils in terms of the individual pupils' conceptual understanding and the way in which the teacher may facilitate positive interpersonal relations within the classroom. This study suggests that it is the manner in which the teacher can unite these two aspects which is of particular significance.

7.7 Comments Concerning the Eliciting of Children's Ideas

The study revealed that the teachers shared an opinion of how children learn, (eg. p. 143) and that this was based upon a constructivist view. Of central significance is the idea that learning is seen as involving conceptual change and in order to encourage such change, teachers need to be aware of, and value, the ideas which children bring

with them and develop in the classroom. (This is discussed in detail in chapter two; pages 15 ff).

This valuing of children's ideas was very evident in the data. The teachers felt that the children needed to express their own ideas and that these ideas should be valued. This was expressed in the interviews (eg: pp. 143, 146, 148), was very evident in the observations (eg: p. 168), and was exhibited in the work with the SENASS advisor (eg: p. 227). Part of this valuing is concerned with encouraging pupils to recognise each other's ideas. It is not simply the interaction between teacher and pupil which is important, but also that between pupils.

The effectiveness of this eliciting and negotiation of children's ideas seemed to depend on a number of factors including:

1. the planning in terms of
 - (a) the resources,
 - (b) the cognitive demands being made of the children,
 - (c) the management of the group dynamics within the classroom and
2. the interpersonal relations.

7.7.1 Planning for Individual Pupils' Conceptual Development

The lesson observations showed that successful lessons had been planned to develop understanding, and that the teacher had a clear idea of the pathway through the topic in general and the lesson in particular. Where inadvertent conceptual jumps were made, this reduced the effectiveness of the lesson (eg: p. 159 ff). The team planning had enabled the teachers to share their knowledge and experience, enabling the team to produce a scheme of work which more closely matched the needs of the children. The teachers themselves commented on the importance of this joint planning in the interviews (eg: p. 136). The fact that the work had been planned carefully, with the understanding that children would be encouraged to articulate their own ideas, meant

that materials would be available to allow the teacher to respond to individual pupils. These alternative activities could be required either because the children already had a good understanding of the topic under discussion and needed extension work, or because the teacher had realised that something important had not been understood and the pupils therefore required overlearning material (p. 37). The extension or overlearning activities would probably be available because the teachers had planned for the eventuality. It would be particularly frustrating, for the teacher and the pupils if a particular need was identified and then the necessary materials were not available. An extreme example of this was observed in lesson five (p. 207) where the teacher forgot to order the apparatus and did not realise this until the lesson was underway. This aspect of planning, to ensure that possibilities had been thought through to enable teachers to respond to the pupils' ideas and their conceptual understanding was particularly evident throughout the field operational phase (Eg: in the interviews (pp 138 and 139), the observations (eg: p. 160) and the work with SENASS (p. 220)).

Gagne's (1965) work (outlined in chapter two) considers learning to be based upon a hierarchical model and it is interesting to note that Gagne's model has been used as the basis for developing science teaching programmes; notably the School's Council Integrated Science Project (SCISP) in the United Kingdom. Gagne's model provides the logic structure of a composite concept and the manner in which the schemes of work were constructed in the department which was studied was based upon this idea. What was particularly significant, however, was the manner in which the extension and overlearning material had been organised. The science teachers had recognised that whilst this logic structure could be helpful, teachers also had to allow for the idiosyncrasies of individual children. Pritchard's (1989) view that

Gagne's model does not identify an efficient route for the individual learner seems to be in agreement with the findings from this study. The teachers recognised the importance of effective questioning to enable the teacher (and pupil) to gain a better idea of the individual pupil's conceptual understanding of the issue under discussion. It appears that the manner in which the work is planned could facilitate this process and hence enable the teacher to respond appropriately. For the planning to be effective, however, it appeared that the teachers needed to be able to anticipate, to some degree, the pupils' responses. It seemed that this requires a certain experience and it was clear that the teamwork enabled experiences to be shared. It is felt that this resulted in more effective programmes than might have otherwise been the case.

The work with SENASS emphasised the importance of team planning. When teacher 1, the school's special needs coordinator and the SENASS advisor were preparing work, it was the science teacher who advised on the appropriateness of the work from a conceptual development perspective. The non-scientists had not appreciated the full implications of some of the work which they had outlined because they had not appreciated the manner in which concepts can be understood at different levels. The science teacher, through experience, could predict which activities might work, and which might not.

There seem to be important implications here for science departments which contain newly qualified teachers or student teachers. It is also interesting to note that this anticipation did not simply relate to the teacher's knowledge of the conceptual development of individuals within the class, but also to his/her knowledge of the group social behaviour. This brings us to the second aspect of responding to children's ideas; the interpersonal relations. The planning with

respect to the group dynamics within the classroom will be discussed later.

7.7.2 Interpersonal Relations

The above discussion highlighted the importance of the teachers' team planning to aid the conceptual development of individual children. The discussion also stressed the idea that learning involves conceptual change and in order to encourage such change, teachers need to be aware of, and value, the children's contributions. This conceptual change does not appear to be a solely cognitive act, and what has been found to be significant in this study is the apparent importance of the interpersonal relations within the classroom.

7.7.2.1 Valuing the Children

Of primary consideration was the manner in which the teachers valued the children highly. There was an empathy and sensitivity towards the children which appears to reflect the comments of Ausubel (pp 13 ff). He identified three reasons why some pupils will resort to rote learning, even to potentially meaningful subject matter, which are repeated here for convenience:

1. some learn from sad experience that substantively correct answers lacking in verbatim correspondence to what they have been taught receives no credit whatsoever from some teachers.
2. some lack confidence in their ability to learn meaningfully, and hence perceive no alternative to panic apart from rote learning.
3. others could be under excessive pressure to exhibit glibness, or to conceal, rather than admit and gradually remedy, original lack of genuine understanding.

The teachers felt that some children would not like to be seen to be wrong when answering questions, and that it was important to build

an atmosphere where children could feel that 'it was ok' (p. 147) to give a wrong answer. This view is supported by the lesson observations (pp 168 ff) and page 169 gives an example where praise was given for trying and the manner in which the pupil was thinking, even though the answer was wrong.

This sensitivity and empathy was expressed clearly in the interviews (pp 145 ff). Teachers felt that this was exhibited through mutual respect, having high expectations and being able to treat children as partners in the learning process. The lesson observations support the findings from the interviews and highlight the way in which the teachers demonstrated their empathy and sensitivity. It was clear that non-verbal cues were as important as verbal cues in enabling children to build and maintain their self confidence and express their scientific ideas (pp 168 to 171). Examples of positive and negative cues can be found on pages 169. An example of a particularly interesting strategy can be seen in lessons 4 and 6. Here, the teacher introduced scientific terminology in a non-threatening manner by using colloquial English. Correct terminology was integrated into the colloquiums and it appeared to be particularly effective (p. 163). This is considered to be a significant finding and appears to be supported by the work of Hidi (1990), detailed in chapter three (pp 43 ff). She presents evidence to suggest that both individual and text-based interest have a profound effect on cognitive effect on cognitive functioning and the facilitation of learning (p. 44). The works of people such as Hidi (1990), and Bernstein (1955), amongst others (see page 46), suggest that interest leads to higher conceptual understanding which builds the pupils' self confidence which then leads to increased interest. Page 46 presents evidence of sentences which have been found to generate text based interest. The manner in which

teacher 4 used colloquial English, as discussed above appears to confirm the assertion made on page 46; ie: that the phraseology used by the teacher could have an impact on the potential interest of the children on the area under discussion and build their confidence in tackling new work.

The development of the science department had been particularly influenced by the work of the Children's Learning in Science Project and the contribution of this work to the development of the Responsive Teaching model is detailed on pages 34 ff. Throughout this model, the elicitation and recognition of children's ideas, and the ability of the teacher to negotiate conceptual understanding with the pupils is central. The emphasis on encouraging children to express their ideas, and the valuing of the children themselves in addition to their ideas is therefore notably significant.

The work of Reyes (1984) and Weiner (1979, 1985) concerned with motivation and attributional theory has been outlined in chapter three (pp 47 ff). Whilst much of Weiner's work was undertaken with adults in laboratory settings, the attributional model remains one of the most theoretically developed and empirically grounded approaches examining student perceptions. Ruble (1980) has suggested that children's concepts of ability and success change over time and that there are developmental differences in capacities for processing and integrating information relevant to these concepts. Nicholls' (1978) work suggests that it is at an age of about 11 years that children separate ability, effort and outcome and they understand that effort and ability both can determine outcome. Nicholls' work also suggests that children at this level understand ability as capacity, and realise that lack of ability can be a potential limit on outcome, regardless of effort. Other researchers (eg; Stipek (1981), Livesley and Bromley (1973), Bromley (1979), Blumenfeld et al (1982), Dweck (1982)) have found similar

results, which is relevant to this study because the children under consideration were 12 to 13 years old, suggesting that Weiner's model might well be appropriate. This body of work also suggests that the findings from this study should be treated with extreme caution if extrapolating the findings to younger children. This is because it suggests that the children's use of absolute evaluative standards, when combined with the conception of intelligence as changeable, implies that self-assessment may not have the same consequences for future expectations and achievement-related behaviour as would be predicted by the attribution theory.

In chapter three, the dimensions of locus, stability and controllability were discussed. The way in which the teachers in this study valued the children and their ideas and the contribution of these factors to the success documented seem to be supported by this background. The teachers appeared to concentrate on the children's effort, rather than their ability, emphasising the manner in which the teacher could help and guide the children towards the successful completion of the tasks and a higher conceptual understanding. This was evident in the dialogue between pupils and the teacher and the way in which the curriculum materials were written and managed. It appears that the teacher was attempting to attend to the locus of success both within pupils (by emphasising effort and by encouragement through high expectations), and outside pupils (by attending to the appropriateness of the tasks and by supporting pupils with appropriate curriculum materials and personal help in the lessons). It was as though pupils were made aware that success is controllable; being due to effort rather than ability. This supports Weiner's view that pupils who blame failure on ability tend to become poorly motivated because ability is not likely to change dramatically and thus effort cannot overcome the

cause for failure. This aspect of controllability has been discussed by other researchers (eg: Blumfield et al (1982), Wittrock (1986)) and they suggest that when uncontrollable causes are blamed for failure, motivation is generally poor because the student feels that there is little he or she can do to increase his or her chances of success. Effort is generally controllable whereas ability and task difficulty are not. It appears that the teachers in this study have attempted to attend to both the controllable and uncontrollable (as far as the pupils perceive them) causes in order to increase pupil success and hence motivation.

This emphasis is also in agreement with Ames (1988) who, discussing classroom climate, distinguishes between a performance orientation and a mastery goal orientation (p. 48). With mastery goal orientation, importance is attached to developing new skills. The process of learning itself is valued and the attainment of mastery is seen as dependent on effort. These are precisely the emphases which seem to have been found throughout this study. Once again, previous researchers suggest that children adapt, perhaps unknowingly, to the classroom climate and different patterns of cognition, affect and performance have been found (eg: Ames (1990), Ames et al (1977), Covington (1984)). This supports the view that the way in which the successful teachers valued the children and actively sought ways to enable success helped the pupils increase their self confidence and hence their conceptual understanding. The influence of self confidence on higher motivation is well documented (eg: Coppersmith (1959), Rogers (1969), White (1959), Entwistle (1981), Allport (1963), Holt (1964), Schunk (1990)). It appears that the teachers in this study have attempted to increase the pupils' self confidence through the planning, the enabling of conceptual development and the fostering of positive interpersonal relations, as discussed in chapter six. It must be emphasised, however, that the

sensitivity and empathy discussed earlier also relates to the social and emotional factors which children bring with them to school. The data suggests that teachers need to be aware of the group social behaviour of the class and be able to manage it effectively. It was also appreciated that children bring aspects of the emotional dimension with them and that whilst the planning cannot take this into account, a certain sensitivity may reduce potential problems and facilitate learning.

7.8 Whole Class Teaching Versus Small Group Work

Chapter six (pp 175 ff) explains how the manner in which the teacher responded to the children was analysed under the two headings of (a) cognitive response and (b) interpersonal response. Cognitive response referred to the teacher responding to individual children's conceptual understanding; eg: accepting and using the children's ideas, discussions related to the science, questioning, and directing pupils to tasks. Similarly, Interpersonal Response was taken to refer to the manner in which the teacher responded by; reducing tension, praising and encouraging children, giving positive and negative verbal and non-verbal cues, using his/her position in the classroom, ignoring pupils (both intentionally and unintentionally), and using excessive authority. These are discussed in greater detail in chapter six (pp 175 to 182)

Whilst the categories of cognitive and interpersonal response were separated to aid analysis, it should be appreciated that the findings suggest that, in reality, the categories are often mixed up, one with the other, and are evident at the same time.

What was significant was the finding that the cognitive response tended to increase and decrease with the interpersonal response (p. 188). It was also revealed that most of the positive responding, in

terms of interpersonal relations occurred when the classes were working in small groups (p. 189). The reverse was also found. Almost all of the negative interpersonal responding occurred when the teacher was teaching the class as a whole (Tables 6.4 and 6.5). Similar findings were revealed with respect to the cognitive response on the part of the teacher. Table 6.4 (p. 186) clearly shows that the teachers responded cognitively much more frequently when the children were working in small groups. It is also interesting to note that the rate of increase in cognitive and interpersonal responsiveness on the part of the teacher increased during small group work (eg: chapter 6, p. 203). An earlier discussion (p. 193) suggested that this should not be surprising. It is when the children are working in small groups that the teacher has the freedom to move around the science classroom and gain access to the children on an individual or small group level. The teacher is then in a position to talk to individual children and question them to enable them to express their ideas.

The National Primary Survey report (HMI 1978) and the National Secondary Survey report (HMI 1979) both pointed to the need for teachers to make greater use of genuine discussion to explore and develop student thinking. It appears that the small group work enabled this higher level questioning and discussion to take place. The assertion made on page 120, that the quality of the interaction between pupil-pupil and teacher-pupil is important if children are to increase their confidence at articulating their ideas appears to be born out by this study. The findings from HMI are in agreement with other researchers. Barnes (1969) asserted that pupil participation is too low, they ask too few questions, and when they are willing to contribute their contributions are not built upon. Similarly Reid and Hodson (1989) comment that in a class of 25 pupils, the opportunity for

any one child to talk meaningfully about science is usually very short.

Kyriacou (1988) suggests that whilst many might regard science practicals as a common example of small group work, the vast majority of practical work involves individual pupils carefully following instructions and directions given by the teacher. He comments that this offers little room for discussion and collaboration other than the cooperation required for the conduct of the practical.

It appears that much of the practical work which is organised in small groups is driven by the need to share equipment. The requirement for children to have close access to laboratory equipment needs to be differentiated from the use of small groups to facilitate collaborative work such as role play and discussion. This study suggests that through careful planning, meaningful discussion can be enabled to take place both between pupils, and between pupils and teacher during the small group work. What seems to be pertinent is the need for the teacher to design appropriate small group work and integrate this into the scheme of work. How teachers may enable and enhance the use of small group work to permit more effective questioning and dialogue has been amplified by the findings from this study. It should be stressed, however, that this questioning is not simply a cognitive act, and that the comments made earlier concerning the interpersonal relations dimension and the manner in which the teachers interacted with the children are particularly pertinent (p. 247).

Whilst the whole class teaching was found to be potentially more difficult, and almost all the negative interpersonal responses were found during this work, this study suggests that it should not be ignored. Whole class teaching appeared to have a significant role to play in the enabling of the small group work in terms of creating an environment where pupils could work on their own without the constant direction, or intervention, of the teacher (pp 190 ff). This seemed to

be concerned with the management of the class as a group, rather than as a number of discrete individuals. The lesson observations highlight this aspect of whole class work and the importance of using the class as a learning structure (pp 171 and 172). It was clear that successful small group work was associated with the teacher giving the whole class a clear, positive lead before the group work began, and followed up the work by pooling ideas and findings towards the end of the lesson. This aspect of facilitating small group work appears to be in agreement with other researchers, such as Kerry and Sands (1984), and Good and Brophy (1980). Kerry and Sands in particular suggest that small group work is more successful where the teacher shows skill in handling and understanding groups. This study agrees with this and the following section amplifies this aspect of the discussion.

7.9 Classroom Management

The positive emphasis in the current discussions is not intended to suggest that the pupils always wanted to engage with the activities in hand. It was evident that teachers needed to reprimand pupils on occasions, or bring off task pupils back on task. Previous discussions have highlighted the influence of the group on the behaviour of individuals (eg: chapter six, p. 166), and a common thread running through the study has been the need for the teacher to be aware of the group social behaviour of the children. The discussion on page 173 points out that there is a considerable body of evidence to suggest that as children grow older, they may need to go outside the family. This could be to learn the social skills that he or she may need as an adult and to fulfil the psychological needs that come with adolescence. It is possible that groups of adolescents might have, or quickly evolve codes of values and behaviour of their own which might be at variance with those of the family or the school. This could lead to conflict

with authority which could manifest itself in the classroom. It was apparent that successful teachers managed the group social behaviour by building relationships according to a personal style which seemed to be based on a collective view. Successful lessons were associated with clear and unambiguous instructions and clear, explicit expectations (eg: p. 174). Successful teachers also appeared to have presence in the classroom (p. 174) and although this is difficult to define, it seemed to be associated with the teacher having an awareness of what was happening and giving the children appropriate verbal and non-verbal cues. The children in the study seemed to expect teachers to be in control, wear 'normal' clothes, and not be particularly idiosyncratic. It was interesting to note that there seemed to be a collective view, between teacher and pupils, and between pupils of what was, and was not, acceptable. There was also an understanding amongst the pupils of how teachers should respond in particular circumstances. For example; off task behaviour, pupil outburst, pupil humour or another teacher entering the room (eg: p. 174).

It was clear that the teachers monitored the use of time and successful lessons occurred where the teacher expressed clear time deadlines, associated with clear boundaries between activities (eg: p. 172). Constant monitoring of the class was considered to be significant, not only in terms of the timing of activities but also in terms of the teacher being vigilant, scanning constantly, monitoring the pace, mood, and conceptual development of the class. It was also noticeable that successful teachers acted early if something was threatening the progress of the lesson. These teachers not only had a sensitivity to the group social behaviour of the children, but also had strategies for dealing with any potential problem (p. 167). This could entail drawing the class together to clear up a misunderstanding during

small group work (eg: p. 172); referring the class to the text book to re-focus pupils' minds (eg: p. 168); allowing praise or reprimands to be heard publicly (p. 169); or using proximity to reduce off task behaviour (eg: p. 161). (An important and possibly central strategy for limiting off task behaviour was ensuring that pupils were able to engage with the activities which is discussed further in section 7.10 below). During small group work, successful monitoring was associated with the teacher having many, if brief, contacts with pupils, ensuring all pupils had an opportunity to have access to the teacher. This also enabled the teacher to constantly check on pupil progress and understanding, praising and encouraging where thought appropriate (pp 168 ff). This is in agreement with the previous discussion on small group work.

It is also useful to note how teachers used open and closed questioning. It might be thought that open questioning should dominate; particularly if the teachers are attempting to elicit the ideas and views held by the children and engage in higher level discussions (p. 165). Whilst this is indeed appropriate, the role of closed questioning should not be underestimated. It was evident that teachers sometimes used closed questions to draw pupils into the group during class discussions, or to help build the self confidence of pupils, where the teacher appreciated that the child knew the answer to the question being posed (eg: p. 165).

The strategies which were found to be effective, and which have been documented in this chapter seem to support the views of others. For example, the work of Fry (1984), has been discussed in chapter three (pp 53 ff). This work explored the possible effects of classroom environments and classroom processes on problem and non-problem children's behaviour and motivations. Fry found that, over a four month period, children perceived as being 'problem children' received more

negative affect from teachers, obtained fewer social contacts and were asked less frequently by their teachers to express their personal views and preferences on academic and class related issues. It was also noticed that the number of serious misbehaviours also increased over the period. It appeared that the problem children, in particular, had become much less sensitive to the teacher's expectations of good behaviour and orderly conduct. Other researchers (eg: Brophy and Good (1970), Rothbart et al (1971), Garner and Bing (1973)) confirm the view that the positive and negative expectations and labelling of children do indeed affect student behaviour and produce inequalities in teacher-pupil contacts and the quality of intellectual and cognitive interactions. As discussed earlier, it is felt that the manner in which the teachers in this study valued the children (pp 248 ff) is particularly significant, and the findings of other researchers such as those detailed above seems to confirm this view. This valuing of the children was evident throughout this study. For example, it was reflected in the planning of the work, the way in which it was structured(allowing for extension and overlearning material), the cognitive demands made upon the children, the management of the group dynamics within the classroom and the quality of the interpersonal relations. The role of small group work, particularly in enabling high quality intellectual and cognitive interactions, in addition to fostering positive interpersonal relations is considered significant and has been discussed in greater detail on page 252.

7.10 Conceptual Understanding

The importance of creating opportunities for the teacher to be able to interact with and question pupils has already been discussed. For this to be effective, it was necessary for the teacher to have a good understanding of the topic under consideration and feel confident

with it (p. 144). To be able to respond appropriately to the ideas expressed by children, it was also necessary for the teacher to have an appreciation of how certain ideas build from certain core concepts and that concepts can be understood at different levels. This requires a background knowledge in addition to the skill of being able to listen to the children's answers. During the developmental phase of the research a training session was organised (led by the Southern England CLIS representative), where some of the findings of the work undertaken by the Children's Learning in Science (CLIS) Project were explored. This involved giving the year 8 pupils a 'test', devised by the CLIS team, and then comparing the findings from the school's results with the national findings. This emphasised the nature of the children's ideas and proved to be quite a shock to some of the science teachers. Many of the children's answers were not what the teacher's expected and it was also noted that the findings from the school's results were consistent with the national findings. The training proved to be a significant stimulus in the subsequent discussions when schemes of work were being planned.

When questioning children in the classroom, it might be appropriate to probe further to gain an appreciation of the level at which the children understand the concept under discussion (pp 165 ff and 144 ff). This might then enable the teacher to direct the children to the next most appropriate activity. This responding has significant implications for planning which were discussed on pages 240 ff.

Part of the field operational phase involved teacher 1 working with the school's special needs co-ordinator and a member of the SENASS team to produce an exemplary module of work. The background to this work is detailed in chapters five (pp 126 ff) and six (pp 215 ff), and some of the curriculum materials produced can be found in appendix 5.

This teacher was chosen for this activity because he had had the greatest difficulty in adapting to the more open, investigative style which had been developed. What is interesting for this study is that the structure and content of the curriculum materials themselves seemed to enable the children to engage in this dialogue with themselves in addition to the teacher. The materials appeared to have enabled the teacher to become a facilitator in the process, and created time for dialogue to take place (p. 227).

The importance of questioning was emphasised during this work. For example, it was evident that children were using alternative strategies to complete the cut and paste task (p. 228). Similarly, p. 229 gives an example of where pupils could complete the task on paper, but without using their knowledge of science. Questioning the pupils revealed the strategies they were using to complete the tasks.

Another theme which emerges throughout the data is the importance of providing a range of approaches in the scheme of work. This was not just to enable the teacher to respond to the different levels of conceptual understanding amongst the children, but also to provide variety and interest, for the teacher, as well as the children. This is concerned with responding to diverse pupil groups, and having an appreciation that the concentration span of children will vary. Examples included: use of text book, class discussion, group work and practical work (p. 138 and 160). There is clearly a group dynamics perspective here, which was discussed earlier.

7.11 Curriculum Materials and Pupils' Self Confidence

The previous discussions emphasised the empathy and sensitivity exhibited by the teachers towards the children. The interviews suggest that whilst work should be planned to challenge pupils, it should also aim to increase their self confidence (eg: chapter six, page 140). This

was also evident during the lesson observations (eg: chapter six, page 157). It was also clear that this feeling of valuing the children extended to the curriculum materials. A number of strategies were used in an attempt to build the pupils' self confidence and make the work accessible (pp 156 ff). Strategies included: attending to the context, reading age, and presentation of the materials; diagram completion; providing a list of missing words for sentence completion exercises; providing outlines of tables for completion during practical work; providing example results, which pupils used during their practical work; matching words with meanings; cut and paste activities and giving specimen graphs to aid the pupils as they drew their own from their experimental results. It was also noted that the laboratories had a spelling list of common scientific words, in a prominent position in each laboratory and that the pupils referred to this when necessary (p. 163).

Strategies such as these not only enabled pupils to engage with the activities and complete them successfully, but they reduced the dependence of the pupils on the teacher. They were able to attempt many of the activities either alone, or in small groups. This aspect of freeing the teacher, to enable him/her to engage in dialogue with the pupils has already been discussed, and is considered to be particularly important. A word of caution must be expressed, however, because this is not to suggest that pupils can simply get on with work on their own if it is structured as suggested here. The role of whole class teaching, in enabling this small group work should not be underestimated (p. 252).

7.12 Summary

The work of Tobin and Fraser (1990), has been outlined in chapter three (pp 41 ff). They undertook a series of case studies of exemplary

practice to provide a focus on the successful and positive facets of schooling. Much of their work seems to have been corroborated by this study, except that my assertion that some of the characteristics were at odds with increasing pupils' self confidence appears to have been born out. These concern the manner in which they suggest that exemplary teachers summarised pupil responses, corrected misunderstandings and indicated where responses were incorrect. In addition, the teacher endeavoured to work from a given answer to the understanding that he wanted a student to have. The findings from this study suggest that this might not increase pupil confidence, particularly for the pupil who rarely got things right! The findings suggest that teachers must indeed lead pupils from the pupil perspective towards the more scientifically acceptable view, but that the manner in which this is done is of paramount importance. The issue of eliciting and valuing the children's ideas has been highlighted. The manner in which pupils can be encouraged to discuss their ideas and how the teacher can increase the self confidence of the children to access their ideas in science and facilitate learning has been discussed. This is a complex process, and it is suggested that this involves a number of factors, based upon the four dimensions of; planning, the pupils' conceptual understanding, the group social behaviour of the pupils and the interpersonal relations. It appears that successful lessons are associated with the teacher being able to orchestrate these four characteristics effectively, and how this may be attempted has been the focus of this study.

It is also worth commenting that it is possible that the increased self confidence and success on the part of the children also had an impact on the teachers. It is possible that the teachers, seeing the success of the strategies they were using, increased their own self confidence, which led to further success. Implicit in the findings

from this study are issues relating to the management of the department which enabled this action research and which contributed towards the success. Of particular note, seems to be the fact that the teachers reflected on their practice. The research seemed to encourage this reflectivity and the notion of the 'reflective' teacher appears to be particularly helpful. It appeared to enable the teachers to question their understanding of the learning process and reconsider their own methodology in a meaningful and constructive manner. T.S. Eliot (Little Gidding), writes:

We shall not cease from exploration
And the end of all our exploring
will be to arrive where we started
And to know the place for the first time.

Throughout this study, the manner in which teachers can enable children to access their own ideas has been a central theme. Perhaps Ausubel's famous comment that the most important single factor influencing learning is what the learner already knows; ascertain this and teach him accordingly, also applies to the teachers. Teacher style appears to be a function of individual personality, and if teachers can better understand where they are, by reflecting on their current practice, and learn to exploit their own personal qualities, then perhaps they might be in a stronger position to influence learning for the benefit of their pupils.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

This study has followed a pathway to attempt to identify the factors and strategies which enable pupils to focus their minds on the conceptual issue being taught and how teachers may raise and maintain the pupils' self confidence. In this chapter, the conclusions are presented, together with some wider issues which seem to arise from the research. The limitations of this research and recommendations for further investigation are also discussed.

8.2 Overview of the Conclusions from the Study

It was clear that the science department under consideration had improved the academic performance of the pupils at GCSE considerably. The level of the improvement was greater than may have been expected from the pupils when compared to the national GCSE science results and the performance of the same children in their GCSEs in other subjects. It appears that successful lessons were associated with a number of interrelated characteristics which have been subsumed under the following four headings:

- the teachers' planning,
- the pupils' conceptual understanding,
- the group social behaviour of the children and
- the interpersonal relations.

In common with many other researchers, this study highlights the holistic nature of teaching. It seems that the manner in which teachers can orchestrate these four characteristics is particularly significant.

What seems to have been particularly evident in this study was the manner in which the teachers concerned worked together as a team. The development of the department had been a collaborative venture and it

seems that the dialogue, experimentation and developments which had taken place had enabled the teachers to reflect on their practice in a supportive atmosphere. This reflectivity is viewed as being important and further comment is made later in this chapter.

8.2.1 Conclusions Related to the Responsive Teaching Model.

The teachers had concentrated on constructing the scheme of work bearing in mind the 'Responsive Teaching model', which is based upon a constructivist view of learning. Central to this view is the importance attached to the ideas which children bring with them, and develop in their science lessons. The elicitation and recognition of these ideas by teachers and the pupils themselves was central to the methodology which had been adopted. Responding to the pupils was seen to be particularly significant in terms of (a) the pupils' conceptual understanding and (b) the fostering of positive interpersonal relations. This study suggests that both strands have a significant part to play in enabling pupils to focus their minds on the conceptual issue being taught and in the building and maintenance of the pupils' self confidence. It was also found that the teachers' planning could have a significant enabling effect on the manner in which the teacher could respond to the children. The word 'orchestrate' was used in the previous section deliberately because it is suggested here that the teacher could be constantly moving between these three dimensions in the same lesson, or even within one interaction with a pupil. The fourth dimension (the group social behaviour of the children) appears to be concerned with the nature of the children themselves. Successful lessons were associated with the teacher being able to respond to the group social behaviour, or the pupils' conceptual understanding, through appropriate interaction. This interaction could be either interpersonal, or conceptual, or more usually, an amalgam of the two;

and it was found that the planning could facilitate this process. For ease of discussion, however, the four characteristics are discussed separately.

8.2.2 Conclusions Related to the Teachers' Planning.

The work had been planned bearing the 'Responsive Teaching model' in mind. This model reinforces the view that learning involves conceptual change and that dialogue between teacher and pupil, and between pupils, is essential in the elicitation and recognition of children's ideas and the negotiation of conceptual understanding. The manner in which the work was planned was instrumental in the enabling of these activities. It appears that the planning enabled:

- (a) resources to be available when needed (for core, extension and overlearning activities),
- (b) appropriate cognitive demands to be made upon all the children,
- (c) a range of activities to be available,
- (d) the management of the group dynamics within the classroom and
- (e) the creation of time to enable dialogue and discussion to take place.

8.2.2.1 The Importance of Teamwork

The teachers had planned the scheme of work as a team. This is viewed as being particularly significant as it seems that the teamwork enabled, amongst other things: views to be shared; a heightened awareness of the ideas children brought with them; a feeling that all contributions to the debate were valued; the workload to be shared and a feeling that all members of the department were progressing in the same direction.

The discussion and dialogue took place in an atmosphere of collaboration and support. This was clearly valued by the teachers and

seemed to enable them to develop and adapt their own preferred teaching styles in the light of the perceived needs of their individual classes. The collaborative nature of the development meant that individual teachers were able to adapt the agreed methodology to suit their own personal style. This was considered significant, not only in facilitating ownership of the content and methodology, but also in reducing teacher stress, which is discussed under Interpersonal Relations. Team planning also enabled the teachers to discuss the way in which concepts could be understood at different levels, and how certain core concepts could best be addressed. This appreciation enabled appropriate materials and work to be planned, in addition to the facilitating of more effective questioning by the teachers. One teacher in particular had a particularly refined 'cognitive perception' and this skill could be discussed for the benefit of all when the team were working together.

8.2.3 Conclusions Related to the Interpersonal Relations

During the development of the science department, the teachers had not overtly considered the interpersonal relations, but had concentrated on the children's conceptual development. It is suggested here, however, that the interpersonal relations have a central role to play in enabling effective learning. Of central significance throughout the study, was that it was clear that the teachers valued the contribution and participation of all children. The teachers had high expectations of the children and encouraged all pupils, whatever their ability, to discuss their understanding of the work, both with the teacher, and with each other. It should also be stressed, however, that listening is also considered to be a contribution. Some pupils preferred to listen quietly to the discussions taking place, but could then ask an apposite question. This was facilitated through the structuring and writing of the curriculum materials in addition to the manner in which the

teachers interacted with the children. Successful teachers had an empathy and sensitivity which built an atmosphere where children were not afraid to be wrong, both in front of the teacher and in front of their peers. This, together with the manner in which the curriculum materials were written, seemed to encourage children to express their ideas and negotiate their conceptual understanding with the teacher, and each other, apparently enabling conceptual change.

The significance of both verbal and non-verbal cues in the fostering of positive interpersonal relations are also highlighted. It is suggested that the significance of the non-verbal cues should not be underestimated.

Teacher stress was found to adversely affect the interpersonal relations, and this could affect experienced and inexperienced teachers alike. Teamwork, appropriate technician use and careful planning (as mentioned above) were found to reduce this stress.

8.2.4 Conclusions Related to the Pupils' Conceptual Understanding

The work which the department had undertaken with the Southern England representative of the Children's Learning in Science Project was very significant in highlighting (a) some of the alternative conceptions of the children and (b) the fact that the perceptions of the school's children matched the national picture. This had the effect of stimulating discussion concerning the children's conceptual understanding of various topics both inside and outside the classroom. It also heightened an awareness of the manner in which teachers can question pupils and structure the curriculum materials to facilitate the eliciting of the pupils' understanding of the topic in hand. (Comment is made later concerning conclusions to be drawn from the involvement of outside agents in the in-service training of teachers.) Open questions clearly had an important part to play in eliciting the

particular idea. Another aspect to closed questioning was the manner in which the teacher could use it to draw pupils into the class, or group, and hence involve some of the more reticent pupils in the discussion. There is an interpersonal dimension here, however, concerned with the sensitivity of the teacher to the needs of individual pupils which is discussed later.

Constructing a scheme of work is not a simplistic undertaking, particularly if it is endeavouring to enable pupils to engage with the material, build the pupils' self confidence and encourage independent working. The manner in which this can be done has been discussed earlier (chapter six), and is summarised in chapter seven. The work with the school's special needs coordinator and the advisor from SENASS was particularly helpful in designing and implementing an exemplar module of work. It also had another significant implication in that it demonstrated that the special educational needs staff could make a considerable contribution to a science department's development by introducing a significant variety of approaches which can be used by science teachers with children. Whilst the strategies had been designed originally for pupils with special educational needs, they were found to be adaptable and very useful in helping all pupils, whatever their ability, to engage with the activities. Above all, they provided safety nets and a variety of approaches which enabled the teachers to respond more readily to diverse pupil groups. It was also found, however, that the teachers' knowledge of their individual classes was very significant. This was evident in enabling the work to be planned to help the teacher to respond to the group social behaviour and conceptual development of the children.

8.2.5 Relationship between Cognitive and Interpersonal Response

The findings suggest that there is a direct link between the interpersonal relations in the classroom and the way in which the

teacher responds cognitively to the children. It appears that positive interpersonal relations can help the teacher to respond to the children's conceptual understanding. Similarly, negative interpersonal relations appear to inhibit a cognitive response on the part of the teacher. It was also found that the rate of increase of cognitive and interpersonal response on the part of the teacher was greatest during small group work.

8.2.5.1 Relationship between Whole Class and Small Group Work

This study suggests that the importance of positive interpersonal relations should not be underestimated. As mentioned above, it was found that most of the responding, in terms of positive interpersonal relations and conceptual understanding, occurred during small group work and that almost all the negative interpersonal responding took place during whole class work. It appears that positive interpersonal relations enabled the teachers to respond cognitively. Small group work, therefore, seems to have an important part to play in enabling children to engage in meaningful discussions with each other and the teacher. It is also suggested, however, that the role of whole class work should not be underestimated. Whole class work appears to have an important part to play in the enabling of the small group work discussed above. The manner in which work was introduced, the class called together to discuss an issue and drawn together at the end of lessons were particularly significant.

8.2.5.2 Conclusions Related to Classroom Management

Successful lessons were associated with, amongst other things, clear boundaries between activities, smooth transitions and the setting of clear, explicit expectations. Whole class work clearly had an important role to play in establishing and maintaining these factors. Similarly, successful teachers built relationships according to a

personal style which was based upon a collective view. These teachers were sensitive to the group social behaviour, mood, pace and conceptual development of the class and monitored the class throughout, acting where appropriate. This applied to the way in which the teachers called the class together on occasions, when it was thought that the small group work was becoming less effective. It was also noted that non-verbal, in addition to verbal cues, were used to indicate praise and encouragement in addition to reprimand.

The manner in which the work was planned seemed to facilitate the management of the class. The nature of the activities, and how they were written has been discussed earlier. It should be stressed that these were considered to be important factors in facilitating positive interpersonal relations in the classroom and in the enabling of children to focus their minds on the conceptual issue being taught. They also appeared to be significant in the building and maintaining of the pupils' self confidence.

8.2.6 Issues Related to the Validity of the Study.

Issues relating to the validity of the method, data and interpretation of a qualitative study have already been discussed. Smith's (1978) criteria to help judge the validity of a study in which participant observation is used have already been outlined (p. 87), and comment has already been made on how they apply to this study (p. 88 ff). It is trusted that the researcher has adhered to these rules, and has demonstrated this to the reader within the discussions by providing a description of the methodological and conceptual reasoning which took place, including the efforts which were made at verification and disconfirmation. It is also hoped that the cross referencing of the supporting materials contained in the appendices will help the reader to justify this conclusion.

Similarly, the 'symptoms of truth' advocated by Bunge (1961),

outlined on page 151, appear to apply to the study. In particular, it is felt that the manner in which the findings support the background theory discussed in the early chapters, and the manner in which the they appear to be both externally and mutually consistent add to the study's validity.

8.3 Wider Issues Related to the Study.

This study raises interesting further questions related to three other significant issues; the initial training of teachers, the in-service training of established teachers, and the potential of action research in aiding professional and school development. Each of these will be discussed briefly.

8.3.1 Initial Teacher Training

Recently, there has been a shift in the manner in which teachers are trained. This shift has been from the universities to the schools themselves, where there is now a much greater emphasis on the practice of teaching where experienced, practising teachers act as mentors. This could prove to be a positive move in terms of (a) enabling student teachers to gain a greater degree of classroom experience earlier in their course, (b) increasing the proportion of the students' training undertaken in schools and (c) aiding a closer liaison between students, practising teachers and those responsible for initial teacher training in the universities. This could help student teachers to gain a deeper insight into how schools function and how experienced teachers practice than has been the case in the past. This might enable individual student teachers to judge whether teaching is a suitable career choice earlier in their training as well as help to prepare them for their first teaching post by giving them an increased level of school and classroom experience.

There is a danger, however, in that the craft of teaching could

dominate, at the expense of a firmer theoretical background. This approach could rely on its commonsense acceptability to students, schools, and established teachers for its validity, rather than on its explicit derivation from research findings. A danger is that there will almost certainly be a variety in the perceptions of what makes for effective teaching and learning between different schools, and between the individuals within each school. Whilst a variety of opinion can be healthy, and might encourage debate, the researcher feels that many newly qualified teachers might need a firm foundation from which they may establish and develop their own style. It appears that student teachers should not simply be expected to copy a particular teaching style favoured by the individual student's subject or professional mentor. Teacher style seems to be a function of their personality. If experienced teachers can exploit their own personal qualities, then it might be possible for them to help less experienced teachers without the expectation of copying. Sound advice during the early stages of teaching, together with attempting to act in ways advised by experienced practitioners is clearly helpful, but mentors should be careful to help foster the development of the student teachers' increased professional competence beyond the initial stages. This might help newly qualified teachers to become more aware of their own preferred style, together with an appreciation of its strengths and weaknesses.

The notion of the 'reflective' teacher has been highlighted by this study and it is felt that the encouragement of this reflectivity should be a cornerstone of initial teacher training programmes. It appears that this might have been a significant factor in enabling the established teachers in the study to have become more aware of their preferred teaching styles and personal qualities. Also, the collaborative and supportive atmosphere within the science department seems to have encouraged this reflectivity and fostered a willingness to adapt.

It would seem sensible that whilst craft knowledge is helpful, the foundations mentioned above should be based upon sound educational theory and practice and that the individuals concerned should not lose sight of the findings from extensive and well documented research. There is clearly a need for universities and schools to work together to attempt to establish an acceptable and helpful balance.

The instruments documented in this thesis, together with the way in which the findings have been interpreted could be helpful to subject and professional mentors. They could form the basis for the production of a package of measures which might be useful for the observation and analysis of lessons. This could facilitate the reflective process and it might be appropriate for further research to be undertaken to refine the instruments themselves, in addition to the manner in which they might be used and interpreted to aid this reflective process.

8.3.2 In-Service Training

The in-service training of many established teachers appears to have been centred around attendance at courses organised by various bodies, including local authorities, universities, colleges and the individual schools themselves. It is possible that some teachers may place the outcomes of their in-service courses alongside their experiences of teaching to help them to reflect on their current practice, but it is the researcher's own experience that opportunities for this reflectivity can be lost in the sometimes busy activity of daily school life.

This study has concentrated on the development of the science department in one school. The science teachers did, during the research, attend a number of courses which were felt to be pertinent to the individuals' needs at the time. Of particular note was the fairly

long course which one member of the department attended which was designed to enable specialist teachers to teach broad and balanced science. Similarly, two members of the department had pastoral responsibilities and attended a few courses which were applicable to these areas. In terms of the science department however, and the professional development of the teachers themselves, the most significant in-service training appeared to be the action research itself which occurred within the school, as part of the daily work of the science teachers. The whole team was involved in the writing and teaching of the materials, in addition to the discussions regarding their effectiveness. Discussions took place formally during departmental meetings and informally during most days of the working week including non-teaching periods, breaks, lunch times, and after school. These discussions were considered to be very important because they enabled opinions and perceptions to be shared. This appeared to enhance the manner in which teachers were able to reflect on their practice and become more aware of the tactics and strategies which seemed to enable pupils to focus their minds on the conceptual area of interest. The importance of the idea of the reflective teacher is one which kept emerging throughout the data. It is viewed as an important conclusion that schools should not only encourage this reflectivity, but should ensure it is research based and not simply rely on craft knowledge.

The researcher feels that action research may be one way forward in terms of enabling a team of teachers to reflect on their current practice. This might encourage effective curricular change which is research based. For those teachers who feel that they do not wish to pursue accreditation, the structure of such research might still facilitate meaningful professional development and curricular change. Where a local university can offer expertise, then this would clearly be beneficial, but perhaps it might also be possible to pursue a

similar programme through distant learning such as that provided by the Open University.

This work has confirmed the view that teachers have their own preferred teaching style, in addition to identifying a number of factors and strategies which appear to enable pupils to focus their minds on the conceptual issue being taught. How teachers may attempt to raise and maintain the self confidence of the children in articulating their ideas has also been discussed. It is possible that the instruments developed and used here might be helpful to science teachers in the evaluation of their own methodology. This 'self appraisal' could be a valuable tool with which departments might encourage discussion and debate about their current practices and hence help to identify areas for further consideration and development. Also, the methodology employed might be useful to others wishing to pursue action research in their schools.

8.3.3 Research Methodology

The researcher had been a participant observer and it appeared that this immersion enabled insights to be gained that might not have been possible for a 'remote' observer. The 'insider' knowledge was particularly useful during the collection and analysis of the data, but the cautions described in chapter four are felt to be significant. Triangulation was important and the agreement of the findings from the different instruments seem to add to their validity and reliability. The whole of the science department was, in essence, the participant observer. The teachers were all intimately involved in the development of the study and this also appears to add to its objectivity. This was also action research, and once again, the whole science department was involved with the aim of working towards educational change in addition to the expansion of knowledge. This mode of research appeared to have

enabled the whole department to grow in terms of their professional expertise and improved practice. This has been an important outcome, as the children, science teachers and the wider school community seem to have benefitted from the study. It seems that action research may be a useful tool which could prove helpful in self-evaluation (individual and institutional) and the management of change in schools generally.

It must also be said that the local university had been at the heart of this development. Their expert help and advice was central in enabling the curriculum change to evolve. Experience and craft knowledge are all very well, but this study also depended on the theoretical knowledge and awareness of the wider research community which was offered so readily by the university in general, and the researcher's supervisor in particular. This is felt to be significant because this has highlighted a way in this which educational research had been seeking to make a contribution to the theory which will be of practical use in the classroom.

There could, however, be some tensions here between the priorities of substantive action and the priorities of the advancement of knowledge. It is possible that the latter may expect research findings to be applicable to all, or a number of cases. The practitioners might feel, however, that it is more useful to apply knowledge to their own cases which are specific and individual situations. This is recognised, but it is hoped that the action research undertaken here might help to show how this tension may be reduced.

The issue of whether the findings can be generalised to the wider school community is an interesting one. Although it was undertaken in one school, and generalisations should be made with caution, the study does highlight a number of issues which might be of use to science teachers in other schools and to those with influence over the National Curriculum.

This work did effect a change in practical action which was based upon the background of the wider research community and the findings which emerged from the study itself. It is hoped that this thesis might help, in a small way, to enable others to see how one researcher has attempted to take theory and action forward together.

8.4 Limitations of this Study.

Concentration was placed on years 8 and 9 for the reasons given earlier. The curriculum materials and methodology for years 10 and 11 were modified in the light of the experiences with the lower school, but not to the same degree. How the findings from the lower school relate to the upper school is not clear and hence the impact of the changed methodology on the improved GCSE results needs to be treated with some caution.

It must be pointed out that six lessons were analysed in detail to enable the analysis to be undertaken in depth, yet within a reasonable time scale. This limitation is a disadvantage of the nature of the small scale research undertaken here and if this work were to be repeated, the number would be increased. This would clearly increase the validity and reliability of the findings. It is felt, however, that the observations which were undertaken and analysed were representative of the teachers concerned. This can be said because of the nature of the study. This was participant observation, where the researcher had known the teachers over a period of four years and had observed the teachers teaching on many occasions. Whilst this familiarity of the teachers had this advantage, it clearly presents a potential problem with objectivity. It is felt that these relationships have been taken into account but it must be stressed that any research which is based upon participant observation is bound to have this issue as potentially problematic. The agreement between the findings from the different

observations, however, in addition to the findings from the other instruments appear to add to their validity and reliability.

This inquiry was undertaken in a single sex (boys) school. This was the nature of the school in which the researcher taught and was felt to have a significant advantage. A mixed school would almost certainly have introduced further complications and the limitations imposed by the single sex environment were felt to simplify the study. It was hoped that this might enable the research focus to be probed deeper than might otherwise have been the case. It is recognised, however, that this advantage also brought its own disadvantages and the different developmental processes due to age, sex and a mixed environment have not been considered.

8.5 Suggestions for Further Study

It would be pertinent to investigate the validity of the findings to both mixed and single sex girls' schools. The findings, together with the methodology and the instruments developed here, might provide useful stepping stones to facilitate such investigations.

It would also be useful for more detailed and controlled studies to be undertaken to gain further insights into the effect of interpersonal relationships on pupils' conceptual development.

This research has focused on the tactics and strategies which teachers might use to enable pupils to focus their minds on the conceptual issue being taught. It has also investigated how teachers might raise and maintain the pupils' self confidence in articulating their ideas. Effective learning clearly involves conceptual change, but how to give an adequate description of the conceptual change process, and the mechanisms of change remain open questions, and an important area for enquiry.

It is possible that certain topics might be taught more effectively through particular contexts but such issues have not been

considered. It would be appropriate to investigate what might constitute good motivators for given ages and abilities. This might enable the planning to further facilitate the manner in which teachers can respond to the pupils' conceptual understanding and foster positive interpersonal relations. This might then enable the findings from this and similar studies to be put into practice more effectively, helping the teacher in the classroom to facilitate meaningful learning on the part of the pupils.

The impact of the research on individual teachers' professional development over a period of time has not been investigated. It might be pertinent to attempt to gain further insights into how effective action research may be at facilitating the professional development of both trainee and experienced teachers in terms of their individual classroom practice and their preparation for wider management experience within schools. This might enable headteachers to make more informed decisions concerning their willingness to facilitate action research in their schools. Similarly, this might help teacher educators gain a clearer picture of how initial teacher training might best be organised and structured in the future.

8.6 Researcher's Comments

It should also be stated that the researcher was the Head of the Faculty and was therefore in a position to influence the development of the science department within the faculty. This is stated because it is felt that the developments might have proved problematic, and the progress of the research might have been restricted if this had not been the case. For teachers contemplating action research, issues such as these should not be underestimated, and the following comments concerning the support of the headteacher are particularly pertinent.

The progress of the development of the science department in the

study together with the undertaking of the further degree had the full support of the headteacher. It could be argued that the increased performance at GCSE was a clear indicator to the headteacher that the development was moving in the 'right' direction. The science department became a source of pride for the whole school. How the research would have progressed if this had not been the case is not known. What is relevant, however, is that the nature of any potential study should be discussed with the headteacher and his or her support established before starting the process. This also appears to be applicable to teachers who are contemplating such research and who work under a departmental head. This is considered important, not only to establish the funding arrangements but also to discuss the nature of the study and whether there may be any wider implications for the department or the school at large. This needs to be made clear at the outset to try to alleviate any potential problems.

The course of this research has spanned three headteachers; two at the school in which the study took place and one at the school to which the researcher moved whilst writing up the thesis. The researcher has been very fortunate in that all three headteachers have supported the study. This is particularly true of the current headteacher who agreed to fund the last two terms of the registration period following the shifting of the responsibility for the funding arrangements from the local authority to individual schools. This is an important matter for any teacher thinking about undertaking a further degree. It is clearly important to arrange potential funding before embarking on the work unless the individual teacher is able to find the fees him/herself. Over a period of three to five years, the costs can be considerable and this issue should not be overlooked.

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APPENDIX I

SCIENCE PROFILE

NAME Ballard, D.TUTOR GROUP 8/1

ASSESSMENT OF ATTAINMENT					
SUBJECT SKILLS		LEVELS			
		1	2	3	4
Investigating and Exploring				✓	
Drawing Conclusions				✓	
Communicating			✓		
Knowledge and Understanding				✓	

ASSESSMENT OF ATTITUDE AND APPROACH							
PUPIL'S				TEACHER'S			
1	2	3	4	1	2	3	4
		✓				✓	
			✓				✓
		✓			✓		
			✓			✓	
							✓

1. Rarely
2. Occasionally
3. Usually
4. Always

PUPIL COMMENT: SIGNED
 I have enjoyed science I like doing practical work.
 I think gradually I've come around and thought
 a little bit more about homework and class work.
 But I'd like to improve on my write ups.

Daren Ballard 4.Jun

TEACHER COMMENT:		SIGNED	
I agree with Daren's comment about putting more effort into his written communication. He works well at practical tasks and he has a very good grasp of most concepts he covers at this Daren scored the second-highest exam mark Well done!			
Dr. Gregoire - 7/6/91.			

PUPIL COMMENT: I enjoy practical science and all SIGNED the topics have been interesting. I prefer write ups with lots of diagrams I need to improve on drawings for diagrams and use a ruler but I now remember to do them in pencil. Write ups are quite easy but I have to improve on my conclusions and improvements. My knowledge in how to do things have greatly improved

Sarah 3/6/91

lots of new facts and information that I previously did not know. Science is a subject that I must concentrate on the most because I would like to be a doctor when I'm older so it is very important. My favourite thing is biology and learning about the human body but I don't like doing things about fish. I am getting on with my phobia so I should get on better with science. I think I could improve if I sat with someone who did not talk to me all the time, and if I tried harder with my presentation of my work.

R Flint
STONER

TEACHER COMMENT:

I think that science is good because you can learn the parts of the body and the names of bones. Science is important because it comes into different areas of study and I would like to be a doctor.

Rodrigo F. Wanner
STONER

TEACHER COMMENT:

SIGNED

PUPIL COMMENT:
I have enjoyed this term of science so far that all of the topics we have covered are very interesting and it's always good to find out new things. I work my hardest at that time and eager to learn when I don't understand I always find out the answers myself. And could ask the teacher if I'm not sure I always try to show interest in what we do. Overall I am a hard worker and I show a lot of interest. I have enjoyed science so far.

David Emy

3/6/91

PUPIL COMMENT:

SIGNED

I think that science is an interesting lesson, because unlike some other lessons we don't just sit around and write things in our books we do quite a lot of experiments which livens up our everyday school day in science.

A simple line drawing of a dental arch, likely a maxillary (upper) arch. It shows a continuous wire with a small circular hole punched through it near the center. The teeth are represented by small circles along the wire.

PUPIL COMMENT:

SIGNED

My comment on science is that I could concentrate more on my work and don't talk as much, and I should try and improve on my class work, also I should try and catch up with class work. One thing I think I am good at is experiments I think science is my best subject because its good

PUPIL COMMENT:

Science hasn't been my strongest subject because I find it difficult to draw conclusions, although practical work has been enjoyable. Topics such as Materials and Processes of Life have been interesting.

PUPIL COMMENT:

SIGNED

I think I need to keep working the way I am. I need to improve on inferences and of write-ups, but I enjoy practicals and I am quite good at them. I occasionally lose interest in Science, even though I enjoy it.

P. Herbert 3/6/91

PUPIL COMMENT: I enjoy Science very much SIGNED
I like the experiments we do and I learn
a lot from experiments. I can work harder
and show interest more but I think
I work pretty fast.

Am. 15th Katikam

PUPIL COMMENT:

SIGNED

I don't like science when I first come to this school but now it is one of my favorite lessons. I have worked well but sometimes I feel stupid and melt around when I try. I think I do really well. A. Hill

PUPIL COMMENT: I enjoy science and I find it exciting you can use equipment such as bunsens. I found Air the best topic because it was exciting and you could talk about it to the class. I could improve by concentrating more in class. S. Stratton 4th June

PUPIL COMMENT: I found air interesting because I knew a lot about the subject and answered lots of questions. I reckon that I can improve by listening more and paying attention to the teacher more often. S. Otway
4.6.91

PUPIL COMMENT:SIGNED

I like science very much, I look forward to every lesson. I have improved a lot since September. I do chemistry at home after school and in the holidays. I get on well with my teacher and my classmates. V. Somerville

PUPIL COMMENT: I like science it is one of my SIGNED best subjects. My teachers are good. I like writing a plan and then the test. I like drawing, I got my first commendation in science. I didn't like doing the work on light

R. J. Rhys Jones

PUPIL COMMENT: I enjoy science. And the SIGNED work we do. I most enjoy practical work. I like the teacher and have some credits. I need to improve on spelling but apart from that I have got off to a good start.

Philip Price

I have improved my write ups and have had good comments I written into my book. I find science enjoyable and fun to solve problems. I have also printed out work on computer and have been awarded for it.

T. Pepper 3/6/91

TEACHER COMMENT:SIGNED

I believed that I have improved in science since we last completed a profile. My attitude has improved and perhaps I am beginning to enjoy science more than before. Also my comprehension and presentation have improved. 3.6.91 P. Hall

PUPIL COMMENT: I feel I have improved considerably SIGNED this term. I think this is mainly due to my increased oral contributions. I think I have to improve on my experiments because I never seem to have enough time. My understanding of scientific theories has also improved.

Markha 3.6.91

PUPIL COMMENT:

SIGNED

*Sgn
Lora*

I enjoy Science, and I like to think and plan investigations. I think I am quite good at this because I have come up with some good ideas. But I need to record my results better. I am good at using scientific language. My knowledge is good because I got a good exam result, but I need to improve by showing more interest and writing longer, detailed conclusions

PUPIL COMMENT: I am quite good at the thinking SIGNED T. West side of Science but I am not very good at the writing side of it.

PUPIL COMMENT: Science is alright, I like doing experiments and the problem sheets. I also like writing from the books, but I think I can improve on my handwriting and my spellings.

SIGNED

David Hepburn.

PUPIL COMMENT:

SIGNED

I like Science, but I find it J Mac Robbie hard to spell long words that we use all the time like problem but I like making up plans to solving problem

PUPIL COMMENT:SIGNED

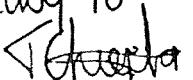
Science can be good fun, sometimes, although we have not done an experiment for sometime, I am trying hard but not doing quite as well as I hoped. I think I have been judged wrong on ~~with~~ ~~with~~ the attainment section.

PUPIL COMMENT:SIGNED

I enjoy ~~Science~~ experiments, but I dislike copying things from a blackboard, as we are sometimes (recently) asked to do. I could improve on maintaining interest, as this can affect how hard I work.

A.R.Thomas

PUPIL COMMENT:SIGNED

I think that science is not one of my strongest subjects and I don't really enjoy it. I find it hard to understand the biology side of science because the new ideas & words that I do not understand. Although I find it fairly easy to write accounts for experiments. 

Observation Schedule – Completed for Lesson 4

APPENDIX II

Field Notes: Lesson 4

The class was undertaking a variety of practical work. Some pupils were working on electrolysis, others on dissolving and others on book work.

<u>Time</u>	<u>Observations</u>
0 - 3	Teacher lets class into the room. All sit down, getting books out. Teacher at the front, sings to the class "Good Morning class", and the whole class sing back, "Good Morning Sir". The atmosphere is very positive, mutual respect is evident and it is clear that the boys look forward to this lesson.
6	Work is introduced, the technician completing the setting up of apparatus. Teacher questions a few boys to ensure that they know what they are doing. There is a mix of closed and open questions. It is clear that the teacher is listening to the boys' answers as if looking for clues to understanding. There is also some social chat. Teacher at the front of the class, relaxed, sat on the demonstration bench, legs crossed. Teacher refers to work completed last lesson.
9	Hands used considerably whilst talking. Boys start group work.
12	Teacher sees a boy who was absent last lesson and moves over to him to talk to him. Teacher refers to himself as "The teacher with the big muscles", smiling. The boy smiles. It is clear that this boy does not know what is going on. Rather than tell the boy himself, the teacher asks the pupil sitting next to this boy to explain what they did last time. He does this, and the teacher moves off towards another group.
15 - 21	Teacher moves from group to group, questioning them as he settles with the pupils. The instructions tell the pupils doing the electrolysis to use 2 Volts, but it is obvious that nothing is happening, and one group asks the teacher for help. The experiment is not working! The teacher looks at this apparatus, determines that it is set up correctly and then shouts out to the whole class "Electrolysis - Try 4 Volts."
24	The Deputy Head enters the room and talks to the teacher. Teacher shouts out "Remember that this has to be done by the end of the lesson". Continues conversation with the Deputy Head, and then leaves the room for 1 minute with the Deputy Head, to get something from the adjoining office. The pupils don't seem to notice that the teacher has left at all - no-one takes advantage of the situation.

27 Teacher continues to move from group to group, pausing to quiz the children. As a child enters, teacher with hand to mouth, obviously listening and receptive. A boy in the next group does not have his book open in front of him. Teacher says, "How do you know how long to heat it for?....Get your text book and check." The boy moves off and the teacher says, "Who is going to look after your experiment?" The boy asks another to look after it. A group reminded that safety specs must be worn.

30 Teacher continues to move from group to group, standing with a group, hands in pockets. Talks to the pupils as equals "Yea, give it a couple of minutes."

33 Teacher stops the class for a discussion, and then carry on. The discussion clears up a few problems that have come to light during the teacher's dialogue with pupils. Pupils carry on with their work.

36 One boy who was quiet, and who had given some good answers during the discussion was approached. Teacher praises his good answers, quietly, and tries to encourage him to be more confident.

39 - 45 Boys pack away apparatus. Teacher checking that everything is going back where it belongs.

48 Class quiet, all apparatus away. Teacher tells the class how to write up their experiments and then questions them on their practicals. The level of questioning was high - "What's the ions and the charges in the tube?" The answers were mainly correct, the teaching leading slightly incorrect answers towards the correct answers. Diagrams drawn scruffily on the blackboard to help explanation. Charges on ions drawn in. At one stage, murmuring started. Teacher's response - "sh sh sh sh sh" and it stops. Good answers praised.

51 When two boys answer a question, teacher holds out his hand and makes it clear that only one boy is to answer. A boy gave the wrong answer and the teacher's response was, "No, but you were thinking positive weren't you?" Bell sounds, indicating the end of the lesson. Class pack up and leave.

APPENDIX III

Interview 3

The following is an extract from the interview transcript for teacher three. This was taken from the beginning of the interview, after the initial greetings and reassurances offered by the interviewer.

Slight pauses are indicated by the use of "....".

I:- signifies the Interviewer, and

R:- signifies the Respondent.

I. "Why do you think the numbers of pupils opting for Double Science has increased?"

R. "We have a lot of White Band kids opting for Double Science because it doesn't sound threatening to them - it's the same course as they followed before. And... a lot of them are seeing that we are successful, we are working well, and they are enjoying it. And the reason they are enjoying it is because, we do a lot of practical work and the practical work is based on their own investigations largely - not exclusively - but largely. They feel that they are involved and we are trying to build the idea of responsibility for their own learning but they certainly feel they are involved in their own learning and....that leads to enjoyment."

I. "What is it about it, why do they enjoy it, you say they are involved..."

R. "The idea of planning things, of following their own ideas through, the idea of doing something practical rather than theoretical, makes them feel that they are taking a more active part in the lesson..they use each other, they use each others ideas as well as their own, it seems a more active thing rather than a passive education."

I. "Right.... Are there any things, as a teacher, which facilitate that, or the other way round, which put stumbling blocks in the way of that happening - I know there are for me personally."

R. "Hand in hand with this has gone what we've tried to do, changing methodology, from a more didactic style of teaching to a more open style, a more investigative style, a more pupil centred style. Em, again I think the pupils have responded to this. They build up responsibility, involvement for themselves."

I. "What about resourcing, do you think that has any, like em, I mean, you wrote the schemes of work for the National Curriculum..."

R. "I'm not so sure that has got as great a part to do with it."

I. "It's interesting you say that."

R. "We fit in with the NC but there are many schools which follow Active Science all the way through and I know Active Science isn't

by any means ideal...we use Active Science obviously, but we're adding to it with Warwick, Salters and so on, which are a more investigative style of teaching and I appreciate that. But I've not always found it easy, I'm not sure the kids have always found it easy in the way we have resourced it. It's I think, a relief to get back to some basic structure, having a text book in front of you. Some kids, although...need to get the balance right here... lots of people respond to the open style they like to touch base every so often and we use Active Science as a sort of base touching exercise. Now again, I'm not saying Active Science is right or whatever, but it does sometimes, the teacher too needs to touch base. We've so many different schemes involved that sometimes you're not sure where you stand anymore. We're always having to refer to the scheme of work to see - that's absolutely right I suppose....(laughing). There seems to be so many schemes involved - we've done an awful lot of work which may, as it turns out, may be to no avail with the changes to the National Curriculum yet again. But you do feel sometimes that you put in all this work to no avail.

- I. "I know what you mean. It's interesting what you said though. You're saying that whilst....active learning etc is all very well, children vary and you need a range of things to do."
- R. "Some need more structure, more support. The open approach works very well with the most able kids, I'm not so sure it works as well with the least able.
- I. "You may well be right."
- R. "they need more reassurance, they need something in front of them."
- I. "So whether because of ability, or some other reason, some children need more structure than others. Which is what you'd expect really isn't it?"
- R. "Yeah."
- I. "That has repercussions for things like, schemes of work doesn't it? Because you need to build in that structure so you can touch base as you say.....What about extending bright ones, or, How do you find you manage, say you have a group of children you find in talking to them that some of them haven't grasped something whilst others have?"
- R. "Well again, there's an awful lot of chat involved in these lessons."
- I. "A lot of dialogue."
- R. "A lot of dialogue."
- I. "Right a lot of dialogue."
- R. "Em, and I find you get sort of puppy dog syndrome with the Year eight lads especially - yapping around you expecting immediate attention. With the brighter ones you tend to say go away and think about that and I'll be around to see you in a second,

whatever, and the less able ones you can fend off...In terms of stretching the brighter ones you tend to make it more technical... by setting them extended problems - making them think through the concepts. Our own course, mix and match as it is, with that.... identified extension work, resources etc. on top of it, with remedial as well to cover the less able would be much better than anything published. It isn't easy, it means that the teacher... it's active for the teacher as well."

- I. "This process seems to work since children are choosing the subject. If you had to pick two or three characteristics of this style, what sort of adjectives would you use?"
- R. "As far as describing the children...they are more inquisitive, I'd say they were, in a sense better scientists, more scientific in the way they go about things, because they see the planning process, they see how the planning process can fall, or whatever, and they can go back and re do things. To an extent they are more scientific. Hopefully, I mean, the idea we're trying to build up is responsibility and that does come with the brighter ones. I don't tell them anymore what sort of thing to write in their books. They go away and I say 'that's your problem, it's your book. They've got to use their book the best way they can so what they write in their books is really up to them. Obviously.....and you need to start cajoling them....."
- I. "Is there a difference in the way a teacher would keep control of a lesson - or control of what children do? Would it be different from a much more didactic style..."
- R. "Because they're actively involved, it grabs their interest more than it might otherwise do and so you've got a head start in a way, they're not just passively learning, they're using their ideas and so feel they are contributing. To that extent control is easier, but then, as I say, it can make for a noisier sort of lesson...but hopefully, it's...their enthusiasm.....the ideas you've got to get through to the children is that they are responsible for their own learning to a certain extent and there are, admittedly, some children who are not willing to take on that responsibility, and need cajoling....."

The interview continued

APPENDIX IV

CALCULATIONS RELATED TO THE INTERPERSONAL RELATIONS

Lesson 5 has been chosen to illustrate how the calculations were performed because it did not produce figures of 0% or 100%. It is hoped that this will make the calculations clearer to the reader. The chart below has been taken from page 209 (figure 6.10), and the table from page 185 (Table 6.3).

LESSON 5

CLASS	Cognitive Response				Positive Interpersonal Relations						Negative Interp. Relations									
	Acc.	Dis.	Op.	Cl.	Dir.	Prog.	Red.	Acc.	Pr.	Ver.	Ev.	Pon.	Ind.	Ign.	Exc.	Ign.	Ver.	Ev.	Amb.	Re
13																				
16																				
19																				
12	✓		✓	✓	✓	✓												✓		
15	✓	✓	✓	✓	✓	✓											✓	✓		
18		✓	✓	✓	✓	✓											✓	✓		
21																				
24																				
27																				
30																	✓	✓		
33																	✓			
36	✓	✓	✓	✓	✓	✓											✓	✓		
39	✓	✓	✓	✓	✓	✓											✓	✓		
42	✓	✓	✓	✓	✓	✓											✓	✓		
45		✓		✓	✓	✓											✓	✓		
48																	✓	✓		
51																				

There is a total of 22 recorded incidents of Positive Interpersonal Response and 6 recorded incidents of Negative Interpersonal Response.

This gives the ratio of positive to negative as 22:6.

Lesson Number	Ratio of Interpers. Rels.	Percentage Interp. Rels.	Percentage IR / time unit	Percentage +ve IR / time unit	Percentage -ve IR / time unit	Percentage +ve	Percentage -ve												
	Whole Lesson	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class	Small Gps
1	1:12	0.0%	100.0%	0.0%	7.1%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	7.1%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	7.1%
2	8: 4	25.0%	75.0%	2.3%	15.0%	100.0%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	25: 1	36.0%	64.0%	4.5%	10.7%	100.0%	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	56: 0	28.6%	71.4%	4.7%	6.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	22: 6	45.5%	54.5%	3.8%	13.6%	83.3%	16.7%	6.9%	4.2%	83.3%	16.7%	6.9%	4.2%	83.3%	16.7%	6.9%	4.2%	83.3%	16.7%
6	24: 2	100.0%	-----	6.5%	-----	100.0%	-----	6.3%	-----	100.0%	-----	6.3%	-----	100.0%	-----	6.3%	-----	100.0%	-----

The previous page shows that the class were being taught as a whole class for 12 time intervals and in small groups for 4 time intervals.

Calculation of Percentage of Positive Interpersonal Relations:

Of the 22 incidents recorded:

— 10 were recorded during whole class work, (ie. 45.5%)

— 12 were recorded during small group work. (ie. 54.5%)

Lesson Number	Ratio of +ve : -ve Interpers. Rels.	Percentage +ve Interp. Rels.	Percentage +ve IR / time unit	Percentage -ve Interp. Rels.	Percentage -ve IR / time unit	Whole Lesson Class	Small Gps Class	Small Gps Class	Small Gps Class
1	1:12	0.0%	100.0%	0.0%	7.1%	0.0%	100.0%	0.0%	7.1%
2	8: 4	25.0%	75.0%	2.3%	15.0%	100.0%	0.0%	9.1%	0.0%
3	25: 1	36.0%	64.0%	4.5%	10.7%	100.0%	0.0%	12.5%	0.0%
4	56: 0	28.6%	71.4%	4.7%	6.5%	0.0%	0.0%	0.0%	0.0%
5	22: 6	45.5%	54.5%	3.8%	13.6%	83.3%	16.7%	6.9%	4.2%
6	24: 2	100.0%	-----	6.5%	-----	100.0%	-----	6.3%	-----

The class were working as a whole class for 12 time intervals, and in small groups for 4 time intervals.

The Percentage of Positive Interpersonal Relations per time period is therefore:

— $45.5 / 12 = 3.8\%$ for whole class work, and
— $54.5 / 4 = 13.6\%$ for small group work.

— The second column shows the percentage of the positive interpersonal relations which were observed whilst the class was being taught as a whole class, or whilst the pupils were engaged in small group work. The sum of the two sub columns will, of necessity, be 100%.

This second category could be misleading. For example: it would not be legitimate to say that the teacher, during lesson 5, exhibited positive interpersonal relations slightly more frequently when the class were working in small groups (54.5%) than when the teacher was teaching the class as a whole (45.5%). This depends on the proportion of time the class spent in small group work and working as a whole class. The percentage has therefore been divided by the relevant number of time periods as shown above.

This appears to give a much better indication of the intensity of the interpersonal relations during whole class and small group work. This pattern is repeated for negative interpersonal relations.

The figures for the Percentage of Negative Interpersonal Relations were calculated in the same manner.

APPENDIX V

CALCULATIONS RELATED TO THE COGNITIVE RESPONSE

Lesson 5 has been chosen to illustrate how the calculations were performed because it did not produce figures of 0% or 100%. It is hoped that this will make the calculation clearer to the reader. The chart below has been taken from page 209 (figure 6.10), and the table from page 185 (Table 6.3).

LESSON 5

	Cognitive Response			Positive Interpersonal Relations						Negative Interp. Relations											
	Acc.	Dis.	Op.	Cl.	Dir.	Prog.	Red.	Acc.	Pr	Ver.	Nv	Pou.	Ind	Ign.	Exc.	Ign.	Ver.	Nv	Lab.	Na	
13																					
14																					
15																					
12	✓				✓	✓	✓	✓										✓			
15	✓	✓	✓	✓	✓													✓			
10	✓	✓	✓	✓														✓			
21									✓	✓											
24											✓										
27											✓								✓		
30												✓	✓	✓	✓	✓					
33												✓	✓	✓	✓	✓					
36	✓	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓					
39	✓	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓					
42	✓	✓	✓	✓	✓	✓															
45	✓			✓	✓																
48										✓								✓			
51																					

The categories used for the calculations (explained on pages 175 and 176) were:

{ Accepts and uses the ideas of pupils (Acc),
Discussion (Dis), and
Directs pupils (Dir);

ie. 3 categories.

The total number of possible incidents were calculated:

Whole class work: 12 time intervals x 3 categories = 36,
 Small group work: 4 time intervals x 3 categories = 12.

Followed by the intensity of the cognitive response during whole class and small group work:

During whole class work, there were 9 recorded incidents, ie

9 out of a maximum of 36 = 25.0%

During small group work, there were 9 recorded incidents, ie

9 out of a maximum of 12 = 75.0%

Lesson No.	Percentage of Cognitive Resp.	Percentage of Cognitive Resp.		Questioning		Questioning	
		Whole Lesson	Class Small Gps	Whole Lesson	Class Small Gps	Whole Lesson	Class Small Gps
1	18.8%		0.0% 21.4%		12.5%		0.0% 14.3%
2	35.4%		9.1% 93.3%		40.6%		22.7% 80.0%
3	48.8%		33.3% 72.2%		43.3%		50.0% 33.3%
4	56.9%		33.3% 69.7%		85.3%		66.7% 95.5%
5	37.5%		25.0% 75.0%		46.9%		41.7% 62.5%
6	31.1%				56.6%		56.6% -----

During the whole lesson, there were 18 recorded incidents (9 during whole class work and 9 during small group work), out of a possible of 48 possible incidents (36 during whole class work and 12 during small group work);

ie. 18 out of 48 = 37.5%

The calculations for questioning were undertaken in the same manner:

The maximum number of incidents was:

2 categories (open and closed questioning) multiplied by 16 time intervals (12 for whole class work and 4 for small group work),

ie. $2 \times 16 = 32$ possible incidents.

This gives:

Whole class work: 10 incidents out of 24 = 41.7%
 Small group work: 5 incidents out of 8 = 62.5%

During the whole lesson: 15 incidents out of 32 = 46.9%

APPENDIX VI

The table below, Table (6.7) has been derived from table (6.5) as shown below.

Lesson	Ratio of small-group:whole class +ve IR.	Ratio of small-group:whole class +ve IR / time unit
1	--whole class teaching insignificant--	
2	3.00:1	6.52:1
5	1.20:1	3.58:1
6	---Class not taught in small groups---	
3	1.78:1	2.38:1
4	2.50:1	1.38:1

Table (6.7)

The first column shows the ratio of the small group to whole class Positive Interpersonal Relations.

For example, taking lesson 5 as an example; this ratio will be:

$$54.5 : 45.5 = 1.20 : 1$$

Similarly, when considering the ratio of small group to whole class Positive Interpersonal relation per time unit, using lesson 5 again, this ratio will be:

$$13.6 : 3.8 = 3.58 : 1$$

Lesson Number	Ratio of +ve:-ve Interpers. Rels.	Percentage +ve Interp. Rels.		Percentage -ve IR / time unit		Percentage -ve Interp. Rels.		Percentage -ve IR / time unit	
		Whole Lesson	Class	Small Gps	Class	Small Gps	Class	Small Gps	Class
1	1:12	0.0%	100.0%	0.0%	7.1%	0.0%	100.0%	0.0%	7.1%
2	8: 4	25.0%	75.0%	2.3%	15.0%	100.0%	0.0%	9.1%	0.0%
5	22: 6	45.5%	54.5%	3.8%	13.6%	83.3%	16.7%	6.9%	4.2%
6	24: 2	100.0%	-----	6.5%	-----	100.0%	-----	6.3%	-----
3	25: 1	36.0%	64.0%	4.5%	10.7%	100.0%	0.0%	12.5%	0.0%
4	56: 0	28.6%	71.4%	4.7%	6.5%	0.0%	0.0%	0.0%	0.0%

Table (6.5)

These ratios have been calculated in the same manner for the other lessons.

APPENDIX VII

PROCESSES OF LIFE YEAR 8REPRODUCTIONPROGRESS REPORTLESSON 1

Group work to determine level of knowledge. Group spokesman to discuss important words/ideas for putting on board.

The pupils enjoyed this activity. The group work was a bit noisy, but productive. The final session indicated that most (but not all) had some knowledge of the anatomical details of human reproduction in terms of the names of the parts involved, but not necessarily how it all worked. There was some hilarity and showing off, but not too much. Knowledge of plant reproduction was rather sparse, pollen being about the only word that came up.

With the 8Y group, the reaction was similar, but there was much more attempt to shock. There was much more writing down of 'slang' expressions to do with human reproduction. Knowledge of plant reproduction was practically nil.

LESSON 2

Video 'Sex and the single plant'. 8X to make notes using the aid sheet.

The video was not very good on the basics of plant reproduction, being mostly about methods of pollen transfer. The pupils were interested, and watched quietly. Most made some notes on the sheet, and their homework was to make a drawing of the various ways that pollen can be transferred from plant to plant. They will have to be shown one of the more explicit plant videos before they can go on to the questions etc. The note taking sheets can be looked at to see how they were used.

PROCESSES OF LIFE ... YEAR 8REPRODUCTIONPROGRESS REPORTLESSON 2 (cont.)

8Y were shown Fertilization and From Conception to Birth as their introduction. As this was the first part of a double lesson, they were given the Heads and Tails test to follow. They were told at the beginning of the video to take notes only if they thought they could do so without missing any of the film. There were a few that did take notes. The majority of the group found the Heads and Tails difficult to begin with, but easier when they figured out what to do, and how to make use of the glossary. Only one boy found it very difficult, because he was completely baffled by the words used.

LESSON 3

8X worked through both question sheets. Some of the group managed to complete both in a single period. They worked well and showed interest. It was easier for me to move around and ask questions to see how much had stuck. I made the notes on fertilization available, but I did not give them out.

In the second part of the double they split into groups to discuss and plan the experiment to investigate the best conditions for the germination of seeds. There was then a class discussion on the ideas that came up. There were plenty of ideas, most sensible, and it was easy to extract four basic experiments to set up next lesson.

8Y had a single lesson to carry on with their heads and tails. I kept the second sheet back to give to any high fliers, but in fact only a few boys managed to finish by the end of the lesson. I told them at the beginning that this piece of work was going to be assessed on *neatness only*! There was a noticeable improvement in some boys work, and at least they all tried to be as neat as possible. One problem with the heads and tails sheet was the possibility of having an answer like - WOMB = UTERUS. Some of the boys did not know what they did, they just knew they were the same. This could be brought out in questioning, if there was time.

APPENDIX VIII

Teachers Notes; Unit REPRODUCTION

Lesson 1

A. Clear aims and objectives shared with pupils (preferably written).

- how long the unit will last
- basic outline of content
- how it will be assessed (not just the end of unit test; could be co-operation; presentation; ideas for investigation; independence etc.)

B. Pupils form pairs. 3/4 minutes to brainstorm what they know about plant/animal reproduction. Looking for key words/ concepts.

Pairs join into 4's- share/ refine. Each group reports back to class (Obviously there might be some hilarity at this point- better now!)

Key words/ concepts listed on board; to be made into glossary- see handout. Could go from board straight to handout. Each pupil to have a copy to keep to refer to for spellings, meanings. Stress need for independence skills. An enlarged version on the wall would be a good idea.

Lesson 2 and 3.

Prior to showing video; tell pupils they are looking for

(i) different kinds of reproduction- it may even be a good idea to tell them that they will be finding out about Asexual and sexual reproduction as the video has a lot of content in it.

(ii) the conditions necessary for each kind of reproduction.

Upper band can be shown the note taking aid. They should certainly have the task of taking notes.

Lower band may find that taking notes takes their attention from the video too much.

SHOW VIDEO

Collective feedback.

Handout; pupils highlight key statements. This may only be held in reserve for higher band

Task sheet; Heads and tails- definitions from glossary.

flow diagram

questions relating to video

(1)

Lesson 4

Using book; Active Science 1.
Pg 101

Discussion of 'Making Seeds' section- drawing on what they remember from the video.

Lower band; worksheet where they match key statements to relevant diagrams
Upper band; do 'extras section'

Pupils divide into groups.

Statement; Seeds can survive for a long time without growing. But when the conditions are right, they develop quickly. This is called GERMINATION.

Question; What conditions do cress seeds need for germination?

Task; Divide into groups- generate a plan to discover best conditions for germination. Each group feeds back to whole group. Pro's and con's discussed.

Practical; Each group takes on the task of setting up 2 environments to test. Each group uses only 20-30 seeds per environment (try to get them to say why this is a good idea.)

Over next few lessons pupils report back on progress and fill in chart (provided.)

At the base of chart are some summary statements- though upper band should be able to do this unaided.

(3)

USING YOUR HANDOUT ON FERTILIZATION.

1. Write 3 facts about A sexual reproduction
2. What is the main difference between A Sexual and Sexual reproduction
3. Complete this flow diagram

pollen is brushed onto the stigma

each pollen grain grows a tube into the

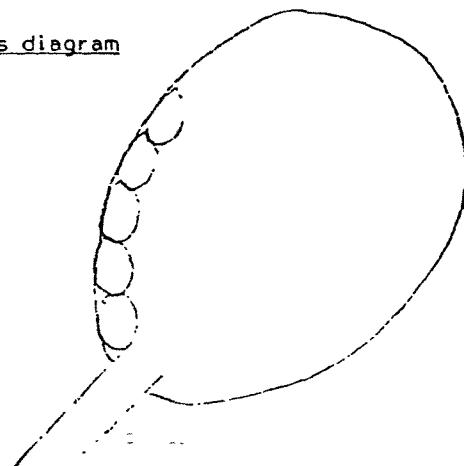
the tube grows down through the tissues of the into the

the male gamete.....ovary

the pollen tube is attracted to one of the ovules by.....

complete this diagram

Ovule



Answer these questions in sentences

1. What is a motile sperm?
2. Where are motile sperms made?
3. Can sperm live anywhere?
4. How does an animal that lives on land make sure sperm don't die before fertilization
5. How big is a human sperm?
6. How many sperm are released at a time?
7. How often is an egg released from an ovary?
8. How many days after ovulation does the egg reach the uterus?
9. What factors can affect the breeding season?
10. Which species can choose to control the reproduction of themselves?

(8)

WHAT CONDITIONS ARE NECESSARY FOR GERMINATION?

First, fill in the information about the 4 environments chosen.

ENVIRONMENT A

ENVIRONMENT B

ENVIRONMENT C

ENVIRONMENT D

Date	A	B	C	D
	Number/height	Number/height	Number/height	Number/height

Look at these statements. Use them to write a summary for each environment.

- plants 4-5 cm tall. Leaves green, stems white
- plants have no leaves
- plants are less than 2 cm tall, leaves yellow
- nothing much has appeared
- most seeds seem to have grown
- few or none of the seeds seem to have grown.

SUMMARY:

Environment A

Environment B

Environment C

Environment D

QUESTION Which environment was the best for germination of cress seeds?

(9)

What are the missing words....

Making seeds

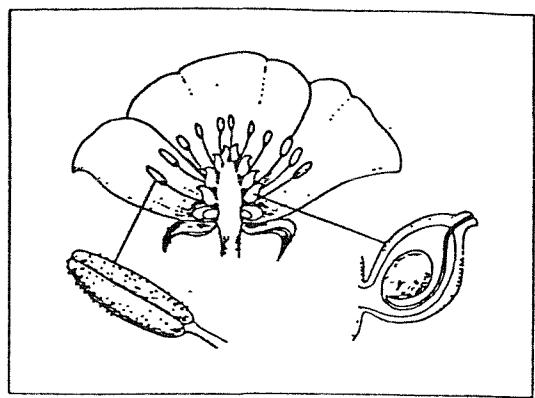
New plants also grow from seeds. A seed **①** all the information that is needed for **②** new plant. Where does it come from?

Half of the information comes from special **③** in a grain of pollen. The other **④** is from special cells in the ovule.

If **⑤** seed is to form, the pollen has **⑥** reach the ovule. When it does, the **⑦** develops into a seed.

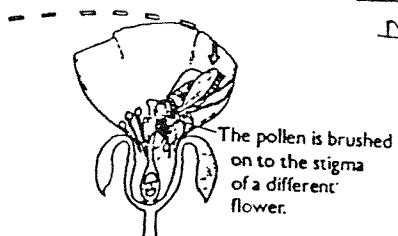
If the pollen **⑧** ovule are from one plant, the new **⑨** will be like a cutting, exactly the **⑩** as the parent. But if the pollen **⑪** from a different plant, the new plant **⑫** be quite different from the parent.

- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.

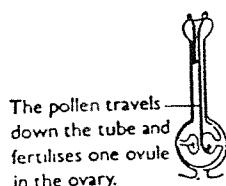
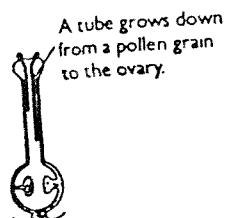


Use these words to label the diagram

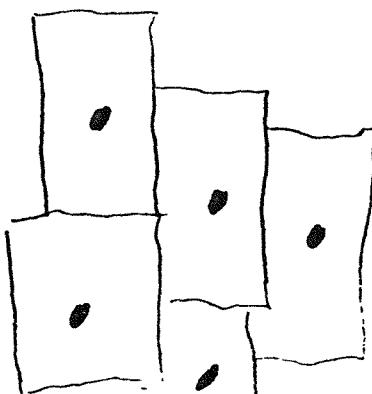
pollen anther ovule



These diagrams are in the wrong order.
Number them.



10

Staining and examining an onion (plant) cell.

Label the cell walls and nuclei

Complete the following:

We took a thin slice of _____ and placed it on a slide. We added a _____ of water with pipette and put a cover slide _____ it. We looked at it under a _____ using the smallest magnification and drew _____ we could see.

Because the cells _____ transparent (see through) we used blue dye _____ stain the slides by _____ a small drop of blue dye _____ the edge of the cover slide. _____ dye was sucked under the cover _____ and stained the onion cells blue. _____ showed up the shape of the _____ more clearly.

ANIMAL OR PLANT CELL?
Fill in the chart below.

Animal	Plant	Reason (see key)	Actual description
A		- - -	- - -
B		- - -	- - -
C		- - -	- - -
D		- - -	- - -
E		- - -	- - -
F		- - -	- - -
G		- - -	- - -

Possible reasons

1. regular pattern
2. irregular pattern
3. there were different sorts of cells within the slide sample
4. not too sure