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How the Use of Montessori Sensorial Material Supports Children's Creative Problem Solving in the Pre-school Classroom

by

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ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES

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HOW THE USE OF MONTESSORI SENSORIAL MATERIAL SUPPORTS CHILDREN'S CREATIVE PROBLEM SOLVING IN THE PRE-SCHOOL CLASSROOM

By: Raja Omar Bahatheg

Maria Montessori famously designed her own materials to support children's development. Thus far, the literature which focuses on Montessori Sensorial education - and on creativity, problem solving and creative problem solving - has not investigated connections between these matters. This study investigated the effect of using the Montessori Method on children's skills, especially in creative problem solving.

This research examines the integration of Montessori materials into a social context to develop children's creative problem solving, and analyses these data using the Creative Problem Solving (CPS) framework [Isaksen et al., 2000] and Rogoff's model [1990] of social interaction. The study provides a new way of using the CPS framework, for data analysis, rather than as a way of training an individual or a group in solving problems creatively.

The methodology combines a quasi-experimental design with a sample of qualitative cases. The research was conducted in one pre-school in Saudi Arabia, in the city of Riyadh, and involved twenty-four five-year-old children (12 boys, 12 girls) and four teachers. Six matched pairs of children were observed using Montessori sensorial materials (MSM) for one academic year. All the children were assessed on their problem solving capacities, in order to compare their development, using the British Ability Scale-II.

The results from the quantitative analysis reveal significant differences between the experimental and control groups in their capacity to solve problems, using a pre-post-test of the four subscales of the BAS II. The qualitative analysis shows social interaction assists children in the "understanding of the challenge" component of the creative problem solving process while individual differences were identified in relation to the three creative skills. The results revealed the children's different ways of framing and solving their own problems creatively through exploring different positions of the materials and applying them in creative solutions. The research also found that children's own individual experiences with, and interests in, the material affected their creative problem solving.

To my father Omar Bahatheg and my mother Aeda Hasobah

To My Wonderful Husband Aggeel Bahatheg

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DECLARATION OF AUTHOR

I, Raja Omar Bahatheg, declare that the thesis entitled

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and the work presented in the thesis are both my own, and have been generated by me as the result of my original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
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- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- none of this work has been published before submission.

Signed
Date

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Preamble

The aim of this research is to study the impact of teacher's social interaction on children's creative problem solving during play with Montessori sensorial materials (MSM). The official curriculum in Saudi Arabia is the *Self Learning Curriculum*, established in 1991. However, there are several weaknesses in this curriculum, and the lack of sufficient educational activities is one of them. I was a pre-school teacher for one year and I have been a teacher trainer for six years. During my work, I observed that children in the pre-school classroom can spend little time at the Toy-table area in comparison with other parts of the classroom. I also attended several Montessori workshops that focussed on educational activities involving Montessori's educational materials. As a result, I began pondering what might happen if I integrated Montessori sensorial materials with the Toy-table area, and would like to pursue this interest in the present study. I am interested particularly in investigating how the MSM might influence children's creative problem solving.

I have thus designed my research to study the effects of Montessori sensorial activities on children's creative problem solving. I divided the sample of children into experimental and control groups, and I further divided the experimental group into one group that interacts with their teacher (Child-Teacher-Interaction, C-T-I) and one that does not (Child-Material-Interaction, C-M-I) to study the effect of teacher-child interaction (or lack thereof) on the way that children play with the MSM to develop their creative problem solving skills.

The quasi-experimental approach allows me to investigate whether there might be a causal relationship between the MSM and improvements in children's problem solving. I used the British Ability Scales II (BAS-II) to identify match pairs and to compare the influences of the Montessori materials on children's problem solving skills.

I used the second element of my research, the qualitative study of a sample of children to gain a more in-depth understanding of the relationship between the MSM and the development of children's creative problem-solving skills, as well as an understanding of the influence of teacher-child interaction and child-material interaction.

This thesis is divided into nine chapters:

The **first chapter** provides an overview of Montessori Educational Materials (Sensorial Materials) and Creative Problem solving.

Chapter 2 discusses the theoretical framework of the Montessori Method and Learning through social interaction.

Chapter 3 presents a literature review of the main research work in the area of the Montessori Method, Creative problem solving and the effect of pre-school environment on children.

Chapter 4 presents the theoretical framework of creative problem solving.

Chapter 5 presents research methodology issues and presents the design of the study.

Chapter 6 presents the quantitative analysis of the children's performance using the British Ability Scales II.

Chapter 7 presents the qualitative analysis of two experimental cases.

Chapter 8 discusses the research findings.

Chapter 9 is the conclusion.

Chapter 1

Montessori Educational Materials and Creative Problem solving

1-1Introduction

This research focuses on the use of Montessori educational activities and investigates the impact of these activities on children's creative problem solving. The chapter is organised into five sections. The first section presents the research problem. This is followed by the definitions of Montessori materials and definition of creative problem solving. Subsequently, it presents the social interaction element and explains pre-school curriculum of Saudi Arabia. The chapter concludes with the research questions that the study seeks to address.

1-2 The Research Problem

Maria Montessori designed her own materials to develop children’s skills. According to Thompson [2006], there has been limited research on the effectiveness of the Montessori methods. This study is intended to observe children playing with the Montessori sensorial materials (MSM) and, potentially solving problems in creative ways. According to Qin, Johnson and Johnson [1995] and Ashley and Tomasello [1998], there are a small number of studies that have investigated pre-school children and creative problem solving. This thesis intends to contribute to the understanding of the influences of the Montessori sensorial materials on children's creative problem solving (see section 3-2).

The aim of this research is to integrate a set of Montessori Sensorial materials (MSM), into one area of pre-school, the Toy-table area, to determine if they can improve children's creative problem solving. According to Payler [2005], Schweinhart and Weikart [1997], Wells [1994] and Tizard, Hughes, Carmichael, and Pinkerton [1983], the early years of education have a far-reaching impact on children’s later educational experiences. Because of this, it is important to prepare a rich learning environment for the children in these early years.

This research also is to observe teachers' interactions with the children who play with the MSM and study how this interaction might influence children in solving their problems creatively playing with the Montessori Sensorial problems (MSP) as Vygotsky [1978] argued that social interaction affects children's performance in solving problems (see section 2-3-1).

In addition, this study addresses the issue of the lack of educational activities in general in the Self Learning Curriculum (SLC) in Saudi Arabia. The intent of this research is to address one of the goals of the SLC which is to encourage creative problem solving in the early years. The study focuses on just one area of the classroom learning environment which is the Toy-table area from the Self Learning Curriculum. Children spend little time in this area compared with other areas because it is not full of activities compared with other areas in the classroom. This research integrates a set of Montessori educational materials, the Sensorial material, to the Toy-table area to determine if these materials might improve children's creative problem solving.

1-3 The Montessori Sensorial Education

Maria Montessori (1870-1953) divided the techniques of her method into three parts: motor education, sensory education and language education [Montessori, 1912/ 2003]. She divided her classroom into six basic areas: language, history, geography, mathematics, sensorial and practical life.

There are three components to the Montessori Method: the child, the prepared environment and a knowledgeable and sensitive adult. Montessori designed and prepared the environment carefully, creating her own materials for children to use. Montessori's classroom environment has six basic components and they deal with the concepts of freedom, structure and order, reality and nature, beauty and the atmosphere, Montessori materials, and the development of community life [Edwards, 2002; Greenwald, 1999]. In a

Montessori educational environment, children are usually grouped into multi-age classrooms [Montessori, 1912/ 2003].

According to Chattin-McNichols [1998] and Gitter [1971], the name of Montessori materials can by translated from Italian to English as 'sensorial material'. However, Lillard [1972] and Phillips [1991] translated the term as ‘sensory’. This research adopts the former (sensorial materials).

Montessori provided ‘sensorial’ materials, designed to attract children’s attention, to educate and develop the senses. Sensorial education is ‘the education of the child’s five senses through specially designed sensorial materials aimed at improving the child’s capacities for discrimination and classification’ [Gitter, 1971: 73]. Sensorial materials are didactic materials that ‘are simply constructed, inherently interesting, and self-correcting to inspire the child to master them and to seek relations between these materials and [the child’s] environment’ [Gitter, 1971: 73] (See Appendix 1.2). One goal of the sensorial materials is to assist children in creating sequences in sensory input by presenting experiences that proceed from the concrete to the abstract [Montessori, 1964].

There are at least five principles that determine Montessori materials. First, the essence of the complex problem that the child is to deal with should be isolated in a single set of materials. For example, a single set of materials might vary in size (alone), but should not vary in size, colour and design. Secondly, the materials progress from the simple to the complex, in design and usage [Montessori, 1965]. According to the Montessori Method [Montessori, 1912/2003], it is in this progression that children need to challenge their capabilities. Thirdly, the materials attempt to equip the child for future learning. Fourthly, the materials move from the concrete to the abstract. Finally, Montessori materials are designed for ‘auto-education’ (i.e. children can learn playing by themselves), and in some cases, the control of errors lies in the materials themselves [Lillard, 1972].

Montessori concentrates on children and how they can learn by themselves in an appropriate environment, with a teacher's first duty being to watch over the environment [Montessori, 1912/2003]. According to Montessori Jr. [1976:22] "the material does not, in the first place, teach children factual knowledge. Instead it makes it possible for them to reorganise their knowledge according to new principles. This increases their capacity for learning".

According to the above argument, young children learn through their senses and Montessori designed the sensorial materials to help children in solving problems. Because of this, I chose sensorial educational materials to be integrated into the Self Learning Curriculum to develop children's creative problem solving (see section 2-2-1 Learning through senses).

In Saudi Arabia, along with the Self Learning Curriculum (SLC) there are different approaches applied in some private pre-schools [Al–Ameel, 2002]. In the private sector, a small number of pre-schools have adopted the Montessori curriculum and applied it instead of the SLC (as far as can be ascertained, there are eight Montessori pre-schools in Riyadh city).

1-4 General Problem Solving

Guilford [1968] defined two major categories of problem solving: divergent thinking and transformation abilities. Divergent thinking is thinking that goes off in different directions, thinking of many original diverse ideas and associations to a problem. Transformation or convergent thinking abilities enable individuals to transform knowledge into new patterns or configurations. Guilford [1977:161] added that problem solving is "producing a new response to a new situation".

Pepler and Ross [1981] connected children's play with problem solving. The researchers argued that there are two types of play: play with convergent materials (those tend to direct play to a single solution, for example, puzzle solution) or divergent materials (those that have a variety of play activities and no right or wrong solution).

Problem solver's actions involve trial and error experimentation to see what works and seek a solution. If an action leads to a successful solution, they frequently use that action in future problems. Through repeated trial and error, children build strategies for solving their problems [Shrager and Siegler, 1998]. In the beginning, children use a trial-by-trial method to identify a solution for the problem and, after several trials, discover the main method for solving the problem [Siegler and Jenkins, 1989].

Fisher [1995] argues that children can learn during problem solving, as Guilford [1968] argued. Fisher [1995] said:

> 'Problem solving activities not only promote knowledge skills and attitudes, they also provide adults/teacher with opportunities to observe the way children approach the problem, how they communicate and learn. There is no better way to check if a child understands a process or body of knowledge than to see if he can use that understanding in the solving of a problem.'
>
> [Fisher, 1995:98]

Fisher encourages teachers to provide more problems in the children's play setting and let them discover solutions to ensure their understanding. Bruner [1973] defines problem solving as the child going beyond the information he or she is given. In addition, Russ [1998] argued that problem solving can involve convergent thinking (single solution) or divergent thinking (multiple means) strategies to obtain successful solutions. Lioyed and Howes [2003] argued that closed-ended materials, for example puzzles, have a single use and are intended to be used in specific ways, while other materials are open-ended; for example, a set of blocks leads to multiple uses and offers many possibilities, which encourage divergent thinking. Pepler and Ross [1981] added that divergent problem solving involves solving a problem that has no single correct solution, but a variety of possible solutions. This research provides more problems for children to solve creatively when playing with the MSM, to study the influence of teacher interaction on solving problems creatively.

There is a relationship between creativity and problem solving. Newell, Shaw and Simon [1964] argued that problem solving has a creative aspect, but creativity is not always problem solving. The next sub-section presents the relationship between problem solving and creativity.

1-4-1 Definition of Creative Problem Solving

Newell *et al.* [1964] suggested that creative activity seems to be “a special class of problem-solving activity characterized by novelty, unconventionality, persistence, and difficult in problem formulation” [1964: 63]. Guilford [1977] added that problem solving and creativity are closely related. Both of them produce new outcomes. In 1979, Noller connected creativity with problem solving by defining each of the three main words, creative, problems and solving:

> ‘By creative we mean: having an element of newness and being relevant at least to you, the one who creates the solution. By problem we mean: any situation which presents a challenge, offers an opportunity, or is a concern to you. By solving we mean: devising ways to answer or to meet or satisfy the problem, adapting yourself to the situation or adapting the situation to yourself. Creative problem solving or CPS is a process, a method, a system for approaching a problem in an imaginative way resulting in effective action.’
>
> [Noller, 1979: 4-5]

Isaksen, Dorval and Treffinger [2000:31] agreed with Noller’s definition and characterized it as “a broadly applicable framework organizing specific tools (understanding problems, generating ideas, evaluating and developing, and implementing potential solutions) to help you design and develop new and useful outcomes”. Noller [1979] and Isaksen *et al.* [2000] included three principles which are creativity, problems and solutions. Isaksen *et al*. [2000] developed the creative problem solving CPS framework (see section 4-3 for more discussion). This research adopts Isaksen *et al*. [2000] CPS framework to analyse children’s creative problem solving when playing with the MSM.

In summary, this research defines creative problem solving as the way children act with materials to express their understanding using the information that they are given and their senses to generate a variety of ideas for solutions by actions. The objective of this research is to study how provision of the MSM affects the ways that children solve problems creatively.

1-5 Social Interaction

One element of this research is to study the influence of teacher interaction on children's creative problem solving during their play with the MSM. Vygotsky's theory presents the zone of proximal development (ZPD). ZPD refers to the gap between what children can achieve alone and what they can achieve through solving problems under the guidance of an adult or more capable peers [Vygotsky, 1978]. Rogoff [1990] built on the ZPD idea and developed the concept of guided participation (GP) which she defined as:

> 'In guided participation, children are involved with multiple companions and caregivers in organised, flexible webs of relationships that focus on shared cultural activities… (which) provide children with opportunities to participate in diverse roles.'
>
> [Rogoff, 1990: 97-98]

Rogoff argued that the development of children during social interaction is accomplished through a combination of the children's skills and the guidance of an adult or older children [Rogoff *et al.*, 1993]. She added that adults may provide guidance in specific skills in the given context. Rogoff [2003] also argued that a change in participation with one's setting is evidence of learning and development.

Rogoff defined two aspects of guidance, namely the environment where the children learn and the type of instruction that the adult uses when teaching (see section 2-3-5). To answer the second research question, this research adopts Rogoff's model of social interaction to explore the impact of adult interaction on children playing with the MSM and how that affects the children's approaches of creative problem solving. This research applies to the educational environment in the Self Learning Curriculum (SLC) which the next section presents.

1-6 The Self Learning Curriculum

From 1965 to 1991, there was no official curriculum for pre-school in Saudi Arabia. The Presidency of Girls' Education in Saudi Arabia, the Arab Gulf Programme for the United Nations Development Organisation (AGFUND) and the United Nations Education, Scientific and Cultural Organisation (UNESCO) supported, and contributed to, the development of early childhood education.

The Saudi Arabian pre-school curriculum in 1991 attempted to focus on each individual child's development, taking into account his or her modes of learning and self-development. The curriculum was called the "Self Learning Curriculum" (SLC). The SLC was updated in 2005. The curriculum was designed to guide teachers of young children drawing on the Islamic educational culture [Samadi and Marwa (SLC), 2005].

The curriculum is presented in seven texts (see Appendix 1.1):

- The basic book: a guidance manual for teachers.
- Five texts planned around different thematic units.
- The seventh text has five different synopsis units.

The basic book offers guidance to the teacher. The teacher's manual includes five components: Goals and objectives, Guidance for the child, Organisation of the physical environment, Daily routine, and Preparing the child for pre-school.

The Self Learning Curriculum [SLC, 1991] explains how to organise the physical environment for children to learn. This environment is referred to as the *educational environment* (EE) and is divided into various areas for the children. The educational environment in the SLC is divided into two basic areas: indoors and outdoors, the indoor environment is in turn divided into seven basic learning areas: Reading area; Block area; Dramatic play area;

Toy-table area; Discovery area; Art area; and an additional area, varying according to thematic units.

1-6-1 Definition of Learning Areas

The Self Learning Curriculum defines learning areas as specific areas in the educational environment that contain activities with other media to support young children's development of interests and skills. For example the Reading area helps children to develop their reading and writing skills [SLC, 1991: 119]. In this way, the SLC suggests that the classroom should be divided into several intensive learning areas, each designed to meet the needs of the child's development. These areas are located around the perimeter of the classroom. There is a "morning circle" (MC) area in the centre of the room to facilitate activities involving the whole class.

1-6-2 The Self Learning Curriculum Version 2005

Early childhood education in Saudi Arabia experienced re-evaluation when the Ministry of Education took a decision in 2003 to separate pre-school from other stages of general education and put it under independent administration. In 2004, this independent adjustment was named the General Administration of Pre-school. The main goal of the administration is to improve and ensure the qualitative and quantitative development of pre-school education in the Kingdom of Saudi Arabia [Badawood, 2006].

The Self Learning Curriculum was updated in 2005. The curriculum is presented in seven books, as in version 1991. There are no major modifications to these units [Badawood, 2006].

The Teacher's Manual Guidance (TMG) has not been changed, though there has been some restructuring to make it easier to use than before. The thematic units spell out what the children are expected to learn by the end of the day in more detail than in the 1991 version. In addition, the general goals formulated in 1970 have withstood the test of time. However, according to Badawood [2006], these goals concentrate on the theoretical aspects more than on practical goals and there is some ambiguity, and overlapping between these goals. Despite all major changes in curricula in Saudi Arabia, there is little evidence of major improvement since its introduction [Badawood, 2006].

1-6-3 Studies of the SLC

The only pre-schools that adhere strictly to the curriculum are the government ones. Private pre-schools often add more activities to the official curriculum in order to meet their own goals (in particular, preparing children to read and write in order to satisfy the children's parents [Al–Ameel, 2002]. The curriculum has not been improved or further developed since its introduction until 2005.

Al–Ameel [2002] studied the effects of different types of pre-school curricula on some aspects of children's experience and development in Saudi Arabia. She found there was no policy concerning licences for teaching young children and a lack of educational activities in areas such as mathematics, language and science. Also, Zamzami [2000] evaluated the SLC and argued that the SLC met the needs of pre-school children, but there was a lack of educational activities, especially in the reading and writing areas.

In an investigation by Al-Otabi and Al-Swilam [2002] of teachers' attitudes towards the objectives of pre-school education, the researchers found that the teachers put the development of educational activities (reading, writing and mathematics), and preparation for elementary school, last on the list. Their first choice was an emphasis on religious concepts (which is to be expected, given the nature of the Saudi Arabian society). Saber [1996] also studied the difficulties that face pre-schools when they apply the Self Learning Curriculum. The main finding of the researcher was that the most important problem in applying the SLC is that parents do not understand the concept of the curriculum and there is a lack of qualified teachers and educational activities related to mathematics, reading and writing.

In summary, the SLC has several weaknesses, including a lack of educational activities in relation to reading, writing, science and mathematics, and parents' misunderstanding of the SLC concept may be because of lack of communication. Private-sector schools add activities to cover gaps in the SLC and to meet their own targets. The SLC guide book is not sufficient to prepare teachers to teach young children and teachers need training to apply the SLC in a pre-school environment. Moreover, as the existing research shows, the curriculum needs to be developed by adding more activities and materials. This study attempts to address the SLC weaknesses in terms of lack of educational activities in general by focusing on the use of Montessori sensorial materials.

1-7 Significance of the Research

The overall aim of the research is to investigate the impact of early experience of playing with educational materials of a sensorial kind on children's problem solving skills and their creativity in solving these problems during play in social interaction with teachers. This study integrates the Montessori materials into the classroom without Montessori's teacher roles. It goes beyond the Montessori Method in the social interaction aspect encouraging teachers to speak with children during their play and encouraging them to reflect and develop their problem solving skills and creativity.

The research adopted Isaksen *et al's.* [2000] CPS framework and Rogoff's [1990] model of social interaction to analyse the impact of the MSM and adult interaction on children's creative problem solving. There is currently little research on the creative problem solving skills of young children, especially of pre-school children in the Arab world. Also there is little research on the relationship between Montessori sensorial materials and creative problem solving in pre-school children. Recently, researchers connected the Montessori Method with creativity and problem solving like Gomes [2005] and Besancon and Lubart [2008]. Gomes [2005] studied whether a creative-focused science curriculum for pre-school at Montessori school increased creativity and problem solving. Gomes separated creativity from problem solving in the Montessori Method, and focused on the science curriculum (see section 3-3-1). Another study by Besancon and Lubart [2008] who studied the development of creativity in Montessori school and other schools (see section 3-3-1). There is little research on studying the effect of the Montessori Method, especially the sensorial education, on children's creative problem solving. Identifying this gap in the literature, this study goes further to build a bridge to knowledge on studying the influences of the Montessori sensorial education on children's creative problem solving.

This study introduces the sensorial materials to pre-school children in the same sequence as in the original Montessori curriculum, to smooth the process of utilising the materials. However, the children in this research used the MSM not in the Montessori way but played freely with the materials in their own way, and became creative in solving their own problems. This research contributes to knowledge about playing with Montessori materials in a learning environment that differs from the Montessori environment.

In addition, in this study the children were not trained in creative problem solving using Isaksen *et al's.* [2000] CPS framework. The current research used the CPS to analyse the data. By integrating the SLC with Montessori sensorial education; this thesis contributes to Saudi's pre-school curriculum and tended to develop its range of educational materials.

1-8 Research Questions

The research addresses the following questions:

1. **Does play with Montessori sensorial materials develop children's skills in solving problems?**
2. **How does interaction between children and their teachers during play with the MSM impact on children's creative problem solving approaches compared to those who do not receive support from their teachers?**

1-9 Summary

Some private pre-schools have adapted the Montessori Method for use in a Saudi context. The Montessori materials focus on the child's senses. This is useful because children in early years use their senses to learn and to discover. This research attempts to discover the effect of the MSM on children solving problems in creative ways. This research considers creative problem solving as the way children act with materials to express their understanding using the information that they are given and their senses to generate a variety of ideas for solutions by actions.

Finally, one goal, and general need, of the Self Learning Curriculum (SLC) is to develop children's creativity in solving problems. Several studies that have attempted to evaluate the SLC have revealed weaknesses such as unqualified teachers, misunderstanding of the SLC concepts on the part of parents, and a lack of educational activities. This research provides the SLC with educational activities when integrating the curriculum with the MSM. The next chapter provides a review of the research on the Montessori Method, social interaction and creative problem solving, and the links between them.

Chapter 2
Montessori Method and Social Interaction

2-1 Introduction

This chapter is organised in two sections and it intends to define learning through play in the early years in view of cognitive theories based on Montessori and social interaction. The chapter discuses the notion of guided participation developed by Rogoff [1990] and the role of the teacher in respect of Montessori's view and that of social interaction theory.

2-2 An Overview of Learning through Play

Play is generally recognised as being essential to a child's growth and development, and is itself a form of learning [Piaget, 1962; Montessori, 1912/2003; Vygotsky, 1962]. Play is also the centre of the early childhood curriculum [Johnson, Christie and Wardle, 2005, Van Hoorn, Nourot, Scales and alward, 2007]. Tepperman [2007: 2] added that "play is not a break from the curriculum; play is the best way to implement the curriculum". In order to support children's development, research has suggested that it is essential to provide an environment with activities that encourage children to learn through play. Over the past two centuries, theories of learning have contained explanations of play and reasons for its existence.

Piaget [1973] identified play as contributing to cognitive development, problem solving, creative thinking, initiative, discovery and imagination, and saw it as fundamental to the development of a child's capacity to learn. Piaget held that children were active learners and that they learn through the activity of play. Piaget [1962] identified six characteristics of play: spontaneous, an end in itself, pleasurable, free from organization, free from conflict, and symbolic.

In addition, Vygotsky [1967] argued that play provides children with opportunities to expand their world:

> ‘In play a child is always above his average age, above his daily behaviour; in play it is as though he were a head taller than himself. As in the focus of a magnifying glass, play contains all the developmental tendencies in a condensed form’
>
> [Vygotsky, 1967: 16]

Vygotsky named two criteria of play: an imaginary situation and rules correlating with it [Nicolopoulou, 1993]. Vygotsky added that play does not merely reflect development, but also contributes to cognitive development [Nicolopoulou, ibid]. In short, “play is the best preparation for future life…play is self-education” [Vygotsky, 1998: 26-28].

Play, from the combined perspectives of Piaget and Vygotsky, can be seen as essentially a form of, or at least a facilitation of, learning. Both Piaget [1962] and Vygotsky [1962] argued that play was an excellent path for children’s cognitive development and a main element of the learning environment. Johnson, Christie, and Wardle [2005] argued that development in children is served by play and that development is seen in play.

Montessori also believed in the importance of play for children [Montessori, 1912/2003]. She designed her own materials to develop children’s learning during their play. Montessori focused on helping children to play and learn through their senses, as discussed in section 2-2-1 below.

2-2-1 Learning through the Senses: the Montessori Method

According to Montessori [1912/ 2003], the phrase ‘sense training’ or ‘sense education’ means that children need to have specific associations made for them between perception of a concept and its corresponding word, such as the perception of blue and the word ‘blue’. However, it is uncertain whether this kind of teaching is necessary at all for children to master the links between sensory impressions and verbal labels. It is quite possible that a child would acquire these basic links through ordinary human interaction, especially through play [Gitter, 1971].

Montessori designed her materials to educate every sense separately. She isolated each sense to concentrate the child's attention upon the sensory stimulus which is acting upon him [Montessori, 1965]. In addition, Montessori introduced a series of preparatory activities that assess children in concentrating on reality related to their environment. Exploration of the environment through the child's senses involves movement and manipulation of objects in the Montessori classroom [Montessori, 1912/ 2003]. Whilst in the preceding exercise the child makes simple movement the child will accomplish movements which are more complex and difficult and exert small muscular effort. In addition, these materials may be introduced to children individually, to small groups, or to the classroom as a whole [Chattin-McNichols, 1998].

Some of the sensorial educational material has control of error, which leads to the children proceeding to correct themselves [Montessori, 1965; Gitter, 1971]. Self-correction leads children to concentrate their attention upon the differences of dimension, similarity of dimension and to compare the various pieces. The materials help the children to improve their visual awareness to control errors by their eyes [Montessori, 1965]. These activities refine the eye's power of discrimination, which increases every time the children pass from one activity to another. The eye makes an immediate analysis of objects in the environment [Lillard, 1972; Chattin-McNichols,1998].

In addition, sensorial materials exercise the children's sense of touching and running their index and middle finger around the object corresponds to feeling the relationship between both of them. The children coordinate their hand movement with their eyes to feel and see differences and similarities in objects. Additionally, the activities develop the child's sense of movement of the hand and exercise the visual discrimination to increase the relationship between reality, concrete wooden objects and abstract thinking [Montessori, 1965].

Two of the basic aims of sensorial education are to develop the whole child and, as Gitter [1971] argues, develop their thinking from the concrete to the abstract. Montessori educational materials attempt to educate the eye to distinguish differences in dimension. They also attempt to provide sufficient practice in recognizing pairs, recognizing contrasts and discriminating between objects which are very similar to one another (e.g. some of the Arabic letters similar to each other like the difference between three letters is the place of the dot). Through the use of sensorial materials, the child trains their senses to acquire basic knowledge [Lillard, 1997]. The pictorial sensorial materials give a general idea of the mathematical exercises that the children can do [Lillard, ibid]. The idea of quantity is inherent in all the materials for the education of the senses. The concepts of identity and difference also form a part of that. Education begins with recognition of identical objects, and continues with the graded arrangement of similar objects.

Research has highlighted the importance of the senses for young children, and of learning through them. Children discover the content of materials through a single sensory means of access [Gopnik and Graf, 1988; O'Neill and Gopnik, 1991; Perner and Ruffman, 1995; Pillow, 1989; Woolley and Bruell, 1996]. Stipek and Byler [1997] argue that children learn through direct experience using their senses. The work of Katz [1993] also indicates that young children should learn through first-hand experience.

According to Lillard [1997] and Chattin-McNichols [1998], children also prepare their hands for writing by using sensorial materials. Throughout all sensory exercises, the child is developing coordination between the hand and eye. Sensorial materials are arranged from right to left and from top to bottom in the Arabic context, preparing the child directionally for reading. The materials are also frequently sized in metric units, giving the child a sense of what the basic metric units of measurement are.

Direct preparation for writing consists of hand movement exercises and learning the shapes that the child will eventually make. The pincer grip using the thumb and index fingers is learnt, as well as hand-eye coordination. Exercises train the eye to recognise exactness of shape, and condition the muscles of the hand to follow the outline of a form, in preparation for forming letters [Lillard, 1997].

DeVries [1987] suggested that sensorial materials by Montessori inherently encourage extension and variation. He added that the constructive environment focuses on open-ended materials with many possible correct answers. In the Montessori Method, the sensorial materials progress from simple materials with a single solution, to materials with more complex (difficult and different possible) solutions. The progression challenges children's abilities. Constructive activities such as building and solving puzzles are a type of pre-school activity that Bruner [1972] and Sylva, Roy, and Painter [1980] consider to be complex or challenging. Yawkey and Toro-Lopez [1985] stated that constructive play involves manipulating objects to construct or create something new. However, in the Montessori classroom, the Montessori materials should be used for their designed purpose [O'Donnell, 2007].

The Montessori environment is a carefully structured one [Montessori: 1965], allowing children specific interaction with materials designed to foster development [Isaacs, 2007]. It is a controlling environment to help children to take more care and refine their classroom environment [O'Donnell, 2007]. The Montessori pre-school programme focuses on the guided use of materials [Isaacs, 2007] and there is little or no free play.

However, freedom is not excluded from the Montessori Method. For example, the children are free to choose which activities they will do. However, the materials are arranged in a very specific order, and the choice of materials depends upon the child having previous knowledge of the materials. Thus, the exercises are sequenced in a specific order [Isaacs, 2007], but this may appear as a significant limitation on the child's freedom or in Isaacs words "these materials are usually arranged in a specific order, setting out a possible sequence that the child may or may not choose to adopt" [2007: 14].

Another element of this approach is that children should be self-motivated in work with challenging materials, but the teacher should not use praise as a motivation, nor give emotional support, nor should there be physical contact with children [Montessori, 1912 / 2003]. The child in the Montessori approach should develop a sense of satisfaction from the work itself, without being dependent on the approval of teachers or others.

In the Montessori Method, the teacher must always take an active role the first time a child engages in an activity [Gitter, 1971 and Lillard, 1972]. The teacher should show the child how the activity is done, instead of explaining in words, and the teacher's words will always be to "encourage" the child (via instructions) to perceive the different sensations with their hand. If the teacher presents the materials to the child every time, the child will be slow to discover or learn (See Appendix 2.1).

Montessori materials aim to improve the children's senses by the special technique of isolating the senses during education [Montessori, 1965]. Montessori designed exercises for the senses of hearing, touch, smell, vision and taste. She avoided combining two or more senses in just one exercise [Montessori, 1912/ 2003].

Montessori [1912/ 2003] claimed that her concept of isolation of problems (every material involves just one problem to solve) would allow the child to work with materials successfully. The first case is cylinders which are the same height but have a diameter that decreases from thick to thin. The child has to solve the problem by finding a hole in each cylinder. The second case is cylinders decreasing in diameter and height. In the first set Montessori presents one problem, which is decreasing diameter, but in the second block she combines height and diameters which is two different concepts. This set of Montessori's materials does not seem to isolate a problem.

Dreyer and Rigler's [1969], Stirling's [1975], and DeVries' [1987] research and curricular developments (Early Years Foundation Stages, Head-start) underscore the importance of the senses and support Montessori's view that young children explore and learn through their senses. The Curriculum Guidance for the Foundation Stage in England [2008] noted that young children are active learners who use all their senses to build concepts and ideas from their experiences. Hohman and Weikart, in the High Scope Curriculum in the United States of America [1995/ 2002], pointed out that children as active learners involve all their senses in exploring and learning. In addition, according to Gitter [1971: 73]:

> ‘The education of the child’s five senses through specially designed sensorial materials aims at improving the child’s capacities for discrimination and classification. It is only through movement and manipulation, and through thinking with the senses, that the child proceeds to later abstract thinking.’
>
> [Gitter, 1971: 73]

For this study, I wish to focus on Montessori materials for use within the SLC in order to address the latter’s lack of choice of activities**.** I limit my choices to sensorial materials because children learn through their senses, especially touch, and this use of the senses helps them in learning to read, write, apply mathematics and develop general skills.

The sensorial materials prepare children for reading, writing and mathematics [Lillard, 1997, Liebeck, 1984, Isaacs, 2007] and this should help to address some of the weakness in the Self Learning Curriculum (SLC). In this study, I focus on integrating Montessori Sensorial Materials (MSM) with educational activities at the Toy-table area in the SLC, in an attempt to discover if it is possible to improve children’s creative problem solving. I also explore the influence of social interaction between children and their teachers, in solving these types of problems.

2-2-1-1 The Role of the Montessori Teacher

In the Montessori classroom, the teacher is part of the environment. The teacher’s important role in a Montessori classroom is to observe the children, prepare the environment for them [Chattin-McNichols, 1998; Lillard, 1972, Lillard and Lillard, 2003] and plan the appropriate activity for the children at each developmental stage [Gitter, 1971: 56]. Montessori teachers are deeply aware of the children's potential and ensure the environment responds to the children's needs and interests [Isaacs, 2007: 20]. Montessori saw the teachers as the ones who manage the classroom to create an effective learning environment for the children. The teachers make a link between the environment and the children but Montessori mentioned that teachers should minimise the interactions between children and adults during child play [Montessori, 1912/ 2003].

When the teacher has given the child a lesson about the materials (see Appendix 2-1), she then steps back to allow the child to work independently [Caldweel, Yussen, and Peterson, 1981; Iasaacs, 2007]. The lessons are offered when the child is ready to be introduced to a new aspect of learning [Standing, 1984, Iasaacs, 2007]. The teacher joins the child once an activity has been completed so that the teacher can talk about what the child's exploration has resulted in and discover his approach to solving the problem.

During the children's play, according to Montessori, the teacher cannot interrupt the child during his play because this interruption may disrupt thoughts or disturb at the moment when a problem is just about to be solved [Chattin-McNichols, 1998; Iasaacs, 2007, Lillard, 1972, Lillard and Lillard, 2003, Montessori, 1912/ 2003]. Montessori argued for children's abilities to teach themselves in a careful prepared environment [Montessori, 1912/ 2003, Iasaacs, 2007].

2-3 Learning Through Social Interaction

The importance of social interaction as a major force in cognitive development is connected with the Vygotskyan theory. Vygotsky [1962] argued that social factors are central to development and learning, and created the term; zone of proximal development (ZPD).

2-3-1 The Zone of Proximal Development

Vygotsky believed in a learning continuum characterised by the distance or gap between a child's ability to solve a problem independently and his/her ‘maximally assisted’ problem-solving ability under the guidance of an adult or a more experienced peer [Vygotsky, 1976; Baroody, 2000]. Vygotsky argued that children can, with help from adults or teachers who are more experienced, master concepts that they cannot understand on their own. Vygotsky defined the ZPD as “the distance between the actual development level as determined through independent problem solving and the level of potential development as determined through problem solving under adult guidance or collaboration with more capable peers” [Vygotsky, 1978: 86]. Vygotsky wrote about learning “through demonstration, leading questions, and by introducing the initial elements of a task’s solution”. He stated that “the teacher, working with the school child on a given question, explains, informs, inquires, corrects, and forces the child himself to explain” [Vygotsky, 1934/1987: 209].

Rogoff [1990] extended the concept of the ZPD by elaborating the role of children as active participants and suggested the concept of guided participation (GP).

2-3-2 Social Interaction in Guided Participation (GP)

Rogoff [1990] developed Guided Participation (GP) based on Vygotsky’s theory. She argued that both guidance and participation are necessary in children’s apprenticeship in thinking. She presented the concept of "apprenticeship" to describe how children learn. She argued that children play an active role in their own development and they are apprentices in thinking:

> ‘....active in their efforts to learn from observing and participating with peers and more skilled members of their society, developing skills to handle culturally defined problems with available tools, and building from these givens to construct new solutions within the context of sociocultural activity.’

[Rogoff, 1990: 7]

She linked learning with defining solutions for problems during social interaction which also helps the child to develop their skills. Rogoff [1990: 140] explained the social interaction by guidance from a more skilled person to a child “the model of most effective social interaction provided by interaction is thus joint problem solving with guidance by a person who is more skilled”. She also argued that social interaction has an influence on enhancing changing perspective but it may be simply to have a greater share of communication. It is also to see a problem from different qualitative vantage points which require a person to become aware that there is another perspective that offers some advantage. She added that for the individual to develop their understanding and skills, they may realise that there is information they do not know, but a changing perspective requires dissatisfaction with one’s current understanding of a problem. She argued that social interaction contributes to making the individual aware that there are alternatives, and then contributes to directing the individual to accept another view which also helps with developing his skills.

Rogoff [1990] argued that there are two perspectives concerning guided participation, the scaffolding process between an adult or a more experienced peer, which influences understanding, skills and learning, and secondly when the child makes ongoing contributions to activities. Rogoff [1986] stated that GP should be comfortable but slightly challenging. She defined the role of adults as preparing the learning environment, working with children in verbal and nonverbal activities and assisting them in understanding how to act in new situations:

> ‘Adults provide guidance in cognitive development through the arrangement of appropriate materials and tasks for children, as well as through tacit and explicit instruction occurring as adult and children participate together in activities. Adults’ greater knowledge and skill allow them to assist children in translation of familiar information to apply to a new problem, and to structure the problem so that the child can work on manageable sub-goals. The effectiveness of adults in structuring situations for children’s learning is matched by children’s eagerness and involvement in managing their own learning experiences. Children put themselves in a position to observe what is going

> on; they involve themselves in ongoing activity; they influence the activities in which they participate and they demand some involvement with the adult who serves as their guide for socialization into the culture that they are learning. Together, children and adults choose learning situations and calibrate the child's level of participation so that the child is comfortably challenged.'
>
> [Rogoff, 1986: 38]

Rogoff discussed two aspects of guidance, one in which guidance is provided through the environment and the second in which guidance is provided by tacit and explicit instruction (see sub-section 2-3-5). In the former Rogoff argued that the adult enables guidance by preparing the learning environment, or the classroom which Montessori did by designing her own materials.

2-3-3 Teacher-Child Interaction

Schoenfeld [1985:141] notes that 'social interaction plays a fundamental role in shaping pupils' internal cognitive structures.' Furthermore, social interaction can increase the effectiveness of the learning process [Vygotsky, 1978; Donaldson, 1978; Wood, 1986; Bruner, 1996; Edwards and Knight, 1994; Anning and Edwards, 2006].

It is also important to note that children are sensitive to being watched by adults. According to Rogoff [1990], children pause in their activities when they become aware of being watched. Their levels of interaction with others were reduced when an adult observed. When the teacher wants to observe children's play she should maintain distance between herself and the children, to avoid reducing their level of interaction with others. Damon and Phelps [1989] argued that adults' roles as teachers in adult-child interaction should be such that both of them should be participants seeking answers instead of following a linear model in which learning is passed down from adult to child. Hausfather [1996] argued that teachers should collaborate with their students to create meaning in ways that students can make their own. Vygotsky [1978] argued that social interaction between children and teachers helps children to create and understand their own learning. Siraj-Blatchford, Sylva, Muttock, Gilden, and Bell [2002] argued that the most effective setting tended to achieve an equal balance between adult-child interactions, cognitive outcomes related to teacher planning and the amount of sustained shared thinking between adult and children.

Bennett, Wood, and Regers [1997] found that teachers needed to take a more interactive role in supporting children's learning through play. The teacher role is to design the environment and select activities that promote children's opportunities to perform skills [McDonnell, 1998]. Dicarlo and Vagianos [2009] argued that when the teachers designed activities to address children's learning objectives, children neglected some of these activities in the classroom. The children are not able to take advantage of the opportunities in such an environment. It is important for the teachers to plan an intervention that will engage children in a variety of activities. It is the teacher's responsibility to redefine neglected activities to assist children's learning.

In addition, teachers or adults need to facilitate play in the learning experience as Seach [2007] argued. Lave and Wenger [1991] argued that by participation in activities and experiences, children increase the responsibilities of their learning. Teachers should prepare the environment with activities starting from simple to complex to develop children's experiences.

Rogoff [1991] explained supportive contexts and how these helped children in developing their learning and skills. She argued that even when children are not interacting with adults verbally, they participated in nonverbal activities and by repeating experiences, children become more skilled:

> 'The routine arrangement and interactions between children and their caregivers and companions provide children with thousand of opportunities to observe and participate in the skilled activities of their culture. Though repeated varied experience in supported routine and challenging situations, children become skilled practitioners in the specific cognitive activities in their communities.'
>
> [Rogoff, 1991: 351]

2-3-4 Peer Interaction

Rogoff [1990; 1998] suggested that children play an active role in their own social and cognitive growth by using the support of equal or more advanced partners during social interaction. She added that more advanced peers may be more likely to control situations, while peers of equal ability may provide more opportunities to engage in joint problem solving. In addition, according to Daniels [2001], interacting child peers may present differing perspectives that may lead to re-conceptualisation. Through social interaction, children may be exposing themselves to other points of view and conflicting ideas, which may push them to rethink or review their own ideas in order to learn and complete tasks [Wood, 2004, Hayes and Wilson, 2003]. Following Rogoff [1990], this study focuses on tacit and explicit teaching in child- teacher interaction to explore its impact on children's creative play with the MSM.

2-3-5 Explicit and Tacit Teaching

Rogoff adopted Ochs' [1979] explanation of explicit instruction as teachers making clear statements that define their own, and the child's, intentions with reference to the materials before them [1991: 81]. Rogoff [1991: 88] added that "the extent of reliance on explicit, declarative statements compared with tacit, procedural, and subtle forms of verbal and nonverbal instruction appears to vary across cultures.

In addition, Goldenberg [1991] equated explicit teaching with direct instruction saying that the teacher presents a model for students and gives exact, specific answers, step-by-step (systematic instruction). Scott [1990] argued that explicit teaching is when the teacher gives direct rules and examples when structuring the lesson. Rogoff and Lave [1984: 109] argued that the tacit process emerges in the role that adults play in the development of children's skills, which is not like direct teaching.

In conclusion, over the last century, researchers have underlined the importance of social interaction and child development and learning [Rogoff, 1990; Wertsch, 1998]. The two central aspects of guided participation are the learning environment and explicit and tacit teaching. Rogoff explained the role of teachers is to simplify learning tasks and provide the necessary support for children to develop their learning during direct or indirect teaching.

2-3-6 Combination of Montessori Sensorial Materials with Social Interaction Theory

This research attempts to place Montessori sensorial materials in a different context. The research tries to combine Montessori methods which are focused on the importance of the child's individuality with social interaction between children and their teachers. In addition, the Montessori classroom is multi-age; whereas children in this research environment are of the same age.

Montessori and Vygotsky agree that children are active in the construction of knowledge [Bedrova and Leong, 1996; Berk and Winsler, 1995] and that they learn through hands-on experiences. They also agree on the importance of children's collaboration in their own learning [Berk and Winsler, 1995 and DeVries and Kohlberg, 1987/1990].

Vygotsky [1962] agrees with Montessori that, for every aspect of learning, there is a period of time which is most fruitful, because the child is most receptive at that stage. 'Sensitive periods' describe the pattern of times when the child gains knowledge of his or her environment. In addition, the phenomenon of the absorbent mind explains the special quality and process by which the child acquires knowledge. Vygotsky [1962] also emphasises that, for learning to occur, an adult must be sensitive to an individual child's existing level of competence and assist the child in moving from one level of development to the next. Montessori and Vygotsky agree that there are periods of time when children experience their gain in knowledge and want to explore it. If the adult or teacher is not ready to help the child at that precise time, the moment might be lost.

The socio-cultural constructivist theories of learning and development [for example Vygotsky, 1978, Rogoff, 1990, Wertsch, 1998] emphasise that children learn how to approach and solve problems by interaction with an adult or a more capable peer. Vygotsky's position is that social factors are central to development. Through guided participation, Rogoff [1990] argued that children participate in activities with their responsibilities adjusted to their skills and adults provide guidance in specific skills in the context of their use. The adults guide the children by searching for common reference points and translating their own understanding of a problem's solution into a form that is within children's grasp [Rogoff, 1986, Rogoff, 1990, Wertsch, 1984]. In contrast, Montessori argued that the teacher's duty is to observe the child and determine the right type of activity for the child to assist his/her development [Gitter, 1971: 56]. The Montessori curriculum is highly individualized [Chattin-McNichols, 1998]. Teachers in Montessori method prepare the classroom for children to discover and learn by themselves.

This study combines the MSM in the Toy-table area without the Montessori role in playing with the materials. Teachers introduce the materials to children in the Montessori way, and then leave the children to play freely with the materials and support them whenever they need to develop their skills in solving their own problems creatively when playing with these materials. One weakness of the SLC is that it does not include educational activities and this research adds the MSM to improve on this weakness.

2-4 Summary

This chapter presented play as a central learning tool for children. Montessori's method focuses on the child's learning during their play through their senses. Her method is highly individualised and concentrates on children educating themselves as she also minimises the role of teachers in children's learning. In contrast, social interaction theory argued that children learn in a social context; for example Vygotsky [1978], Rogoff [1990], Bruner [1990] and Wertsch [1984]. The originality of this research is to place Montessori's approach in a socially interactive environment to study children's creative problem solving. One type of social interaction is the interaction between teachers and children in a pre-school environment.

This research focuses on child-teacher-interaction. Rogoff argued that teachers guide children in their learning through tacit and explicit teaching.

She defined explicit as direct teaching and tacit as indirect teaching. The next chapter presents a literature review of research in the areas of Montessori method, social interaction and creative problem solving and the link between them.

Chapter 3

Research on the Montessori Method, Creative Problem Solving, and the Effect of the Pre-school Environment on Children

3-1 Introduction

The aim of this research is to explore the influences of Montessori sensorial materials and children's interaction with their teachers on their creative problem solving. This chapter is divided into three sections. The first section focuses on research about the effectiveness of the Montessori Method. The second concerns the literature on children's creative problem solving and interaction during problem solving. The final section discusses research on the effect of the early childhood learning environment on children's cognitive development.

3-2 Research on the Effectiveness of the Montessori Method in Promoting Child Development

This section summarises the literature on the debate concerning the effectiveness of the Montessori Method. According to Thompson [2006], there has been limited research on this topic because the proponents of the philosophy are just beginning to recognise the validity of standardised testing. Since Montessori classes are now included in some state schools in the USA and Europe, standardised testing has become part of the programme. Also, according to Murray [2008]; Chattin-McNichols [1998]; Lillard [1997] and Stirling [1975], there is limited research in Montessori sensorial activities which is this research focus.

3-2-1 Research on Montessori Sensorial Materials

In 1969, Dreyer and Rigler argued that Montessori sensorial materials helped children in drawing geometric forms, and describing objects on the basis of their physical characteristics. Stodolsky and Karlson [1972] added that the set of blocks in the Montessori sensorial materials enhance children's competencies in visual matching, sorting, and copying designs.

In 1975, Stirling, a PhD researcher, studied the interaction of mothers with their young children over five weeks and found that mothers could construct Montessori sensorial activities to help their children develop certain skills. The sample consisted of sixteen mothers and their children, from age 30 months to five years of age. The researcher chose ten materials: rough and smooth boards, coloured tablets, geometric insets, sand cans, taste cans, smell cans, sand-paper numbers, spindle boxes, sand-paper letters and command cards. The mothers were invited to participate in the workshop, which took place for three hours, once a week.

The research methods were interviews with the mothers and a report form for them to record their children's interest in and performance on each material (some specific questions asked were: how many times did your child do the exercise?; did your child continue the whole activity? and did your child enjoy the activity?). The results showed that children's skills improved as a result of utilising the kit, although it was not equally effective on all groups of children. The thirty-month-old children made the greatest amount of progress, but the four- to five-year-olds made the least amount of measurable increase by the kit. However, Stirling stated that, for children at age four and a half, "interest in the last five difficult activities in the kit was excellent" (p. 132), but that children of four and a half to five years of age were the least productive in terms of skills growth and interest in the material kits (p. 133).

This raises the question of whether the material kits were motivating and difficult enough for children to play with and to show evidence of skills growth, development and interest in Montessori sensorial kits. If the last five materials, as the researcher stated, created an interest for the four year old children, then the whole set of materials may not have been suitable for five year olds. Thus, the findings raise questions concerning how the researcher selected materials to suit the needs of children of all ages. A failure to have chosen sufficiently difficult exercises might have been partly responsible for children from four and a half years to five years old not showing progress in their skills or interest in the sensorial activities that the researcher chose.

According to Pickering [1992] sensorial activities help children to learn classification and ways of categorising the world through their five senses. Pickering adds that sensorial materials teach the child to become a precise observer and more sensitive to the impressions of the environment; the child is able to distinguish and relate new information to what he/she already knows. Pickering [1992] adds that sensorial materials expand the child's vocabulary and teach mathematical skills.

The next section presents the effectiveness of Montessori methods compared with other programmes. In particular, it presents the effectiveness of the Montessori language and mathematics methods.

3-2-2 Comparison between the Montessori Method and other Pre-school Programmes

During the second half of the 20th century, a number of studies tried to examine children's performance in the traditional curriculum compared to an alternative curriculum such as the Montessori one. Academic performance is one area in which the Montessori approach has been shown to outperform traditional forms of teaching. This has been shown through research designed to evaluate the effectiveness of pre-school programmes.

Early studies compared five approaches to educating children from low income homes [Karnes, Teska and Hodgins 1970; Karnes and Johnson 1986; and Karnes, Shwedel, and Williams 1983]. Karnes *et al.* [1970] conducted a longitudinal study of five different pre-school curricula (nursery school, Direct Instruction, Montessori, Community/Integrated and Goal). The researchers post-tested the children in 1st, 2nd and 3rd grades and again when they were 16 years old. Cognitive measures of the five different groups were taken at the ages of four to eight, ten, and finally when the children were sixteen.

The results suggested that no one programme demonstrated superiority over the others. This connects with the result of Hadeed and Sylva [1999b], whose conclusion was that it is the quality of an educational environment rather than the type of childcare that accounts for differences in learning experiences, implying that the Montessori materials would have the same effect that any other materials would have, given the same setting. Although Montessori pupils in this study showed no significantly different test scores, they did have the highest success ratings and graduation rates at the end of high school.

Other large-scale studies were conducted by Miller and Dyer [1975] and Miller and Bizzell [1983a, 1983b, 1984] of the long-term effects of four different pre-school programmes in the USA one of which used the Montessori method on boys. These programmes compared nursery schools, Direct Instruction, Montessori and the Darcee School, which blended specific pre-academic goals and motivational goals with a control regular Head Start programme. Children attended for six hours a day for one year and were followed up over eleven years. The results indicated that boys who had attended the Montessori programme achieved higher IQ scores and better grades in reading and mathematics at school than boys attending the other programmes.

In contrast with the Karnes *et al.* studies above, the achievement scores of the Montessori pupils in the Miller studies were at the first level insignificant, but then rose sharply [Miller and Dyer, 1975]. Also, Montessori pupils had significantly higher reading and mathematics scores and IQ by grade 6 [Miller and Bizzell, 1983a]. However, when gender was taken into consideration, it was found that the reading and mathematics scores for Montessori boys were increasing the means for the Montessori group and that Montessori girls were neither highest nor lowest among the group [Miller and Bizzell, 1983b]. The Miller studies found that gender might affect the research findings.

The researchers claimed that the individualised nature of the Montessori Method (Montessori education concentrates on individuality during learning, with all children learning by themselves according to their skills) might have made a difference to the results, since the method may help one student to excel at one subject, while another student excels at something different. Since only group means were used in comparison groups, substantial changes for individual pupils would not have been detected.

The two longitudinal research programmes by Karnes and her colleagues [1983] and Miller and her colleagues [1984] followed a large number of low-income children in several different one-year pre-school programmes. They focused on achievement and cognitive skills and compared results to control groups. The programmes selected by Miller and Bizzell [1983a] were the same programmes that Karnes *et al.* [1983] selected, with the exception of the Community/Integrated and Goal programmes, although Karnes *et al.* did not find a difference in children's cognitive development. Miller and Bizzell found that boys in the Montessori programme achieved higher and better grades at school. This finding lends support to the perceived usefulness of the Montessori Method in children's development.

Tovikkai [1991] compared a Montessori programme and a play-oriented programme in Thailand in order to identify which programme provided more appropriate activities for children. The results suggested that children in the play-oriented programme had more opportunity to develop their competency in language, motor skills, shape and size, identification, creativity and problem solving. On the other hand, those in the Montessori programme had more opportunity to develop competency in mathematics and science than did children in the play-oriented programme.

In 1992, Kendall supported Faust [1984] who argued that Montessori materials help children to solve problems. Kendall found that Montessori children demonstrated a significantly higher level of independence, initiative and problem solving when he examined the nature and degree of autonomous behaviour among Montessori elementary children. His samples consisted of thirty 3rd year children from two accredited Montessori schools and thirty 3rd year pupils from two state schools.

There is a contradiction between Kendall's [1992] and Tovikkai's [1991] results, in that Tovikkai found that Montessori children were less able to solve problems while Kendal found that Montessori pupils had a significantly high level in problem solving. However, the children in Kendall's research were older than the children in Tovikkai's sample.

Studies by Miller *et al.,* [1970-1984], Karnes *et al.,* [1969-1983], Willkinson [1991], Tovikkai [1991], Kendall [1992], Brand and Welch [1989], Douglas [1993] and Vance [2003] indicate that the Montessori method has significant effects in specific areas but not in overall achievement. In recent years, the number of programmes has increased substantially, particularly at pre-school and elementary level [Bagby, 2002]. However, there has been limited research on the Montessori approach, and a number of studies have indicated that there is no different effect in Montessori pre-school experiences compared to other pre-school programmes, which I present next.

3-2-3 Research on the Effect of the Montessori Method on Children's Academic Achievement

Researchers have examined Montessori children's academic achievement and compared them to traditional school experience. In 1997, Fero investigated whether there was a significant difference between the academic achievement scores (language, mathematics, etc) of pupils in grades 2 to grade 5 according to whether they were taught with the Montessori Method or at traditional school. The result did not show that Montessori pupils achieved a significantly higher overall level academically than pupils in traditional classrooms. In 2000, Reed also investigated the understanding of the place value concept and the abilities of Montessori elementary pupils by comparing the task responses of grades 1-3 of a Montessori school with a traditional comparison school in the Columbus, Ohio, metropolitan area. The researcher found no statistically significant differences in procedural tasks between the schools at any grade level.

However, a recent study by McCladdie [2006] compared the Montessori method of reading to the Balanced Instruction Literacy Approach in order to ascertain which method is most effective for African–American children attending state elementary school grades 2 to 5 in Philadelphia. Based on the research results, Montessori pupils scored higher in their test compared to other pupils. This finding is supported by Harris [2004] who examined the academic progress of at-risk children in Ontario, Canada from 1991 to 2002 on implementing the Montessori programme and Rodriguez, Irby, Brown, Lara-Alecio and Galloway [2003] who investigated second grade reading achievement scores in Spanish and English among pupils who had participated in a Montessori programme alongside those who had participated in a traditional bilingual programme. Both studies agreed with the McCladdie [2006] finding.

Overall, the acquisition of language skills is one area of education in the Montessori Method that has proven the effectiveness of the method [Rodriguez, 2003; Centofanti, 2002; Ibeji, 2002, and Douglas, 1993]. Vance [2003] also showed the effectiveness of the Montessori Method in mathematics.

Agreement on whether the Montessori Method is better than other programmes cannot be obtained. There may be advantages of being on a Montessori programme, but some studies claim no different effect compared to other pre-school programmes. The findings encourage the present research to focus on the integration of Montessori Sensorial materials in a Self learning curriculum in order to investigate the influence on children's creative problem solving as a specific goal.

In summary, comparing with other programmes, such as Head Start, High/ Scope and traditional school programmes, some researchers found evidence of the effectiveness of the Montessori Method, but others claimed that there were no differences between the programmes. Researchers used standardised tests to measure children's achievement. However, with no standard guidelines available to assess the degree of Montessori implementation in the classroom evaluated, the researchers adopted different instruments designed to measure programme implementation. The range of responses obtained with these instruments made it difficult for researchers to confirm the outcomes which Montessori made. The present study is not designed to assess the Montessori implementation, though the research discussed above does form a backdrop to the current research.

3-3 Research on Creative Problem Solving in Early Childhood Education

The relationship between creativity and problem solving is close [Nickerson, 1999 and Auth 2005]. According to Guilford [1964], both terms refer to the same mental phenomena. Guilford [1964] and Mumford, Reiter-Palmon and Redmond [1994] argued that creativity is a form of problem solving. Guildford [1968] identified two major categories in creative problem solving, namely: divergent thinking and transformation abilities (see section 3-6 for more explanation). Feldhusen and Treffinger [1985] also related creativity with problem solving.

Arieti [1976] argued that the definitions of creativity have been focusing fundamentally on a process, a product, or a personality. Besemer and O'Quinn [1986] added that the creative product is the observable outcome of the creative process. Parnes [1972] defined creativity as follows:

> 'Creativity is thus a function of knowledge, imagination and evaluation… without knowledge, imagination cannot be productive. Without imagination manipulation, abundant knowledge cannot help us live in a world of change. And without the ability to syntheslze, evaluate and develop our ideas, we achieve no effective creativity.'
>
> [Parnes, 1972: 6-7]

Parnes's definition of creativity focused on imagination and how that leads to achieving a novel product, whereas Davis [1992] defined creativity as a process or a sequence of steps that creative people utilise in clarifying a problem, working on it, and producing a novel and appropriate solution. As can be seen, the researchers above connected creativity with producing product and solving problems. This product is a phase of solving that problem and because of that, as Guildford argued, creativity is connected with problem solving.

In the context of childhood, Sharp [2001] argued that each child can be considered to have creative potential and be capable of creative expression. In this sense, it is essential to consider each child's creative abilities. Fisher [1998] argues that all children are born with creative ability, but they need practice in creative processes to develop their potential. Children vary in their ability to learn from experiences and to solve problems in creative ways. Fisher [1998] adds that individual differences have been found relating to differences in intelligence and experience.

Craft [2002] agreed with Fisher that all children are born with creative abilities and young children enjoy experimentation and problem solving. Craft [2002] and Jeffery and Craft [2005] posit that the possibility of being able to think is a requirement for being creative. They argue that developing young children involves moving their thinking from "What does this do?" to "What can I do with this?" and, when a difficulty arises, "How can I get around this problem?". It sometimes involves moving from concrete to abstract. This fits with the Montessori approach to designing educational activities that develop abstract from concrete thinking. Both Fisher [1998], Craft [2002] and Jeffrey and Craft [2004] connected children's abilities and their individual differences with their differences in intelligence and experiences.

Treffinger, Selby, Isaksen and Crumel [2007], Selby, Treffinger, Isaksen and Lauer [2004], and Selby, Treffinger and Isaksen [2002] worked on the model of Creative Problem Solving (CPS) and found new insights on abilities and individual differences and how they affected learning styles. They changed their question from "how creative is this person?" to "how do people channel and direct their creative energies?". They concluded that problem solving style is a very important dimension of creative productivity.

Aside from children's abilities and their style in solving problems, Tegano, Moran and Sawyers [1991] and Hanapi [2006] argued that it is appropriate to focus more on the creative process than product with children. They argued that young children do not always have the skills to make a creative product. Davis [1986] supports the view that, for children, emphasis on the process rather than the product of creativity means that there is no single right solution. Another reason to concentrate on the process aspect is that children do not have skills in using materials. Children are young and do not have manipulative experience. Arieti [1976] argued that early education can be pivotal in developing creativity in people. Arieti [1976: 28-29] said that "early experiences can play a determining role in stimulating and directing the individual toward a certain kind of activity". Schirrmacher [1988] added that much of children's creative effort is expanded in the manipulative experience of trying things out and becoming acquainted with them. Essa [1996] stated that, in the process, the children have sensory experiences, communicate and relive experiences. Schirrmacher [1988] and Essa [1996] raised another element which affected children's creative problem solving, which is children's experiences with materials.

There are two practices deriving from different theories and philosophies on how young children learn, and the role adults play in the process. One approach is the exploratory model of learning, which suggests that children construct knowledge by confronting and solving problems through direct experience and the manipulation of objects [Stipek and Byler, 1997]. The goal is to create an environment in which children may explore, learn and develop through involvement with materials and in events. Children need such experience to develop their creativity. The other approach postulates that learning results from social interaction [Hedegaard, 1999; Lompscher, 1999], which will be discussed further in sub-section 2-3-2.

Pepler and Ross [1981] investigated the effect of playing with materials to solve divergent and convergent problems. When trying to understand this process, it is helpful to consider Guilford's [1956] differentiation between both types of problem. Convergent problems often have one correct solution, but problems associated with divergent thought often require generating many solutions.

Pepler and Ross's [1981] experimental research studied three to four-year-old children in Southern Ontario using a puzzle and a play block. A single solution was found in convergent activity; in divergent play, there was no particular solution. The materials used in this research were similar to Montessori ones. Some of the Montessori materials have a single solution like the four cylinder set and others have different solutions, like the triangles, brown stairs and colour cylinders.

The researchers found that the children who had divergent play experiences were more imaginative in their responses to divergent problems and gave more unique responses to divergent problem tasks than children who had convergent play or non-play experiences. Although children who played with convergent materials used more strategies in convergent problem solving, they did not perform as well on divergent problem tasks. However, the research did not mention how these materials were similar to Montessori materials, which might have assisted the current researcher in the design of her study.

Skinner [1990] also investigated problem solving during pre-kindergarten years, focusing on naturalistic and informal learning, which promotes exploration and discovery. Skinner argued that every new problem should allow children the opportunity to create their own solution, and he encouraged the children to think in different ways. Moran [1990] and Saracho [1990] also argued that learning environments should be rich in problem solving activities that capture the child's curiosity and encourage questioning. These questions help children to think creatively.

Similarly, Sharpe [1994] argued that young children need an appropriate learning environment that allows them to utilise their own experiences in solving a problem. Stipek and Byler [1997] also argued that children construct their knowledge by confronting and solving problems through direct experience and by manipulating objects, leading to creativity and exploration during problem solving. Mundry and Loucks-Horsley [1999] suggested that children should explore, ask questions, and revise their thinking to accommodate new ideas and expand their personal experiences.

Gönen, Uzman, Akcin and Özdemir, [1993] studied creative thinking in five- and six-year-old kindergarten children in Turkey. Children were given thirty minutes to complete three activities. The researchers tested children's creativity by administering the Torrance Creative Thinking Tests individually. The researchers found that six-year-old children scored higher than five-year-old children. Older children in the Gönen *et al.* [1993] study were more creative than five year old children. The researchers suggested that children should be helped at home and school to develop their creativity during art, story-telling and using unstructured play materials. Older children might have more experience and develop cognitively more than younger children, which might affect their creativity. This finding was supported by Ahlberg [1998] who argued that the content of a problem leads children to think of possible solutions and children are influenced by their family experience and pre-school setting.

In summary, the research studies above have put forward three major elements of creativity: product, person and process. There are also other major elements of creativity in young children, which are experience and the learning environment. In promoting creativity in young children, more emphasis should be placed on the process rather than on the product because of children's limited experience and knowledge [Tegano *et al.*, 1991 and Hanapi, 2006]. The following section discusses the effect of social interaction on children's creativity.

3-3-1 Research on Creative Problem Solving and the Montessori Approach

As stated above, there is limited research on Montessori, especially the relationship between Montessori and creative problem solving. Gomes [2005] studied whether a creativity-focused science curriculum for pre-school at a Montessori school could increase creativity and problem solving in children. Gomes did not apply his research in a Montessori school but adopted the

Montessori philosophy of education, which included several points. One major key point is that children construct their knowledge themselves experientially, by interacting with the environment, the materials and others in the environment.

Gomes [2005] used an action research method that included observation of the children in two classrooms, one using the creativity-focused science curriculum, and the other using the existing curriculum. He also used Thinking Creatively in Action and the Movement test of Torrance (1981) to collect data. The results showed a significant increase in scores for the creativity-focused group.

Gomes' research applied the Montessori philosophy in school but without Montessori's science curriculum or her materials in science or in different areas. The school adopted the traditional curriculum but with the Montessori philosophy, which did not mean that this school was one of the Montessori schools. The researcher found significant improvement in children's creativity and problem solving using the creativity-focused science curriculum, but not in a Montessori environment, which was one basic element in designing her method.

Besancon and Lubart [2008] also connected the Montessori Method with creativity. They studied the development of creativity in children schooled in diverse learning environments in Paris. The three schools were Freinet (French pedagogy), Montessori and traditional schools. A longitudinal study was conducted over two years with 210 children. Children were enrolled in 1st to 4th grades in the first year of the research and from 2nd to 5th grade in the second year. The researchers used three divergent thinking tasks from the Torrance Test of Creative Thinking (Torrance, 1976). Children who took part in this research were individually tested each year.

The results indicated that children's creative performance in Freinet and Montessori schools was higher than in traditional schools. They also found that children in the Montessori school were associated with an overall increase in creative abilities (fluency, flexibility and originality), but this was not observed among children in the Freinet school. They explained this difference in terms of the effectiveness of the Montessori schools increasing creativity. However, the teaching staff in the Freinet school were varied, with fewer teachers engaged in the Freinet teaching and some of them proposed a more traditional pedagogy in the Freinet school.

The researchers argued that several elements influence the relationship between schools and creativity, which are: the curriculum, the influence of the teachers and peers (social interaction) and the influence of the tasks. Different curricula, such as Montessori and Freinet, use different types of exercises to develop creativity.

Besancon and Lubart's [2008] research showed the effectiveness of the Montessori Method in developing creativity in children, compared with other schools. However, there is little research on the relationship between Montessori and creative problem solving.

3-3-2 Creative Problem Solving and Interaction

Children in the classroom play with materials by themselves or have social interaction. A child might play with peers, individual, with small groups of other children, or with teachers. Social interaction is one element that might affect children's performance during solving problems in creative ways, which this research attempts to address, focusing just on child-teacher interaction. This section discusses the importance of interaction in solving problems.

Bruner, [1996], Rogoff, [1990], Sutton-Smit, [1986], and Vygotsky, [1976] argued that there is a relationship between social context and creative problem-solving skills. The notions of the zone of proximal development developed by Vygotsky explained this relationship, (see sub-section 3-2-2). Rogoff [1990] extended the notion of the ZPD, and introduced the concept of Guided Participation (see sub-section 3-2-2-2). Researchers argue that when children focus on the process of play, they engage in multiple combinations of ideas and solutions that they use to solve problems. Children interact with their peers or with adults supporting their learning.

Ramani [2005] and Qin, Johnson and Johnson [1995] state that few studies have been undertaken to investigate interactive problem solving in pre-school children. Ramani further states that the kinds of tasks referred to in the pre-school cooperative problem-solving literature are limited. Anning and Edwards [2006] and DeCorte, Greer and Verschaffel [1996] added that adults help children to learn problem-solving principles in situations that are very close to life because of their young age. For the same reason, Wertsch, McNamee, McLane and Budwig [1980] argue that, before a child is able to function as an independent problem solver, the responsibilities for reaching a goal are taken by adults in adult-child interactions. It can be argued that children gain an advantage when they work on cooperative problem solving, which they can later take forward into individual tasks [Springmuhl, 1985; Tudge, 1985].

Coltman, Petyaeva and Anghileri [2002] studied the role of social interaction in promoting effective learning in 4-6 year-old children relating to 3D shapes. Problem solving tasks were designed using selected subsets of 3D shapes: poleidoblocs. The children in the experimental group had adult support, while the control group had no further intervention. Adults encouraged the children to check their findings, to reinforce their solutions. Children who could not execute the task received graded help. In the post-test, the experimental group's success was over 90%, while the control group remained considerably lower at 33%. Children with the support of an adult solved the teaching tasks and carried out a self-correction process to achieve a successful solution.

It was concluded that children cannot by themselves gain knowledge or find a method. The limitation of the study was that the adults interacted on only a small number of tasks. However, interaction improved children's capacity to solve problems.

This finding agreed with Klein, Hammrich, Bloom and Ragins [2000] research which explained the best way to teach science to young children during pre-school and early elementary school, based on Head Start Science and the Communication Programme (HSSC) at schools in three states in the USA. Children learned to match, discriminate and categorise sequences and solve scientific problems. The classroom context was supposed to be collaborative, with teachers and children engaging in small problem solving teams using verbal interaction. The result was a positive change in children's understanding of scientific concepts, as reflected by their ability to answer questions requiring higher level cognitive skills. Playing with an adult helped to improve understanding of tasks and therefore helped children to be problem solvers. According to Kontzisis [2000], children learn new concepts when they work together with their teachers and the teachers, according to Tegano *et al*. [1989], should know how to use problem discovery and solution strategies to motivate creativity.

Thinking Activities in Social Context (TASC, Wallace and Adams, 1993) sets out a framework and a thinking skills curriculum for children. One of the early learning aims in TASC is for the teacher to communicate with children through a range of activities using appropriate problem solving and thinking skills. This is in order to teach children that their unusual solutions or ideas are acceptable and to help them gain confidence in expressing notions that are outside the norm [Wallace, 2002].

Wood, Bruner and Ross [1976] and Wood, Wood and Middleton [1978] analysed mothers interacting with their three to four-year old children in solving Piagetian problems. The children had to work with three characteristics of wooden blocks (size, peg type and orientation). The children succeeded in doing the problems alone after they had been taught by their mothers. Young children can, with help, succeed in solving problems [Woodhead, 1998].

In conclusion, through communicative function with adults, children can solve problems and discover different solutions. Teachers should assist children to break down difficulties in problems and share experiences. It can be argued that children learn from more competent partners. Vygotsky's [1962] theory focused on social interaction leading children towards the acquisition of skills. The current study plans to study who teacher-child interaction influences children's creative problem solving when playing with the Montessori sensorial materials.

3-4 Research on the Effect of the Pre-school Environment on Some Aspects of Child Development

Some research claims that the classroom environment has an effect on children's development. The present study wants to control this element to study the influences of Montessori sensorial materials (MSM) on children's creative problem solving in Saudi pre-schools. The objective of this section is to review critically the research on the effect that the learning environment has on children's development, particularly cognitive development, in order to link the research findings to the first and second research questions (the extent to which the learning environment affects children's development in creative problem solving skills).

There is a debate concerning the effect of the learning environment on children's development, researchers being divided into two groups, one finding evidence that the quality of child care has no effect on children's development and the other finding evidence that quality does have a positive effect on children's developmental outcomes.

Does the quality of the child centre have an important effect on children's development?

Some research evidence supports the argument that non-parental child care is harmful for development, but there is a view that child care has no effect, or only a short-term effect, on children's development, as discussed below.

Deater-Deckard, Pinkerton and Scarr [1996] studied the long-term effects of child care quality on children's behavioural adjustment. They conducted a longitudinal follow-up of 141 children in three states. They used the Infant-

Toddler Environment Rating Scale and Early Childhood Environment Rating Scale (ECERS), assessment profiles, caregiver-to-child ratios, caregiver wages and caregiver education and training as measures. They found that the child care quality composite score at Time 1 did not predict changes in children's behavioural problems or social withdrawal at Time 2. The researchers concluded that the learning environment has no effect on children's social development or behavioural problems. However, some research found that more hours in child care might cause problematic behaviour [NICHD, 2004].

Scarr [1998] also concluded on the basis of several studies [Chin-Quee and Scarr, 1994; Deater-Deckard *et al.*, 1996], that variations in the quality of child care have no considerable short- or long-term effects on children. However, these findings may be explained by the relatively poor data on quality collected in these studies. According to Vandell and Wolfe [2000], only one measure of quality was collected during the pre-school years of each child, even though the typical child switched child care arrangements fairly frequently.

Peisner-Feinberg, Buurchinal, Clifford, Culkin, Howes, Kagan and Yazejian [2001] came with similar results that Vandell and Corasaniti [1990] showed. They studied the relation of pre-school quality to children's cognitive and social-emotional development in second grade after adjusting for family factors in Los Angeles, Hart Ford, Frontal and Piedmont. Although the researchers found that child care had only a modest long-term impact on children's patterns of cognitive and socio-emotional development, they found that high quality care in pre-school years had a positive correlation with children's cognitive and linguistic development. Nevertheless, they compared a high quality second grade classroom to medium quality child care, and they measured children's language abilities, mathematics and reading skills in just 30 minutes, once per year, which suggests limitations on the assessment.

A study by Lefebvre and Merrigan [2002] used data from a longitudinal sample of children aged 0 to 11 years at Cycle1 of the Canadian National

Longitudinal Survey of Children and Youth (NLSCY) to investigate the relationship between child care and developmental outcomes. Motor and Social Development scores were gathered for children aged 0-47 month and Peabody Picture Vocabulary Test assessment scores for children aged 4-5 years. The findings suggested that pre-school child care has no effect on pre-schoolers' cognitive development and an insignificant effect on the motor and social development of infant-toddlers. The estimates show that some observable family characteristics, such as mother's education, had strong effects on a child's score. The present study might pay attention to this factor.

Lipps and Yiptong-Avila [1999] used the same NLSCY data, but analysed it differently. Their results showed that children in child care, who attended aged four to five years, were rated by their teachers as being near the top of their class in mathematics in grade 1 (1996-97). Unfortunately, neither study presented information about the quality of child care. In addition, the latter study confounded day care experiences with other types of programmes for pre-school-age children, and did not take into account the frequency of participation in these programmes.

According to Kohen, Forer, and Hertzman [2006], the findings from the national Canadian survey need to be interpreted alongside findings from other studies, including experimental, qualitative and quantitative child care studies. The outcomes observed may not be representative of all the skills or achievements in schools, although they can serve as indicators. The NLSCY data is limited, as it was collected every two years, and much information could have been lost during the intervening time. Moreover, no information was collected on the quality of child care.

The counter argument is that high quality care is associated with better developmental outcomes, while lower quality care is associated with poorer developmental outcomes [Blau, 1999; Scarr, 1998]. The longitudinal study of Effective Provision for Pre-school Education (EPPE) by Siraj- Blatchford and Sylva [2004] and Sammons *et al.* [2003] followed 3000 children (3-7 years old) from 141 centres in different areas of England to explore the impact of pre-school provision on young children's progress and development using qualitative (case study) and quantitative methods. They measured the quality of the centres using ECERS-E and ECRERS-R and child assessment using the British Ability Scales (BASII). Profiles of each child's social and emotional adjustment were also completed by a pre-school educator using the Adaptive Social Behavioural Inventory (ASBI). They found a significant correlation between the quality of pre-school and children's cognitive and social development. The present study will apply research on high quality child care.

Other data was provided by the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K). A sample of 10,224 children entering kindergarten for the first time in 1998 was studied by the U.S Department of Education. Magnuson *et al*. [2004] used ECLS-K data from 1998-99 to analyse the effects of child care on children's reading and mathematics skills. Since family background might influence pre-school attendance, researchers controlled for family background (household income, parental education, family structure and size, and language spoken in the home). The quality of the pre-school centre was found to be directly related to better results in reading and mathematics performance at school entry and to positive effects on academic outcomes. However, longer hours in pre-school were associated with more behavioural problems.

The strengths of these studies are that they followed a large sample, including four random types of pre-school provision (nursery classes, playgroups, private nurseries, and local authority day nurseries). However, the Siraj-Blatchford *et al.* study did not control for family factors that may have influenced child development [Clarke-Stewart, Vandell and Burchinal, 2002; National Institute of Child Health and Human Development (NICHD), 1998] and the Magnuson *et al.* [2004] study did not give precise information concerning the quality of the pre-schools. In addition, the researchers found that longer hours in pre-school were associated with more behavioural problems. Magnuson and Waldfogel [2005] recommended another method besides observational.

The (NICHD) [2002] studied the effect of the quality of child care on children's academic skills and language performance. The sample was made up of 1,000 children (0-56 months), some whose mothers had not completed high school, some from single-parent families and some from white but non-Hispanic families. The longitudinal study controlled for family characteristics such as mother's education, race and ethnicity, gender, partner status and family income. The study tested the quality of centres through observational assessment of ten or more hours per week at 6, 15, 24, 36, and 54 months. The observers visited for half a day at 54 months and completed two 44-minute cycles of the Observational Record of Caregiving Environment (ORCE). The study measured cognitive and language development by using sub-tests of the Woodcock Johnson Picture Vocabulary and Memory of Sentence test, the pre-school Language Scale Expressive and Receptive test, Batteries and Letter-word Skills. Social competence was measured by the mother completing the Social Skills Rating System for their children. Behavioural problems were assessed by having the mothers and caregivers complete the appropriate versions of the Child Behaviour Checklist.

Although the longitudinal study found that children whose child care increased in quality over time had better pre-academic skills, better language skills and better cognitive development, children with more child care hours per week had more behavioural problems according to their caregivers. This is supported by Magnuson *et al.'s* [2004] findings. The strength of this study is that it used multiple methods to assess children at different stages, achieving greater internal validity. However, the study did not use a variety of methods to assess the quality of child care, as Siraj-Blatchford and Sylva [2004] did, and the study did not explicitly reflect educational dimensions of the child care setting.

Burchinal, Peisner-Feinberg, Bryant, and Clifford [2000] investigated the impact of child care centres on early cognitive and language development in three-seven-year-old children and found that higher quality care was correlated with higher measures of cognitive, language and communication development. Sylva's [1992] research also suggests that the long-term effects of early learning education are reflected in increased educational aspiration and motivation, not just cognitive skills. However, according to Ramey and Ramey [2000]; Waldfogel [2002] and Brooks-Gunn [2003], high quality pre-schools led to short-term improvement in cognitive development and long-term increases in academic achievement.

This section started with the question: **Does the quality of child care have an important effect on children's development?** Research findings show that high quality child care does matter. Some researchers provide evidence that child care quality has no relationship with later development, and some children cared for exclusively at home did better socially and cognitively (Deater-Deckard *et al.* [1996]; Chin-Quee and Scarr [1994]; Vandell and Corasaniti [1990]). However, some researchers did not give information or measure the quality of pre-school, or they carried out their research in areas where childcare quality, caregiver education and training were "low" and that might affect the research results.

The literature review also mapped out the relationship between pre-school quality and child development. The different opinions in the literature suggest further exploration of the characteristics of pre-school that can affect child outcomes. Based on the literature cited above, it seems that a high quality learning environment can have positive effects on cognitive and language performance and other aspects of a child's development. Regarding the above discussion, I applied the current research in an environment rated from middle to high quality to control the effect from the environment on children's development to study just the influences of Montessori sensorial materials (MSM) on children's creative problem solving.

3-5 Summary

This chapter has reviewed research into the effectiveness of the Montessori Method on children's development. Research has also shown that educational materials help children to learn.

In advancing creativity, more emphasis is placed on the process rather than the product because of the limitation of children's experiences, knowledge and their level of cognitive development. There are several elements in creativity including experiences and interaction. Researchers emphasise the importance of these elements, especially with young children. In addition, there are several studies on problem solving, including mathematics, social and cognitive problem solving, but the present research concentrates on research investigating the effectiveness of early experiences playing with the MSM educational materials on children's creative problem solving. There is currently little research on the creative problem-solving skills of young children, especially of pre-school children, in the Arab world.

This chapter reviewed research on the physical learning environment in early years and cognitive development. Research has indicated that the quality of pre-school influences children's cognitive and socio-emotional outcomes, as well as language skills. Research into early experiences in pre-school has shown the effect of these experiences on cognitive development. The chapter also highlighted research showing the importance of social interaction between children and teachers.

The study investigates possible links between playing with sensorial materials and children's creative problem solving during children's play alone and during play with adults. The theory chapter presents three basic categories in this study namely: the Montessori Method, creative problem solving, and social interaction, as well as the links between them.

Chapter 4
Theoretical Framework

4-1 Introduction

This chapter is organised in two sections. The aim of this chapter is to present the theoretical approaches to Creative Problem solving with definitions of each stage and component. The second part presents the CPS framework for the qualitative analysis. It presents the Isaksen *et al.* [2000] definitions of the CPS's components and stages and Rogoff's definitions of tacit and explicit teaching. The framework of the analysis also presents an adopted definition of the CPS's components and stages and Rogoff's model.

4-2 Theoretical Approaches to Creative Problem Solving

Guilford [1968] expounded a principle that creativity is a form of problem solving. Both creativity and problem solving share many of the same processes. Bink and Marsh [2000], Finke, Ward and Smith [1992], Huckstep and Rowland [2001], Lubart [2001] and Runco and Nemiro [1994] argue that creativity is a special case of problem solving. Finke *et al.* [1992] and Mumford, Mobley, Uhlman, Reiter-Palmon and Doares [1991] agree that some problem solving processes are required, such as problem identification and construction, identification of relevant information, generation of new ideas, and the evaluation of ideas.

Researchers have defined creative problem solving differently and highlighted different elements for creative problem solving. Isaksen, Dorval and Treffinger [1994: 374] saw creative problem solving (CPS) as a 'general name for all methods in which problems are solved by groups using techniques for structuring and stimulating creativity'. Isaksen highlights three elements of creative problem solving: methods, solutions and creativity. Lugt [2000: 505] defines creative problem solving as 'a key activity in the process of originating new product ideas'. Torrance [1966: 6, 1974b: 8] defines creativity connected with problem solving as:

> 'becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on, identifying the difficulty, searching for solutions, making guesses, or formulating hypotheses about the deficiencies, testing and retesting these hypotheses and possibly modifying and retesting them and finally communicating the results.'
>
> [Torrance, 1974b: 8]

Torrance's definitions add more elements to creative problem solving, which are sensitivity to problems and identifying the difficulty. Fisher [1990: 38] added "generating ideas" which is another element to define creative problem solving by saying "a way of generating ideas that can in some way be applied to the world. This often involves problem solving utilising particular aspects of intelligence." Mayer's [1992] definition agrees with Torrance in terms of novelty of solutions. Mayer [1992: 363] defines creative thinking as "cognitive activity that results in one or more novel solutions to a problem." Suddendorf and Fletcher-Flinn [1999] state that creative problem solving may profit from the capacity to generate more novel ideas which is agreed with Fisher definition. According to Guilford [1956, 1977], creativity involves divergent thinking of aspects of mental ability. Divergent thinking refers to the ability to produce many different ideas as a response to a problem. Newell *et al.* [1964] assumed that creative thinking is a special kind of problem solving technique. Torrance [1966] reiterated this idea, adding that creative thinking is one type of problem solving method. All the above definitions feature the word "creativity".

In organisations, participants, according to Craft [2002: 8-9], feel creatively involved when they are challenged by goals, operations and tasks. The process involves feelings of being able to take the initiative and to uncover relevant information, the feeling of being able to interact with others, the feeling that new ideas are met with support and encouragement; and the feeling of being able to put forward new ideas.

Craft [2000] holds a view of creativity as 'possibility thinking', related to problem solving, thinking about the world in a novel way that incorporates problem finding. Creativity may be defined as the development of novel ideas that are useful [Amabile, 1996]. Beetlestone [1998] listed six key elements found in other research definitions for creativity. She identified creativity as a form of cognitive learning, the expression of ideas and feelings, productivity using the imagination, performance, originality, coming up with novel solutions and an emotional interaction between an individual and the environment. Beetlestone agreed with Parnes [1972] about the importance of imagination and the ability to synthesize and develop ideas to achieve creativity.

Milgram [1990: 220] defined creativity in the following terms: “A product can be a response, an idea, a solution, or an actual product. Original means unusual and of high quality”. Furthermore, Gardner [1993: 54] defined creativity as “an ability to solve problems or fashion products in a domain in a way that is initially seen as novel but that ultimately is recognized as appropriate for a domain”. Huckstep and Rowland [2000] argued that there is another issue in the ascription of creativity to persons rather than their products, which agreed with White. White [1972: 134] said “creativity is a medal which we pin on public products, not the name of a private process”. The definitions of creativity have several principles, as Parnes [1972] and Beetlestone [1998] state. These principles relate to the problem, ideas, imagination, novel solution or person, product, and are part of the definitions of creative problem solving.

4-3 Creative Problem Solving Framework

Alex Osborn [1952] developed a model for the original description of the creative problem solving (version 1.0). Osborn presented seven-stages of CPS process: Orientation (pointing up the problem), Preparation (gathering pertinent data), Analysis (breaking down the relevant material), Hypothesis (piling up alternatives by way of ideas), Incubation (letting up to invite illumination), Synthesis (putting the pieces together), and Verification (judging the resultant ideas). This was elaborated upon over time by Parnes [1967] as version 2.0. It came to be known as the Osborn-Parnes approach to Creative Problem Solving (CPS). Ruth Noller worked with Parnes and others to develop this version and presented version 2.1 and developed it further to present five stages of CPS as version 2.2 [Noller, 1979, Parnes *et al.* 1977]. The five stages are: problem sensitivity, mess or objective, plan, action, and new challenges.

In 1985, Isaksen and Treffinger began to modify the Osborn-Parnes approach and developed version 3.0: mess finding, data finding, problem finding, idea finding, solution finding and acceptance finding. According to Isaksen and Treffinger [2004] the next major emphasis on that time to develop the CPS was to study the impact of CPS in a variety of settings.

This led them to change their description of the CPS framework and developed it in a newly described way as version 4.0. The new version organised the six CPS stages into three main problem-solving components based on how people behaved naturally. The three components were: understanding the problem (mess-finding, data-finding, and problem finding), generating ideas (ideas-finding) and planning for action (solution-finding and acceptance-finding).

Educational research and learning theory influenced Isaksen and Treffinger over more flexible approaches to CPS. According to Isaksen and Treffinger [2004] the constructivists argued that each individual must construct their own process approach in a personally meaningful way. Relevant research into human problem-solving processes led Isaksen and Treffinger to initiate research on the graphic depiction of the CPS and the impact of presentation of the process on people's understanding of the nature and dynamics of effective applications of CPS. As a result, Isaksen and Droval [1993] altered graphic depictions of CPS considerably and emerging from the 1985 "buckets" and extending with three components in 1987, leading to separating the framework completely in 1992 with version 5.0. Version 5.0 provided separation for each of the three components and moved from a linear to a cycling graphic shape.

The components within this framework of CPS might be used in a variety of different orders or sequences. As a result of several years of work to develop this version, Isaksen, Dorval and Treffinger presented version 5.1 of CPS adding the new metacomponents of Task Appraisal and Process Planning [Isaksen, Dorval and Treffinger, 1994]. The researchers developed version 5.1 which was more involved with two important themes: integrating the Task appraisal and Process Planning dimensions more effectively into the overall CPS framework, and making the language of the CPS more natural and descriptive. In 2000, the researchers introduced extensive changes in the language of the CPS framework and developed version 6.0.

The following fifty years of research on creative problem solving (CPS) made an important contribution to the deliberate development of different CPS models. Isaksen *et al.* [2000] developed a cyclical framework with four components and eight specific stages. Problem solvers do not always apply these components or stages in any particular order or for any specific length of time. This research applied this model to the qualitative data analysis. The four components of the CPS are: Understanding the Challenge, Generating Ideas, Preparing for Action and Planning the Approach.

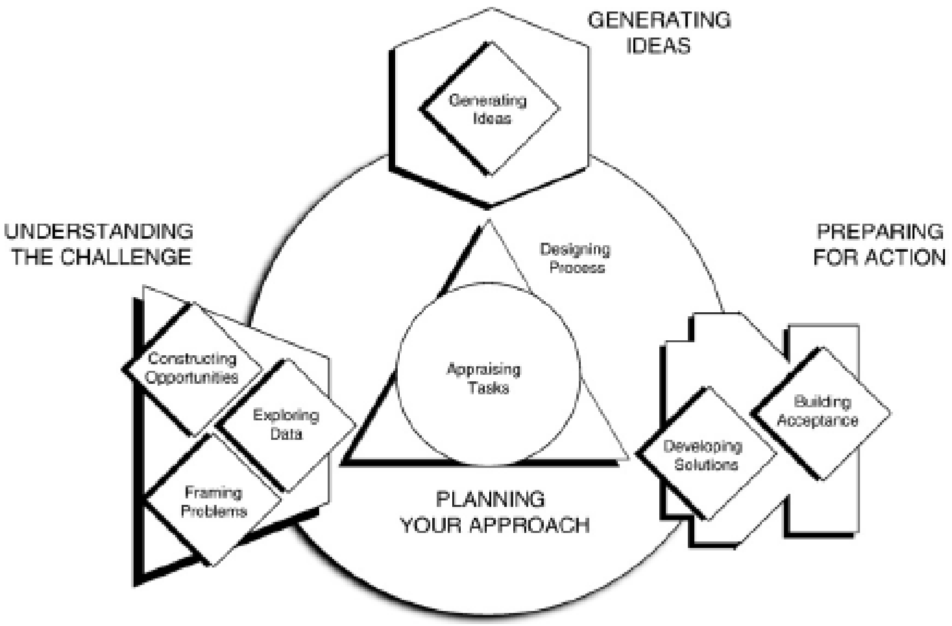


Figure: 4-1 The Creative Problem Solving Framework. (CPS Version 6.1™). Adopted from Isaksen, Droval and Treffinger [2000: 37]

4-3-1 The 'Understanding the Challenge' Component

Isaksen *et al.* [2000] and Treffinger, Isaksen and Dorval [2006] explain about gaining a clear focus for one's problem solving efforts. Understanding the Challenge requires the problem solvers to clarify the situation and it also involves determining what data they need to know, how they will identify, formulate and develop the problem during their work. This component includes three stages:

a) Constructing Opportunities.

This stage deals with the question 'What is the challenge with which I am going to be working?' The situation at this stage is broad and general and not clearly defined. The problem solver is always confronted with a wide variety of tasks. The objective of constructing opportunities is to help clarify the focus or direction for problem solving endeavours.

b) Exploring Data.

The aim of this stage is to find as much diverse information as possible that will be important for the problem solver to consider in examining opportunities, or stating problems. Problem solvers examine the situation to collect information, ideas and feelings from a myriad of viewpoints. After this, the problem solver determines which data seems to be the most important to enable a better understanding of the problem. It helps the problem solver take a more detailed look at the context, the people involved in the situation, and the ultimate outcome, and to discover what issues might be fundamental to the issue.

c) Framing the Problem.

Framing the Problem helps the problem solver to develop tangible, stimulating and specific problem statements. During this stage, the problem solver generates a variety of problem statements and chooses or constructs a specific statement. It prepares the problem solver to generate ideas by providing a firm and well-defined problem statement that will encourage new ideas and possible outcomes. A problem identifies a specific gap between the opportunity needed and the present situation. It encourages the problem solver to generate new, exciting possibilities that will be powerful in the move forward towards a desired future. The reason for the Framing the Problem stage of CPS is to help to identify specific pathways.

4-3-2 The 'Generating the Ideas' Component

This component has one stage which involves the generating of ideas. Problem solvers use this stage to solve problems that have already been defined, and to consider unusual ideas. The major focus of the Generating Ideas components and stage is to produce many options and novel ideas for solving a problem to produce change. The researchers define the four key principles:

Fluency: the ability to generate many clear options.

Flexibility: the ability to generate many different categories of options (see Appendix 4-1).

Originality: the ability to generate unusual or unique options.

Elaboration: the ability to add details to options to make them feel more complete, richer and more interesting.

Torrance [1965: 143] defined fluency in terms of quantity of ideas, flexibility as the number of principles or approaches that can be used, and originality as the number of uncommon ideas that can be contributed. He defined elaboration as extra detail which elaborates over and above that which is necessary to communicate a basic idea [Torrance, 1974b]. Fisher [2005] argued that the more the child generates ideas in play and informal settings the more fluent he will be in generating solutions. For Fisher [2005] flexibility is the ability of a child to overcome a mental block, to alter the approach to a problem, and originality is seen as novelty in terms of unusual or rare responses. Fisher also defined elaborations, as the number of additions that can be made to some simple solutions to make them more complex (p. 35-36).

4-3-3 The 'Preparing for the Action' Component

The purpose of preparing for action is to translate interesting and promising ideas into useful, acceptable and accessible action. It involves two stages: Developing Solutions and Building Acceptance. Problem solvers will use the

Preparing for Action component to deal with situations that require them to transform promising ideas into actions. It is helpful when making decisions, developing or strengthening options, identifying forces that have an impact on implementation efforts, or developing a specific plan for gaining acceptance and use.

a) Developing Solutions

This involves working on promising ideas to analyse, refine and improve them. It is about transforming ideas into action to help turn them into workable solutions, including options or alternatives. Ideas represent options or possibilities that are promising and appealing but need to be expanded or developed.

b) Building Acceptance.

This involves looking at an option from the viewpoint of others and examining potential solutions in ways that may lead to effective action. It is about working on the most appropriate challenge or problem, generating diverse and unusual ideas, developing early, rudimentary solutions and externalizing them for the outside world.

4-3-4 The 'Planning the Approach' Component

This involves monitoring thoughts as they occur to ensure that they are generated in the right direction. It helps to manage efforts and actions and guide the way towards the next step.

Working with the three process components of Understanding the Challenge, Generating Ideas and Preparing for Action has a specific strategic purpose. At some point, the problem solver finishes the task. The management component then deals with structure and reorganisation. Continuous monitoring allows the problem solver to confirm that his efforts have been focused and relevant; otherwise, redirection is needed. It helps to control flows of energy. There are two stages in Planning the Approach:

a) Appraising Tasks.

A basic understanding of the task to be undertaken is needed. Appraising Tasks allows the problem solver to question and reflect on what really needs to be done. The fundamental issue is to consider what needs to be known or learnt before designing the approach. It allows the problem solver to ascertain the suitability and potential effectiveness of applying CPS.

b) Designing the Process.

In this stage of Planning the Approach, the problem solver uses existing knowledge to plan CPS components and stages. The approach is customized. Engaging in the Designing Process allows a thoughtful and reflective spirit as well as building motivation and commitment.

4-3-5 General Critique of the CPS Framework

According to Puccio, Firestien, Coyle and Masucci [2006], the CPS is a model designed to capture the essence of the creative process, its guiding principles having first been published in 1953 by Osborn. It is not surprising that individual models of the creative process have been created, with the intention to bring about creative solutions to problems. Puccio *et al.* [2006] reviewed many studies on the impact of CPS in the workplace, such as the degree to which CPS training develops attitudes that are likely to foster creative problem solving. The researchers focused on using the CPS model to foster individual creativity to solve problems. The main target of the present research is to explore creative problem solving during play with MSM, but I did not engage in training children to use the CPS model and left them to play freely.

According to Torrance and Sisk [1997], significant positive results occur when creative abilities are deliberately nurtured. Treffinger *et al.* [2006] said that, ‘while CPS has been studied in experimental research, it has also always been a model that draws as closely as possible on what people really do when they’re solving problems. It is not a laboratory model that is strange or uncomfortable in everyday life’ (p. 16). CPS models have grown and changed by observing creative problem solvers dealing with problems. The researchers add that CPS is a practical approach to everyday situations. It derives from studying what people really need to solve problems creatively and not just in special settings or laboratories. Everyone can use CPS in personal life (p. 16).

Several researchers have used the model to teach simple problem-solving in creative ways, and they concur with the analysis method proposed for the present research involving children in play.

According to Isaksen and Treffinger [1985], there are some specific ground rules to follow when using the CPS process. The divergent ground rules include deferring judgment, looking for a number of ideas, accepting all ideas, stretching the imagination, allowing simmering time for new ideas, and seeking combinations of ideas. Convergent ground rules involve being deliberate, being explicit, avoiding premature closure, taking the risk of examining difficult issues, developing affirmative judgment, and keeping the eyes on the objective.

This research seeks to use the CPS to analyse data and compare two experimental groups designed to capture the essence of the creative process. As Puccio said above, and as Isaksen *et al.* [2000] also found, it is a descriptive framework not a specific set of assessments.

4-4 Framework for Analysis

This thesis adopted two frameworks to analyse the research data: the CPS by Isaksen *et al.* [2000] and Rogoff's [1990/2003] definitions of explicit and tacit teaching.

4-4-1 Framework for Analysis of Creative Problem Solving (CPS)

The CPS framework is adopted from the Isaksen *et al.* [2000], as was described in section 3-6. I present here in table 4.1 the theoretical definitions of each stage, the current research adopted definitions and some examples of data from each stage.

Table 4.1 The theoretical definitions of CPS's stages and research operationalism

CPS Stages	**Theoretical Definitions**	**Research Operationalisation**	**Examples**
UNDERSTANDING THE CHALLENGE COMPONENT:			
1- The CONSTRUCTING OPPORTUNITIES STAGE	- Generating broad, brief, and beneficial statements that help set the principle direction for problem solving effort [Treffinger *et al.*, 2008: 392]. Beneficial means that opportunities statements identify what you want to move towards or accomplish - the goal you hope to attain or the direction you hope to follow, not what you want to avoid [Isaksen *et al*., 2000: 67] - It helps to clarify the focus or direction for problem solving efforts. [Isaksen *et al.*, 2000: 64]. - It directs efforts towards the key opportunities and challenges [Isaksen, 2000: 71].	The children identify or choose the material they want to play with from other materials, determine the problem they are trying to solve and what is of interest to them.	- Children construct the opportunity by **choosing** to play with a particular material, saying "I want to play with this". The children define their choices and clarify their reasons to focus on this material.
2- EXPLORING DATA STAGE	It generates and answers questions that bring out key information, feelings, observation, impressions and questions about the task [Treffinger *et al.*, 2008: 392]. - It develops the focus or direction of problem-solving efforts, requiring a clear and accurate understanding of current circumstances [Isaksen *et al.*, 2000: 73]. - It helps to define important clusters within the task and involves asking "What	It is children's exploration or discovery of all the possibilities of the material's potential, different positions, shapes, properties, such as rolling, sliding, rotation, in order to use the materials creatively in their designs.	- The child uses the cylinder in different ways rolling it then stopping it from rolling by blocking it with another cylinder. - The child discovers two vertical and horizontal positions. - The child explores different possibilities with triangles, such as making a hexagon, or trying to create different

	part of this task is really the most important to focus on?" -It helps discover several major clusters of concern, examines tasks from different viewpoints and determines which data seem most important to gain specific focus for the challenge [Treffinger *et al.*, 2006: 40-41].		patterns. - The child explores the new position of the right-angled triangle (RAT) by rotating it 45 degrees twice, then he adds it to the middle red QT on its base side.
3- FRAMING PROBLEMS STAGE	- Framing problems involves seeking a specific or targeted question (problem statement) on which to focus subsequent efforts [Treffinger *et al.*, 2008: 392]. - The focus of the task will help in shaping the approach to framing the problems. -How and why else do tools help in framing the problems? - The purpose of the Framing Problem stage is to help to identify specific pathways and to help move current reality closer to a desired future state [Isaksen *et al.*, 2000: 82]. Isaksen *et al.* [2006] found three problem statements beginning with a phrase that invites the group member to be a creative thinker: - IWWM= In What Ways Might. - HW= How Might. - H2= How To.	If the child plays with the sensorial materials differently from copying the Montessori solution, to present a creative solution which this study is searching for, the child framed the problem. The teachers and I in some episodes helped the children by framing the problem for them, asking them "in what ways could you play with the material differently?" The children also asked how they could place the materials differently from the Montessori way, thus framed the problem then generated an idea. For example: - When the children connected the triangles differently from the Montessori Method they moved from framing the problem to generating an idea. - By mixing the tablets and holding two	- The child takes QTs from the box adds QTs next to each other to make a hexagonal shape which is like the Montessori solution. Then the child takes out one QT and adds two IOTs to make a Diamond shape, which is different from the Montessori solutions. The child is framing the problem and starting to generate an idea. - The child mixes the tablets and puts two of them next to each other, which is like a Montessori solution. The child changes the positions by holding up the two tablets in front of each other, which is different from the Montessori solutions. The child indicates that the problem is framed and starts to generate an

		tablets up in front of each other, the children used them differently and started to generate an idea. The children seek a problem statement by indicating a specific action during their construction, not a spoken statement.	idea.
THE GENERATING IDEAS COMPONENT AND STAGE	It includes coming up with many, varied or unusual responses to a problem [Treffinger *et al.*, 2008: 392]. - It is an opportunity to produce many new possibilities for dealing with an invitational problem [Treffinger *et al.*, 2006:53].	It produces many new possibilities in response to a problem. The child makes primary moves to produce a solution. There is often overlap between framing the problem and generating ideas. It can be said that when children are framing the problem, the next stage will be generating ideas.	- When the child says "I want to make a rocket", the child generated an idea. - The child moves the triangles, using two yellow QTs, and puts them on top of each other, differently from the Montessori position. The child moves from framing the problem to generating an idea.
PREPARING FOR ACTION COMPONENT:			
1- DEVELOPING SOLUTION STAGE.	- Developing a solution involves analyzing, refining or developing promising options [Treffinger *et al.*, 2008:392]. - It involves working on options to refine or improve them with the goal of transforming them into possible solutions [Treffinger *et al.*, 2006: 64]. - The role of Developing Solutions in transforming ideas into action is to help turn interesting ideas, thoughts or images into workable solutions [Isaksen *et*	It involves analysing by doing and working on options to improve them by adding, taking away or combining the material with another material to discover a new possible, or more elaborate solution.	- The children add more cylinders to develop their solution, which they call a fountain. - The child develops a solution further by adding the green cylinders. - The child develops the solution further by adding two more QTs on two sides of it and three grey QTs at the top of the shape.

	al., 2000: 131).		
2- BUILDING ACCEPTANCE STAGE	- It involves searching for a potential source of assistance and resistance and identifying possible factors that may influence successful implementation of a solution [Treffinger *et al.*, 2008:392].	It involves feeling near to completion and seeking feedback.	The children **accept** their solution by telling their teacher, friends or the researcher and also by showing personal satisfaction.
PLANNING YOUR APPROACH COMPONENT:			
1- APPRAISING THE TASK STAGE.	It allows reflection on what actually needs to be done. The main issue is to consider what you would like to know or learn about before you actually design your approach to the process [Isaksen *et al.*, 2000: 173]. Appraising task elements involves identifying and examining the key persons involved in the task, identifying desired results or outcomes, exploring the situation in which the task exists; and determining the appropriateness of using CPS [Treffinger *et al.*, 2006: 21].	The children in this study did not train in the use of CPS; they did not know what needed to be done before they started playing with the MSM; they had not identified the people that were going to be involved in their solutions or identified their desired solution; they had not stated what they wanted out loud, but played spontaneously- for all above reasons, I did not consider this stage from the research analysis.	- At later stages of the research, the children revealed their plans by telling their friends or an adult "I want to make a rocket using these triangles" at the beginning of their play. However, the children in this research played freely and had no training in using this framework. As a consequence they were not aware of which part of the CPS was more appropriate for their solutions.
2- DESIGNING PROCESS STAGE	It requires an understanding of CPS, the persons to be involved, and the working context [Isaksen *et al.*, 2000:178].	It requires an understanding of the CPS, the persons involved, and the working context [Isaksen *et al.*, 2000:178]. I did not consider this stage from the research analysis.	

4-4-2 Framework for Analysis the Child-Teacher-Interaction

Definitions of explicit and tacit teaching were adopted from Rogoff [1994] (see section 2-3-5). I provide here in table 4.2 the theoretical definitions of explicit and tacit teaching for comparison with the current research operationalism and present some examples from the research data.

Table 4.2 The theoretical definitions of Explicit and Tacit Teaching and the research operationalism

Theatrical Definitions	**Research Operationalisation**	**Examples**
Explicit Teaching: Rogoff adopted Ochs' [1979] explanation of explicit instruction, saying that "caregivers make the context of statements explicit by clarifying their own and the child's intention and specifying the referents of a statement" [1991: 81]. Rogoff connected explicit teaching with clarification and specific statements. Rogoff added [1991: 88] "the extent of reliance on explicit, declarative statements compared with tacit, procedural, and subtle forms of verbal and nonverbal instruction appears to vary across cultures.	Explicit instruction includes elements namely: - Clarification of ideas - Specific statements or answers. - Direct instruction - Referring to similarities between objects [Rogoff and Lave, 1984:100].	- Examples of explicit instruction or teaching: - When the teacher tells the child to add the material vertically, the teacher directs the child in the way the child puts the material. - When the child asks the teacher how s/he can move the material to achieve her/his goal and the teacher shows her/him.
Tacit Teaching: Rogoff and Lave [1984: 109] argued that the "tacit process is illustrated in the role adults play in the development of children's narrative skills but not through direct teaching". Troff and Sternberg [1998: 116] defined tacit teaching as particular know how that is usually not directly taught or even openly expressed or stated". They added that tacit knowledge is picked up through experience "is acquired under conditions of low environment support …without much direct instruction. In general, tacit knowledge is unspoken, underemphasized, and conveyed in an indirect manner.	Tacit instruction from the research definitions are that it is not directly taught; or it is provided by indirect suggestion.	Examples for tacit instruction or teaching: - When a teacher asks if there is another way to add the material in the solution or move it to different places. He or she is not teaching the child directly where he should add the material to solve the problem but offers suggestions. When a teacher sits next to the child and plays with the material and develops her own solution in different ways without interacting verbally, he or she helps the child to solve the problem by experience, without speaking.

4-5 Summary

This chapter has presented a theoretical approach to the CPS framework, which has four-components, and each component has its own stages. It also shows the definition of each stage from Isaksen *et al.* [2000] and Treffinger [2008] and gives examples from the research data. In addition, to study the influence of child-teacher-interaction on solving the children's own problems when playing with the Montessori sensorial materials, this research adopted Rogoff's model of social interaction. The chapter provided Rogoff's definition of explicit and tacit teaching. It also showed the research operationalism (definitions) for each stage of the CPS and Rogoff's definition of explicit and tacit teaching to analyse qualitative data. The next chapter presents the research methodology.

Chapter 5
Research Methodology

5-1 Introduction

The study requires a methodology that can focus on the influences of Montessori sensorial materials (MSM) on children's creative problem solving, to answer the research questions, namely: **Does play with Montessori sensorial materials develop children's skills in solving problems?; How does interaction between children and their teachers during play with the MSM impact on children's creative problem solving approaches compared to those who do not receive support from their teachers?** Different research designs and methodologies were considered. This chapter is organised as follows. The first section presents general theoretical issues concerning research methods. In the subsequence section, an argument is presented for adopting a quasi-experimental approach and elements of an ethnographic approach. The final section discusses validity, reliability and ethical considerations.

5-2 Research Methodology

Researchers may use quantitative or qualitative methods and sometimes combine them to triangulate their research. Blaxter, Hughes and Tight [2006] indicate two research branches: qualitative/quantitative and deskwork/fieldwork, with four approaches to design (action research, case studies, experiments, and survey) and four techniques for collecting data (documents, interviews, observation and questionnaires). The next section evaluates the two research families and the four approaches to designing research.

The first research family is qualitative or quantitative research. While qualitative and quantitative research may investigate similar topics, they usually address different types of questions [Britten and Fisher, 1993]. According to Blaxter *et al.* [2006]:

> 'Quantitative research tends to involve relatively large-scale and perceived sets of data, and is often, falsely in our view, presented or perceived as being about the gathering of 'facts'. Qualitative research, on the other hand, is concerned with collecting and analysing information in as many forms, chiefly non-numeric, as possible. It tends to focus on exploring, in as much detail as possible, smaller numbers of instances or examples which are seen as being interesting or illuminating, and aims to achieve 'depth' rather than 'breadth'.'

[Blaxter *et al.*, 2006: 64]

There are a variety of circumstances in which qualitative or quantitative methods are appropriate. The value of qualitative methods is that they can address research questions of immediate relevance that are difficult to investigate. Qualitative methods are also appropriate when researching a previously unexplored topic or a poorly understood one, where a hypothesis cannot be adequately constructed in advance. Such methods can help determine what the issues are and define the nature of the subject area. They also help to describe the shape and nature of phenomena, whereas quantitative methods are concerned with the extent of phenomena [Blaxter *et al.*, 2006; Cohen, Manion and Morrison, 2007]. However, qualitative methods are not useful when the extent of a phenomenon needs to be measured or a statistical relationship is to be explored between variables; for this, quantitative methods are more suited [Cohen *et al.*, 2007, Britten, Jones, Murphy and Stacy, 1995].

Qualitative methods may record data in the form of words, sentences, photos and what is called soft data, whereas quantitative research records data in the form of numbers in computer-readable formats, called hard data. Quantitative researchers consider alternative interpretations of data, compare results with previous studies and draw wider implications than are possible from qualitative data [Neuman, 2006].

However, there is an overlap between qualitative and quantitative research. According to Blaxter *et al.* [2006], quantitative and qualitative research can be used to explore and generate hypotheses and theories in the same areas.

Whilst collecting quantitative data, researchers can also collect qualitative data through open-ended questions.

Multiple measures (triangulation) to discover the same phenomenon help researchers to see all aspects of it [Neuman, 2006]. Triangulation involves the mixing of qualitative and quantitative methods of research and data [Neuman, 2006: 150]. According to Laws and McLeod [2006], methodological triangulation is classified as being either simultaneous or sequential. “Simultaneous triangulation" is the use of qualitative and quantitative methods at the same time. In this case, there is limited interaction between data sets, but the findings complement one another at the end of the study. “Sequential triangulation” is used if the results of one method are essential in planning the next method. The quantitative method can be completed before the qualitative method is implemented or vice versa [Morse 1991: 120].

According to Patton [2001], triangulation is a strategy or test for improving the validity and reliability of research or the evaluation of findings. Mathison [1988: 3] argued that triangulation has raised an important methodological issue in naturalistic and qualitative approaches to evaluation, controls bias and establishes valid propositions, because traditional scientific techniques are incompatible with this alternative epistemology. Patton [2001: 247] states that “triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data”.

The second family of research is fieldwork or deskwork. Blaxter *et al.* [2006] explain that fieldwork is ‘the process of going out to collect research data’ (p. 64) and deskwork involves ‘research processes which do not necessitate going to the field’ (p. 65). Through understanding both approaches, researchers may conduct a range of research that can be used in complementary ways [Neuman, 2006].

1- Action Research

Greenwood and Levin [1998:50] defined action research as simultaneously involving “the co-generation of new information and analysis together with action aimed at transforming the situation in democratic directions". Improvement and involvement are central to action research [Robson, 2002].

The main target for the current study is to discover the effect on children's creative problem solving through Montessori Sensorial Materials (MSM) and also to observe children's social interactions during play with the MSM in their social classroom setting. As the teacher's way of working may influence the children's performance in the classroom, action research does not seem to be suited to the current research.

2- Case Studies

Yin [2003:4] defined case study as "the method of choice when the phenomenon under study is not readily distinguishable from its context". The case is the situation, individual, organisation, school, child or whatever it is that researchers are interested in [Robson, 2002]. Case studies are often used to illustrate problems or indicate good practices. Social science research recognises in them an underlying methodological philosophy about how we understand the social world and its link to theory and practice in the literature. Case studies help researchers to study people's experiences and the strength of their practice in reality and this allows researchers to show the complexity of social life [Cohen *et al.*, 2007]. Cohen *et al.* [2007] added that the complexity of cases can make analysis difficult, and it is difficult to know where 'context' begins and ends (more explanation in section 5-3-3).

This research integrates Montessori sensorial materials (MSM) with the Saudi Pre-school Curriculum in the Toy-table area, which has not been studied before. The present study seeks to explore children's creative problem solving during play with the MSM in their daily social setting, so the case study approach should be helpful in answering the second research question.

3- Experiments

Bowling [2002:216] defined an experiment as:

> 'A situation in which the independent variable … is carefully manipulated by the investigator under known, tightly defined and controlled conditions, or by natural occurrence … the experiment consists of an experimental group … and a control group …. The experimental and control groups should be identical (apart from the exposure of the experimental group), in order to minimize variation between them.'
>
> [Bowling, 2002:216]

Experimental research is a way to focus on causal relations [Neuman, 2006; Krathwohl, 1998]. There are four types of design: true experimental, quasi-experimental, single case experimental and non-experimental fixed designs [Robson, 2002]. In the true experimental, two or more groups are set up randomly. The experimenter manipulates the situation so that different groups get different treatment. True experimental research is often carried out in the laboratory. Quasi-experiments are less random. Single case design focuses on individuals rather than groups and effectively seeks to use persons as their own control, subjecting them to different experimentally manipulated conditions at different times, and non-experimental fixed designs lack an active manipulation of the situation by the researcher [Krathwohl, 1998].

True experimental design is not suitable for the current research. As the study's object is multiple interactions among children, with or without teacher, a single case design would not be appropriate. The quasi-experimental design might help as a second method to answer the research questions (as discussed further in section 5-3-1).

4- Surveys

Aldridge and Levine [2001:5] defined a social survey as involving:

> '… an overall decision - a strategic decision - about the way to set about gathering and analysing data. The strategy involved in a survey is that we collect the same information about all the cases in a sample. Usually, the cases are individual people, and among other things we ask all of them the same questions.'
>
> [Aldridge and Levine, 2001: 5]

Surveys are carried out for descriptive purposes, and can provide information on a wide range of characteristics and the relationships between them [Robson, 2000].

The Montessori materials cannot easily be given to a wide range of children for observation. For this reason, the survey is not suitable.

5-3 Research Methods

The research is divided into two parts: Part 1: the quasi-experimental method is used to answer the first research question and Part 2: the ethnographic-case study method is used to answer the second research question. Further discussion is used to focus on the two research methods in detail.

5-3-1 The Quasi-Experimental Method

The first research question asks: **Does play with Montessori sensorial materials develop children's skills in solving problems?** This question seeks to uncover relations between sensorial materials and children's problem solving. Brog and Gall [1983] state that experiments carried out by educational researchers are concerned with testing the effect of new educational materials and practices on students' learning. They help researchers to test causal relationships in a variety of situations [Neuman, 2006]. Robson [2002] added that the quasi-experimental approach is a basic experimental stance in work outside the laboratory. The experimental method is the ultimate type of formal research designed to establish cause and effect relationships between two or more variables.

According to Cohen, Manion and Morrison [2000], in experimental research, investigators deliberately control and manipulate the conditions that determine the events in which they are interested. Experimentation involves making a change in the value of one variable, called the independent variable, and observing the effect of that change on another variable, called the dependent variable [Brog and Gall, 1983]. Demert and Towner [2003] added that quasi-experimental research focuses on questions of causation in which researchers have some control of subjects but can only work with an intact group. They added that researchers attempt to gain some control over initial group differences usually through matching or statistical techniques.

These are called quasi-experiments because they are variations of experimental designs. Some have randomisation, but lack a pre-test; some use more than two groups, and others substitute many observations of one group over time [Neuman, 2006]. Robson [2002] lists a range of quasi-experimental designs: single-group post-test-only, post-test-only non-equivalent groups, pre-test-post-test single group design, pre-test-post-test non-equivalent group design, pre-test-post-test equivalent groups through matching designs, interrupted time series designs (a single experimental group on which a measurement or observation is made before and after some form of experimental intervention) and regressing-discontinuity design (all participants are pre-tested and those scoring below a criterion value are assigned to one group and all above that criterion are assigned to a second group).

For this research, the single-group post-test-only design does not show the improvement of children before and after the experiment. The experiment needs a pre-test to determine children's progress and it is not possible to assess whether any difference in outcomes for the two groups is due to the treatment of, or other differences between, the groups. The post-test non–equivalent group design is not appropriate either, because, if the groups are not equivalent, then that makes it difficult for the researcher to judge whether influences are due to the treatment or due to differences between individuals. The design does not have a pre-test to compare individual progress. The regressing-discontinuity design is not suitable either, because of the non-equivalence of groups. The interrupted time series external designs measure or observe a sample before and after. However, they do not have an equivalent sample to prove that the progress is due to the treatment and not due to other factors. The pre-test-post-test equivalent group through matching design makes it possible to determine whether the differences in outcomes between the two groups are due to their treatment or due to other elements. This design is considered to be appropriate for this research as it aims to discover whether the effect is due to the Montessori sensorial materials and not to other elements. This research should have a pre-post-test-matching-group design to answer the research questions.

There is an argument that quasi-experimental research simply seeks associations between treatment and outcomes and that no further information or reasoning is required about why and how outcomes are linked [Demert and Tower, 2003]. This limitation means that a longitudinal ethnographic case study, triangulated with a quasi-experimental research approach, is helpful for presenting the changes occurring in children’s skills in solving problems creatively.

Another limitation of the quasi-experimental approach is time constraints. In order to generate a detectable impact, a certain amount of time is required. However, with increased time, there is also an increasing possibility of experimental problems, for example history, mortality and maturation among the comparison groups (see section 5-4). These issues and how the current research design address these are discussed in section 5-3-1-1 and section 5-4.

5-3-1-1 Pre-test-Post-test Control Group Design Through Matching

This study uses a pre-test-post-test experimental group design with matched pairs. Matching refers to experimental and control groups that are closely comparable on a pre-test that measures the developmental variable or the variable correlated with the dependent variable [Brog and Gall, 1983; Robson, 2002]. Matching reduces initial differences between experimental and control groups and is also useful in studies with small samples. It is also useful when large differences in the dependent variable are not likely to occur between an experimental and control group, because the small differences that do occur are more likely to be detected. The more the matching variable correlates with the dependent variable, the more effective the matching is in reducing these errors [Robson, 2002; Cohen, 2007].

5-3-1-2 Matching Characteristics

An experiment should have two sample groups: the experimental group (provided with treatment) and the control group (no treatment). The control group is important in experimental research because it serves the purpose of determining if the treatment has had an effect. However, individual differences in the control and experimental groups have an effect on research results. For internal validity, this study will use matched pairs (see section 5-4). There are several criteria for selecting matched groups. According to Wallen and Fraenkel [2001], the sample should be compared for age, gender, ability, socioeconomic background, and ethnicity, as well as equivalent scores in pre-tests. Mertens [1998] also states the importance of matched pair variables in terms of gender, age, type of disability and ethnicity.

The selection of sample may result in individuals differing from one another in ways that are related to the variables in the study. According to Wallen and Fraenkel [2001], researchers should decide which variables are most likely to create problems and do their best to prevent or minimise their effect. By matching control and experimental groups, the effectiveness of the treatment can be seen and measured. However, there are limitations to matching pairs. Firstly, it is difficult to match more than two or three variables. In addition, samples are no longer random, even though they may have been before matching [Brog and Gall, 1983]. Taking that into consideration, the present study's pair-matching variables are restricted to age, gender and similar general problem solving skills (see sub-section 5-3-1-2 for more explanation).

In sum, the quasi-experimental method is not sufficient to answer the research questions relating to the influences of children's social interaction and their creative problem solving. To collect more data on how children use the materials and solve problems in creative ways, and to answer research questions, the ethnographic-case study methods with the quasi-experimental method were combined (see section 5-3-2).

5-3-1-3 Data Collection Method for the First Research Question

This research used the British Ability Scale II (see section 5-3-1-4) to define the research sample and to answer the first research question. Before I started, I asked children's parents whether their children had played with the Montessori materials before the matched pairing. An overview of the research purposes is set out in Table 5.1 below. An additional sub-question was added to enable a fuller answer to the two main research questions.

Table 5.1: Research questions with related data collection methods

Research Question	***Persons involved***	***Methods***	***Time***	***Purpose***
1- Does play with Montessori sensorial materials develop children's skills in solving problems?	Children Researcher	BAS-II pre and post tests.	60 minutes for each child	Determining whether there are significant changes in children's problem solving skills using the four sub-scales at pre-post BAS-II testing.
Sub-question: a. At the end of the experimental period, will children who have played with sensorial materials show a significant difference in general problem solving using the British Ability Scales BAS-II from the control group?	Children in experimental group and control group	BAS-II.	60 minutes for each child	Determining whether there are significant changes in children's problem solving skills using the four sub-scales at pre-post BAS-II testing.

5-3-1-4 Background to the British Ability Scales II (BAS-II)

The problem solving assessment utilised in this study is the British Ability Scale II [Elliott, 1990]. The assessment is used to determine a child's General Conceptual Ability. The BAS-II is organised into two batteries, one covering pre-school children's scales, known as the Early Years Battery, and the second covering the school years known as The School Age Battery. The Early Years Battery is composed entirely of cognitive scales, whereas The School Age Battery consists of cognitive and achievement scales.

The Early Years Battery can be used to assess children under 6:0 years old. However, it might also be used to assess 6:0 to 7:11 year olds who have had difficulty with The School Age Battery. The cognitive scale is designed to measure abilities that are intrinsic to learning and educational performance and distinctive abilities, as well as contributing to the General Conceptual Ability Score. However, the BAS-II is not a scale for the measurement of IQ (unlike other tests such as Wechsler, Binet, and Spearman) [Elliott, 1990].

I discussed the BAS-II scales with professors in the field of Early Childhood Education at King Saud University, and they all agreed on the suitability of the scale. The BAS-II scales have been applied in Saudi Arabia before [see Al-Ameel, 2002]. Al-Ameel translated the BAS-II from English into Arabic and then back-translated to check for accuracy. Al-Ameel found that the BAS-II sub-scales did not need any alteration and could be applied as-is; however, she changed some words concerning literacy skills. This study did not involve literacy skills, so the BAS-II sub-scales have been applied with no changes.

The BAS for the Early Years Battery has seven sub-scales: Block Building; Verbal Comprehension, Picture Similarities, Naming Vocabulary, Pattern Construction, Early Number Concepts and Copying (see Appendix 5.1). It had to be determined whether all the sub-scales related to the first study question about improvements to children’s problem solving. Every material in sensorial education presents a problem that the children have to solve during play.

This study does not focus on measuring children’s language and therefore neither the Verbal Comprehension nor the Naming Vocabulary sub-scales were used. The early Number Concept sub-scale was not used either, because this study does not focus on children’s numeracy. The four selected sub-scales were: Block Building, Picture Similarities, Pattern Construction and Copying. The researcher used the BAS-II, because, as noted in Chapter 2, the Montessori Method does not have an instrument for measuring children’s performance. The four sub-scales reflect children’s problem-solving skills, but also present some problems (see Appendix 5.2). Several other researchers have used sub-scales of the BAS-II, for example, Sylva *et al.* [2006], who used five sub-scales and Locket, Ginsborgt and Peers [2002] who used four sub-scales.

I sent letters to the children's parents in order to obtain permission to involve them in the research as sample. The next step was to administer the BAS-II on the children. I had had training in the use of the BAS-II at the University of Southampton. A PhD member of staff from the psychology department trained me on ten volunteer children. I administered the test in front of her and discussed it. We administered the BAS-II together. We scored the assessment separately and then discussed our scores. If there were discrepancies, we discussed them until agreement was reached. The procedure was repeated until we reached a high level of agreement. This was followed by a discussion on whether I should look at children's separate scores for the four BAS-II sub-scales or the total score. It is difficult to find matched pairs that have the same score for every sub-scale. It was agreed that matched pairs would be selected using the children's total scores on the four sub-scales.

I had further training in Saudi Arabia with a volunteer PhD assistant in Early Childhood Education trained in BAS-II. Together with the PhD student assistant I administered the BAS-II on ten children, using the above procedure. Then I administered the BAS on 108 children to find matching pairs. The total time taken for each child was up to 30 minutes.

5-3-1-5 The Research Sample

I limited my focus to one school because of the ethnographic case study design. I wanted to record the children's development on creative problem solving and I could not remove the materials from one school to put them in another school. In addition, I chose this school because, according to the literature (section 3-4), this research needs to be applied in middle to high quality pre-schools. The General Administration of Pre-school (GAP) recommended eight high quality pre-schools to the researcher. I put the pre-school names in a bowl, made a random selection and informed the GAP about the choice. Measuring the educational environment of the pre-school was the first step to be taken (see section 5-4-2). The pre-school environment data is presented in this chapter because it falls into the category of pre-finding data.

All the children in this research were five years old (***mean*** = 5.15 years) and of Saudi nationality. The selection began by eliminating children who had previously played with MSM; this was ascertained by asking parents. None of the matched pairs had ever been to a Montessori school or played with the materials, in particular not sensorial materials. Then I sent a letter to parents requesting permission for their children's participation (see Parents' Letter - Appendix 5.3). I explained that the use of the BASII was not for the purpose of judging the child's overall ability, but simply for sample selection and to compare their progress over the duration of the research period.

I started to administer the BAS-II immediately after parental approval. The experimental room contained two chairs and a table. I sat next to the child. The BAS-II took approximately 30 minutes for each child. The researcher tested 108 children and found twelve matched pairs. These children were in four different classrooms. Six children were in Teacher 1's classroom and six children were in Teacher 2's classroom. These twelve children formed the experimental group. The second group, the control group, had seven children from Teacher 3's classroom and the other five children were from Teacher 4's classroom.

5-3-1-6 Matched Pair Criteria

1. Saudi nationality.
2. All children should be five years old.
3. Gender.
4. Six matched pairs of boys and six matched pairs of girls with a similar BAS-II score.
5. New to Sensorial materials.

5-3-1-7 Teachers' Participation

I explained the main purpose of the research to the head teacher. The head teacher had a meeting with her teachers and explained the research idea to them and asked them to volunteer. I was not present at that meeting. All the teachers (16 in total) agreed to volunteer for the research. However, when video recording was mentioned, most of them withdrew. Only two volunteered to participate and agreed to be recorded, under the condition of covering their faces. The other teachers refused to be videoed for cultural and religious reasons. The two volunteers were from two different classrooms so these were used as the experimental classrooms. I had a meeting with them and the ideas behind the research were explained, as well as how to introduce the materials in the classrooms. It was agreed that the Montessori materials would not leave these two classrooms until the end of the academic year. The two teachers are coded Teacher 1 (T1) and Teacher 2 (T2). I asked them to sign a permission letter, along with an agreement to volunteer and to be video recorded. The teachers signed the paper and returned it (see Appendix 5.4). I put the two teacher's names in a bowl and randomly chose Teacher 1's classroom as the Teacher-Child-interaction (T-C-I) experiment and Teacher 2's as the Child-Material-interaction (C-M-I) experimental classroom. Teacher 3 and Teacher 4 were in the control group (see Appendix 5.5 for teachers' qualifications and experience).

This research used the quasi-experimental matched pair technique to study the effect of the Montessori sensorial materials on children's problem solving skills and to ensure that changes were due to the materials, not to other factors. This method was not considered suitable for the study of changes in children's creative problem solving. For this reason elements of an ethnographic case study approach were adopted.

5-3-2 Ethnography as a Research Method

The second research question is: **How does interaction between children and their teachers during play with the MSM impact on children's creative problem solving approaches compared to those who do not receive support from their teachers?** The question raises issues of social interaction and the way in which children solve problems creatively. From the previous discussion, elements of the ethnographic case study method help to gain insights into children's play in the classroom environment. I should observe children's daily play, in order to answer this question. According to Ellis [2004: 26] "ethno" means people or culture; "graphy" means writing or describing. Ethnography means writing about or describing people and culture, using firsthand observation.

Duranti [1997] used the term 'written description' to describe ethnography:

> 'We can say that ethnography is the written description of the social organization, social activities, symbolic and material resources and interpretive practices characteristic of a particular group of people.'
>
> [Duranti, 1997: 85]

Robson's [2002] definition agrees with Duranti's. He states that ethnography "provides a description and interpretation of the culture and social structure of a social group" (p. 186). He adds that "… people are studied for a long period of time in their own natural environment" (p. 186). According to Pole and Morrison [2003], ethnography helps researchers to understand social interaction and interpretive practices, and to understand the significance for the actors involved. Ellis [2004: 26] added "Ethnographic fieldwork includes everything you do to gather information in a setting, especially hanging around, making conversation, and asking questions". Ellis [2004: 26] added that this perspective reflects a way of viewing the world-holistically and naturalistically- and a way of being in the world as an involved participant.

Children are the main actors in this research, in their play with MSM with or without their teacher's assistance. The fact that this is a quasi-experimental method raises a question as to whether it is a pure ethnographic method or whether it just contains elements of the ethnographic method. LeCompte and Preissle [1993: 3] present several key elements of ethnographic approaches, as adapted below:

- Phenomenological data are elicited.
- The world view of the participants is investigated and their 'definition of the situation' is presented [Thomas, 1923].
- Ethnographic research strategies are empirical and naturalistic.
- The constructs of the participants are used to structure the investigation.
- Participant and non-participant observation are used to acquire first-hand data.
- Observational techniques are used extensively to acquire data on real life settings.
- The research is holistic: it seeks a description and interpretation of all events.
- There is a move from description and data to inference, explanation, suggestions of causation, and theory generation.
- Multiple methods are used [LeCompte and Preissle, 1993: 232].

As this research involves observing the classroom environment, the children and their relationships, action, activities and physical objects; it is possible to suggest that this study has elements of ethnographic research in addressing issues of naturalistic and empirical, first-hand experience, hanging around, making conversation and asking questions, concentrating on social interactions, explanations, suggestions of causation, and using multimodal methods to collect data. The quasi-experimental method may reveal causes and effects, but it cannot reveal how creativity occurs, while observation using the ethnographic approach can help to answer the creativity question. However, observations during free-time play and the quasi-experimental method cannot satisfy the criteria for the pure ethnographic method, neither are they suited to the deep analysis of children's creative solutions using the CPS framework. For this reason, I used a case study approach to study the development of the children's creative approaches to problem solving with the MSM in depth.

5-3-2-1 Participant Observation

This research involved observations of children throughout a complete academic year. The author participated in the learning environment as an assistant teacher to observe the children while they play with the MSM during everyday preschool activities. Dewalt and Dewalt [2002: 1] defined participant observation as “a method in which a researcher takes part in the daily activities, rituals, interactions”. Schwartz and Schwartz [1955:1] defined participant observation as “a process of registering, interpreting, and recording”. Thus, participant observation is a method of collecting daily data through interpretation of what is going on. Jorgensen [1989] argued that through participant observation researchers can describe what goes on, who is involved, when or where things happened and why. Jorgensen [ibid] added that researchers are able to experience the meaning of interactions between people through performing the role of an insider. Agar [1996] used participant observation for formal and informal interviews.

According to Spradley [1980] and Schensul *et al.* [1999] participant observation refers to the general approach to fieldwork used in ethnographic research. Homan [1980], Humphreys [1970] and Gans [1999] argued that ethnographic participant observation can supply detailed, authentic information, unattainable by any other means, and that it is appropriate for problems when little is known about a phenomenon.

The role of the researcher as an observer is a face-to-face relationship with the observed, with an emphasis on the researcher participating in activities with those being observed in their natural life setting [Schwartz and Schwartz, 1955]. Christensen [2004] agreed with Schwartz and Schwartz about the value of building a relationship with those observed, especially in the case of children, because this continues throughout the research process. Schwartz and Schwartz [1955] added that the role of participant observation may be formal or informal, and based on spending varying amounts of time in the research situation; it may be integral to or largely part of the social structure. Alder and Alder [1987: 8] argued that researchers should assume social roles that fit into the world they are studying. Li [2008] argued with this assertion, adding that researchers should also immerse themselves in the culture they are studying to experience what they experience. Becker [1986: 232] and Jorgensen [1989: 19] added that participant observation involves a detailed description of a phenomenon in terms of the research problem. All the researchers discussed above view observation as a primary method of collecting data, but that action can also be recorded by audio recording, photography, video and documents.

Bryman [2008] and Gans [1968] identified three roles of participant observers: total participant, one who is completely involved in the situation and resumes the research stance once the situation has unfolded; researcher-participant, whereby the researcher participates in the situation but is only semi-involved, so the researcher can function fully as a researcher in the situation; and total research, which entails observation without involvement in the situation.

For this research, I spent the whole academic day for a whole academic year with the children, playing with them and teaching them as an assistant teacher. During the day when involved with the children, I was able to observe their play and interaction. When watching the video recordings and listening to the children's audio recordings, I observed their play and interaction, transcribed everything and presented it to the T1 and T2, requesting their comments.

5-3-3 Case Study and Theory

Yin [1994] defined case study as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence" (p. 13). Creswell [1994] defined case study as the researcher exploring "a single entity or phenomenon bound by time and activity … 'and collecting detailed information by using "a variety of data collection procedures during a sustained period of time' [Creswell, 1994: 12]. Kolb [1984] showed that case study is 'a meaningful design' for measuring experiential programmes.

Stake [1995] and Yin [1994] divided case study research into different areas. Yin [1994] identified three types of case study, namely:

- Exploratory case study - an intuitive investigation that may lead to defining further research questions;
- Descriptive case study - a complete description of a phenomenon in its context;
- Explanatory case study – aiming to explain cause and effect relationships.

Stake [1995] also identified three types of case study in social research:

- Intrinsic case study, in which every case is viewed in a unique way, and which generates interest not because the case is representative of other cases nor because it highlights a particular issue, but because, in Stake's words, "in all its particularity and ordinariness, this case is itself of interest" [Stake, 1994: 237];
- Instrumental case study, in which the case is chosen to help the researcher to investigate the meaning of particular phenomena;
- Collective case study, when a group of cases is studied to look into either general or specific phenomena.

This study is an exploratory case study, which is one of the types identified by Yin. The research seeks to discover in what ways five-year old children are able to play with sensorial materials in divergent ways to demonstrate their creative problem solving skills during interaction with adults or friends or by themselves; alternatively, there might be no effect on creative problem solving skills.

This research used a longitudinal element of the ethnographic case study approach to gain an in-depth understanding of when and how children play with the activities and develop their creativity; and triangulation was also used. Working with the children for a full academic year, and using multiple methods of collecting qualitative and quantitative data should help the researcher to understand children's interaction with materials and how their social interaction might affect their creativity in solving their own problem creatively playing with the Montessori sensorial materials.

The strength of the triangulation methodology lies in the fact that it allows for flexibility and attainment of a deeper, more valid understanding of cases than could be achieved through a single approach [Carr, 1994]. I spent one academic year in the pre-school using different data collection tools, such as daily observation, video and audio records.

5-3-3-1 The Teacher's Role during their Interaction with Children

Teachers interacted with children in both groups. The teacher's role is to present the MSM to children in the same way that Montessori presented them and to ask the children to find other ways to use the materials. In C-M-I, T2 restricted her interaction with the sample children. If a child asked for assistance, the T2 recommended them to ask for help from their friends.

In the C-T-I group, T1 left the children to use the materials by themselves first. The role of teachers in SLC was to let the child try by themselves then support them in their play [Samadi and Marwa, 2005]. When T1 observed that the child kept repeating the same solution then T1 interacted with him asking "in what other ways can we use the material" to let the child to predict in what way he can use to the materials to develop the play itself, and to develop their own skills in discovering new ways to play with MSM and find new creative solutions [Vygotsky, 1978 and Rogoff, 1990, Wood, 2004].

If the child did not have another contribution to play with the MSM differently, the T1 would then suggest verbally for the child to add the material differently from the way he is used or show the child how to add materials. If the child asked for help after that and told the T1 that he could not understand the new challenge then T1 guided the child by showing him several steps then asked the child to participate to complete with her the solution. Once the children began their different solution (in a group or individually), the T1 occasionally served as mediator by encouraging their steps for using the material in the process of solving the problem by making a suggestion to combine materials together or by asking the name of their creative solution. Teachers did not always guide the children to find creative solutions but leave the children first to try by themselves. The balance of responsibility between teachers and children in finding and remembering creative solutions changed from episode to episode and from material to material [Baker-Sennett, Matusov and rogoff., 1993 and Rogoff, 1995].

5-4 The Internal Validity of the Research

Validity can be enhanced by multiple methodological approaches along with triangulation. Assumptions behind triangulation rest on the premise that weaknesses in one method can be counterbalanced by strength in another [Cunningham, 1997]. According to Merriam [1998: p 204-205], internal validity is enhanced by the use of six basic strategies, which include triangulation, member checks that require data to be returned to the people from whom they were derived, long-term observation of the same phenomena and peer examination, where colleagues are asked to comment on findings in participative or collaborative modes of research in all phases of the research. The transcription of the video data to the observation sheet was adopted from Sylva *et al.'s* [1980] method (see Appendix.5.6). In week six, Teacher 1 and Teacher 2 chose one day's transcription of one of their classes in Week one to check with the video and give their opinions on it – whether I had described the children's play and every activity appropriately. The teachers confirmed that the transcription was accurate.

According to Goetz and LeCompte [1984] and LeCompte *et al.* [1992], when ethnographic researchers spend long periods of time in the field to understand the participants, their views, and their situation, and are involved in the lives of those being studied, the internal validity of the research is judged to be strong. They add that internal validity in ethnography refers to "science observations and measurements are authentic representations of some reality" (p. 210).

According to Brog and Gall [1983], the internal validity of an experiment is the extent to which extraneous variables have been controlled by the researcher. If extraneous variables or threats are not controlled in the experiment, we cannot know whether the changes observed in the experimental group are due to the experimental treatment or to the threats. While the experimental treatment is in progress, if the threats are ignored, then they occur concomitantly with the treatment and they become confounded by it. Campbell and Stanley [1963] suggest eight threats to internal validity and Cook and Campbell [1979] develop this model by adding another four threats [Robson, 2002]. I, as a researcher, tried to address the experimental threats in order to have high internal validity for this research in Table 5-2, and ignored none of them (see Appendix 5.7 for more exploration of the threats and how to control them).

Table 5.2 Experimental Threats to Internal Validity

Threat	Author's explanation	Eliminated of the threat in the present study
1- History	The experiment was over an extended period of time, thus enabling further events to occur in addition to those originally intended [Robson, 2002].	The control and experimental groups had the same head teacher in the same school but different class teachers. However, other events might occur in the homes of the children, over which the research would have had no control.
***2*- Maturation**	There is a physical development in participants unrelated to the treatment[Robson, 2002; Wallen and Fraenkel, 2001].	Children experience physical developmental changes similar to those in the experimental group. Both groups would develop new abilities.
3- Instrumentation	Certain methods can differ between the pre-test and post-tests [Robson, 2002].	Having all the sample pre and post-tested using the same instrument, in particular BAS-II.
4- Testing	If the pre-test and the post-test are similar, participants may show an improvement because of their experience with the pre-test [Campbell and Stanley, 1963; Cohen *et al*., 2007; Robson, 2002].	Brog and Gall [1983] argue that, if there is a long period of time between pre- and post-tests, it is unlikely for an extraneous variable to operate. The current research had a full academic year between pre-post test.
5- Regression	The participants are selected because they are unusual or atypical [Mertens, 1998].	The research eliminated children who had a significantly higher or lower score in the British Abilities Scales BAS-II from the research sample.
6- Mortality	This term is used to indicate participants who drop out of	No child dropped out.

	the research group [Mertens, 1998; Cohen and Manion, 1994].	
7- Selection	There may be preliminary differences between the control and experimental groups before involvement in the study [Robson, 2002].	Matched pairs were used, one child of each pair being in the control group and the other in the experimental group for the reason of the experimental design of this research.
8- Selection by maturation interaction	This threat of validity (maturation) is the differential characteristic that causes the group to differ [Cook and Campbell, 1979].	Matched pairs were used to eliminate the effect of this threat.
9- Experimental treatment diffusion	The control group may learn about independent variables and might use some of the experimental group's ideas themselves [Robson, 2002].	Observation in the ethnographic approach (use of video in the experimental and control groups) help to avoid movement and diffusion of the treatment to the control classroom. In addition, with support from the head teacher, all four teachers had different break times and the researcher explicitly told members of each group not to talk with each other about the experiment while it was in progress.
10- Compensatory rivalry by the control group (t*he effect of participants themselves*)	Some children in the control group may try extra hard to prove that their way of doing things is the superlative and thus affect the result [Malone and Mastropier, 1992].	All control group children were in a different classroom from the experimental group.
11- Compensatory equalization of treatment:	Participants in the control group would become disgruntled if they thought that the experimental group were receiving extra resources.	All classrooms contained the same materials, apart from the experimental classrooms. Thus, the teacher's collaboration with the researcher controlled this threat.
12- Resent and demoralization among the control group	*The* control group feels demoralized because they are not part of the chosen group. This might affect their performance.	In this research, children did not know in this study that they were part of the control group, due to the procedures described previously.

5-5 Generalisability and External Validity

The term generalisability is used in quantitative research to refer to sampling and random sampling statistical procedures [Neuman, 2006 and Robson, 2002]. Campbell and Stanley [1963: 175] said that external validity asks generalisability questions about populations, settings, treatment variables, and measurement variables. The emphasis in quantitative research has mainly been on populations (large samples). However, according to Hinton [1987], Carr [1994] and Cohen *et al.* [2000], the strength of this qualitative approach is seen when the sample is well-defined and can then be generalised to the large population. Generalisability of qualitative or interpretive research is disregarded, because of the "widely shared view that it is unimportant, unachievable or both" [Schofield, 1993:92].

'Generalisability' needs to be redefined for qualitative research, according to Simons. She questioned whether the term should assume a polarity or stem from 'a particular view of research' [Simons, 1996: 225]. The objective of case study is to understand the particular phenomenon within a particular context rather than to generalize [Merriam, 1998]. Instead of statistical generalization, Yin [1994] proposed that the aim of a case study is to develop analytical generalisability, by comparing the particular case against theory [Yin, 2003; 1994]. Although generalisation can be limited in a case study, Stake [1995: 2] maintained that 'the case is an integrated system', and produces valid modification and 'naturalistic generalization'.

Furthermore, it has been argued that case study offers the possibility of 'naturalistic generalization' by using tacit knowledge of situations to judge if they are similar [Stake, 1978]. Stake put forward the idea of 'naturalistic generalization' and associated it with narrative case study. Stake said, ''case studies will often be the preferred method of research because they may be epistemologically in harmony with the reader's experience and thus to that person *a natural basis for generalization*'' [Stake, 1978: 5]. Stake added [1995] that case studies can modify generalisation either by producing counter-arguments that recognise difference and result in the refinement of a generalisation, or by producing a positive example, thus heightening confidence in the generalisation. He said [1995: 8], ''we do not choose case study designs to optimise production of generalizations. More traditional comparative and correlation studies do this better, but valid modification of generalization can occur in case study''. Elliott [1990: 59] makes a similar point. He states, ''I would certainly want to argue that 'experiential' case studies, employing a symbolic and holistic mode of description, can be externally valid. And I claim that here validity rests on their usefulness as projective models for others in exploring their own unique situation''.

Another kind of external validity was described by Bracht and Glass [1968], namely the concept of population validity based on sampling strategies. They called it ecological validity, which looks into the degree by which the result of an experiment can be generalised from one type of environment to another. Mertens [1998], Brog and Gall [1983] and Cohen *et al.* [2000] describe the ecological validity that Bracht and Glass described. This research has tried to address the experimental threats in Table 5.3 in order to achieve high external validity for this research (see Appendix 5.8).

Table 5.3 Experimental Threats to External Validity

Threat	**Author's Explanation**	**Eliminated of the Threat**
1 - *Explicit description of experimental treatment*	It is important to describe the experimental treatment in coherent detail in order for other researchers to replicate it [Brog and Gall, 1985].	All materials used in this research explained in Appendix 1.2
2- *Multiple treatment interference*	When participants receive more than one treatment, it is not possible to say which of the treatments is bringing the results.	This research used only the Montessori sensorial materials.
3- The *Hawthorne effect*	It is occur when participants speculate that the study may result in a change in their performance [Brog and Gall, 1983, Robson, 2002].	Montessori sensorial materials were introduced to children in the same manner that other materials of the classroom were introduced to them,
4-*Novelty and disruption effect*	A new treatment may produce positive results simply because it is new.	The materials were already in the classroom when the children arrived in the first day of the academic year at pre-school.
5- *Experimenter effect*	The effectiveness of a treatment may depend on the specific individual who administers it.	T1 and T2 presented the MSM in the same time they presented other materials of the classroom.
6- 7 *Pre-test and Post-test sensitisation*	The pre-test may act as part of the experimental treatment or dependent upon giving a	It might be claimed that the pre-test using the BAS-II affected the participants'

	pre-test and affect research results [Cohen *et al.*, 2007].	performance on the post-test because the children had had this test before. However, the length of time between the tests was one academic year, which might reduce the effect. Also, this threat can be controlled by comparing with a control group [Best and Kahn, 1998]. Also, all the experimental children brought something from the pre-test to the post-test.
8- *Interaction of history and treatment effects*	An experiment which takes place at a certain time with contextual factors cannot be repeated in another setting.	The MSM can be found in different schools where children play with them. It is not a unique situation that cannot be repeated by another researcher in a different setting and time.
9- *Measurement of the dependent variable*	The effectiveness of the research may depend on the type of measurement used in the study [Brog and Gall, 1983, Robson, 2002].	It eliminated when comparing experimental results with a control group, as this study did.
10- *Interaction of measurement time and treatment effects*	The timing of the administration of the post-test might influence the research results.	All groups had the pre- and post-BAS-II at the same time and results for the control group and the experimental group were compared. If the time administration had influenced the research results, it would have influenced all the groups, not just one.

Qualitative and quantitative researches are more useful when used conjointly [Gliner and Morgan, 2000]. Ethnographic data collection consists of fieldwork, in which multiple data sources are accessed, such as ethnographic interviews, video and audiotapes. Generalisability and objectivity are accomplished through triangulation, multiple instances of phenomena and multiple levels of analysis [Agar 1986, Kirk and Miller 1986, Hammersley, 1992 and Hammersley and Atkinson, 1994]. In an attempt to minimise the ten threats described above using triangulation, this study aimed to achieve generalisation in view of Anderson's term [1998] "lessons learned" way of and the findings of this study are linked to existing theories of young children.

5-6 Research and Reliability

The main purpose of an ethnographic approach is to produce a wealth of data, as Geertz [1973] mentions, which allows researchers to study and understand children's interaction. However, Hammersely [1992] argues that this approach focuses on the 'unscientific' nature of interpretive claims, and can be incompatible with realism. Hammersley [1992: 6] adds that 'the relevance of ethnography to practice is most likely to be general and indirect, rather than providing solutions to immediate practical problems'.

Drew, Hardman and Hart [1996] explained reliability more clearly, as follows:

> 'Reliability in qualitative designs has much the same general meaning as it does in quantitative designs: under similar circumstances, can the study be replicated with similar results? Are the results an accurate reflection or rendition of what actually occurred, of relationships, of observed interactions…?'

[Drew *et al.*, 1996: 168]

According to Cohen *et al.* [2000], reliability can be checked in quantitative research using a number of techniques, for example the test-retest method, where the same test is given twice to the same participants within a period of time and the two sets of results are compared. The present study uses two methods: the results from the pre-post- test of the BAS-II and observations during an element of ethnographic study.

5-7 Ethical Consultation

5-7-1 Ethics of Participant Observation

Fluehr-Lobban [1998], the American Anthropological Association [1998], the American Sociological Association (ASA) [1997] and Dewalt and Dewalt [2002] have all identified four ethical components of participant observation (PS). Firstly, that researchers should have adequate training before beginning a research project. Researchers should know how to enter a new setting, how to develop an effective field relationship, be attentive to the situation in question and know when to step back and how to leave the setting. The researcher has worked with children as a teacher and trained others to teach young children. She has also been trained in using the BAS-II with children.

Secondly, researchers should have the basic principle of developing an internalised sense of the meaning of the protection of human subjects, and have alternative strategies for addressing some of the more common ethical questions that arise in fieldwork. In addition, researchers should prepare themselves to anticipate different issues, both social and political, that might arise in the setting. This means that researchers need to review previous research and other materials available regarding similar situations. Confidentiality is most important when working with young children. When a child talks about his health problems or his family, it is important to protect this information and not present it in this research or to his teacher; if necessary the pupil's family will have to be informed.

Finally, participant observers should show respect for the people working with them. The basic principle that research needs to include is "respect the rights, dignity, and worth of all people" [ASA, 1997]. The researcher respected the children's rights by explaining the research purposes to them, even after permission was granted by their parents, so that they were aware of the research's identity. Participants in this research (teachers and children) should be aware that any of their interactions with me as a researcher may constitute form of data gathering. As a researcher, I did not present any information that would harm or endanger the children or their teachers. In addition, the participants' rights were respected when they did not want to be videoed or recorded. Most importantly, the transcript exactly reflects what happened in the classroom and was checked with the teachers participants to ensure the validity and reliability of the research data.

When social research involves direct contact with children, it is essential to deal with ethical issues. According to Christensen and Prout [2002], there are three ways to see children during research: the child as object, the child as subject and the child as social actor [Christensen, 1998; Christensen and James, 2000a]. Recent approaches also see children as participants and co-researchers [Alderson, 2000; Woodhead and Faulkner, 2000]. Some researchers have seen children as objects that are persons acted upon by others rather than as a subject acting in the world. This approach ignores the understanding of children as social human beings in their own right. Developing alongside is an approach acknowledging children as subjects and recognising that the children are people with subjectivity. The third approach sees children as subjective rather than objective, and that extends to seeing children as social actors with their own experiences and understandings. This approach observes the children in action, interaction, their changes and their effect on others in the social and cultural world in which they live [Corsare, 1997; Prout and James, 1990; Thorne, 1993]. Developing from the perception of children as social actors is the fourth approach that sees children as active participants in the research process, just as they are in their social life [Alderson, 2000; Thomas and O'Kane, 1998].

Christensen and Prout [2002] argued that the understanding of children as social actors and participants is based on a more appropriate assumption of what they call 'ethical symmetry' between adults and children. They mean that at the start, there is an ethical relationship between the researcher and the child, and the information is treated in the same way, whether the subject is adult or child. The researcher allows a child the same ethical consideration as an adult.

In this thesis, I see children as subjective beings with their own experiences and rights, following the same ethical principle that children have the same rights as adults. I should obtain the children's agreement to be volunteers in the research, after obtaining the parents' permission. In the case of a child who refuses to be a volunteer, even when the parent has approved, I as researcher respect that; and after further discussion with the parent I would exclude the child from the research sample if necessary.

5-7-2 Issues in Research with Young Children

There are ethical concerns with pre-school children. Hood, Kelley and Mayall [1996] found that 'we could not approach children directly; their socio-political positioning means that adults must give permission. In considering access to children, adults give priority to their adult duty to protect children from outsiders; this took precedence over children's right to participate in the decision to talk with us' [Hood *et al.*, 1996: 126]. Children's parents are the gatekeepers; they can present barriers to conducting research involving children, to protect them from outsiders.

Researchers in University of Southampton must have ethical approval before they start their empirical research. I completed ethical protocol requirement forms to obtain permission from the University to conduct my research.

In order to obtain admission to schools, it was essential to obtain permission from the General Administration of Pre-school (GAP) as a first step in the process of ethical consultation. In Saudi Arabia, this is the first step to doing research in schools. Researchers have to present all research materials, and all forms of agreement related to their research to the Ministry of Education, of which the GAP is a part. I participated in meetings at which I thoroughly discussed the different considerations and requirements of the research from the point of view of parents, teachers and children. No school allows researchers to contact parents until the school sees the GAP permission. The Minister of Education is the gatekeeper that helped me to contact all the participants. The GAP sent the permission letter to the school asking for assistance for the researcher whilst conducting her research.

As the study was about to commence, the school sent a copy of the GAP permission to the children's parents. I also sent a letter to all parents to acquire their permission for their children to be involved in taking the BAS-II (see Appendix 5.3). It allowed them the right to exclude their children from the research. All parents agreed to allow their children to participate in the research. However, one boy did not want to participate in the research despite his parents' permission so I as a researcher respected his rights, excluded him from the research, before the matched pairs were selected, and I also advised the parents of their child's decision.

After identifying the sample, another letter was sent to parents whose children were involved in the study. This letter was to confirm their agreement and to ask them to explain the research aims to their children. In this letter, I explained that the children would be videoed and recorded for an approximately 60 minute period during the day (children arrive at school at 7:15 am and leave at 1:30 pm). I asked parents to inform me and staff of the children's responses by letter. In addition, it is part of the ethical process of consultation to emphasise teachers', parents' and children's rights to withdraw from the study at any time. The parents of the sample children agreed to their children being recorded on video and audio equipment, and none of the children dropped out of the research. All children also remained anonymous by changing their names and cover their faces in pictures.

Furthermore, an information letter was sent to parents of children in the setting who were not part of the study. As other children move around the pre-school, it is possible that they may appear on the recorded materials. I also had to ask parents' permission to include their children in the data that I collected to protect their rights concerning being involved in this data. All parents agreed to their children appearing on the video. In addition, I sat with the children and explained to them how they could help me when I observed them playing with others, and I also asked for their permission to do that and they approved.

After these steps, I visited the pre-school and had a meeting with its head teacher, to outline the aims and scope of the research including the criteria for the selection of case-study children. The head teacher explained the aims of the research to her teachers and told them they would be video recorded. All teachers agreed to volunteer as long as they were not video recorded, apart from two teachers who agreed to be videoed, but with their faces covered for religious and cultural reasons. These two teachers were given descriptions of the research. Teachers were advised to cover their faces for the purpose of video or other images in the thesis. If not, I ensure that the teachers' faces were obscured electronically.

Another process in the ethical consultation has some clear child parameters. Because of the children's young age and limited experience of what they were agreeing to, permission must be obtained with careful negotiation. I had to explain what I was planning to do (I explained to them that they were to play with the MSM, that I wanted to observe how they solved problems and that they were helping me to do my research if they allowed me to observe them), and asked them if they minded being video recorded or recorded in conversation during their play. If the children were uncomfortable, distracted by the equipment or if they had had enough of wearing the audio recorder, I would immediately stop observing them. The children were very clear in conveying their wishes. In addition, the children were given the opportunity to review, to play with the equipment and to talk about the videoed material. They were also provided with a copy of their video recorded sessions.

Flewitt [2003] described researchers' responsibilities and the issue of confidentiality to protect children. Flewitt [2003] said that

> 'Decisions about when to stop observing participants, or about when not to transcribe data relate not only to my own personal understandings of privacy and respect, but also reflect my epistemological stance. Epistemological beliefs about *what* can be known are linked to ontological beliefs about *what exists* and to ethical beliefs about *how* the researcher can find out what can be known and *what the researcher should do* with what is divulged.'
>
> [Flewitt, 2003: 139]

As a researcher, I respect the children's and teachers' involvement in this research. A meaningful relationship is built up and the researcher cannot walk away from it.

5-7-2-1 Ethics of the Interaction between Adult and Young Children in a Research Setting

Children's lives have sometimes been explored solely through the views and understanding of adults who claim to speak for children. Researching with children raises a number of ethical issues to do with consent, access, privacy and confidentiality. One difficulty researchers face is negotiating privacy, whether in the school or at home. Obtaining a separate space away from the classroom can be a sensitive issue [Holland *et al.*, 1996; Mauthner, 1997]. These researchers argue that this issue is sensitive because adults who see themselves as 'protecting' children may feel that children do not have any personal rights at all, or else fail to consider the children's need for a private space for an interview. Negotiating interview privacy is a delicate matter in child research. One reason is the need for exclusion of other members for a range of reasons, which the family or teacher may not wish to confront directly [Daly, 1992; Mauthner, 1997], making it easier to ensure privacy on the basis of noise or potential interruptions. Children in this research sat privately with the researcher when applying the BAS test only. The room is a part of the school and the head teacher allowed the researcher to use this room. Anyone was free to enter the room at any time.

Christensen and James [2000] argued that reflexivity is necessary in research with children. The children reflect upon their experiences, practices and involvement in the research in their everyday lives at school. In this way, Christensen and James argued that children appear as respondents and actively interpret and shape the research process. They also argued that forming relationships with children throughout the research process is important in order to maintain a continuing dialogue over which the children feel they have control.

O'Kane [2000] argued that the research should offer children a way to reflect and comment on their involvement in the research process and decisions.
Christensen [2004] argued that children should be free to introduce their own themes and conclude an interview on their own terms. Children should be free to decide when the interview should stop and sometimes the researcher could

suggest finishing the interview when the child is beginning to feel 'fed up' or tired. The children in this research shared their experience with the researcher every day. They had experiences with the video, digital photo and types during play periods, even whilst eating. Their freedom was respected by stopping the videoing whenever the teachers, or the researcher, felt they do not want to be recorded or observed. As an author the researcher included the children's experiences in the research account so as to provide rich data for answering the research questions and sharing the output of this research.
The British Psychological Society (BPS) [1991] and Christensen [2004] emphasised that children's rights take priority over the interests of the research and that it is important to inform children about features of the research that might affect their health. This research did not have any effect on the children's health.

One serious ethical problem is the risk of published research reports leading to disadvantages for the whole group of children [Fraser et al., 2004]. Ethical reviews can help researchers to be aware of this risk and learn how to deal with it. Ethics is about helping researchers to be more aware of these problems and questions in research and encouraging them to consider how they might deal with them. This research has been presented without harming any of the children; by changing their names, covering their faces in the pictures and giving them complete anonymity.

5-8 Research Design

For the first research question, after the BAS pre-test, the children were divided into two matched groups (control and experimental). The experimental group was further divided into two sub-groups: one with the materials and interaction with an adult (first case study) and the second experimental group with the materials without interaction with an adult (the second case study). Girls and boys were involved in equal number. The matched pair technique helped me to compare child development in problem solving before and after the experiment.

5-8-1 Materials Presentation

The second step in the research design was to present the Montessori sensorial materials to children using the Montessori Method. The teachers presented 25 MSM to the children over a period of 22 weeks (Table 5.4: The Weekly Schedule of MSM).

The Montessori Sensorial materials (MSM) were introduced to children weekly. To understand the children's interaction with materials in depth, I needed to observe them daily as part of an ethnographic approach. I needed to experience the same events as them and to observe their development in creative problem solving skills during play with the MSM.

Table 5.4: The Weekly Schedule of Montessori Sensorial Materials

Week	Montessori Sensorial Materials
Week1	Cylinders decreasing in diameter (B1) - Pink Tower (PT)
Week2	Cylinders decreasing in height only (B3) - Brown Stairs (BS)
Week3	Cylinders decreasing in diameter and height (B2)
Week4	Cylinders decreasing in diameter and increasing in height (B4) - Red Road (RR)
Week 5	Colour Tablet Box2 (COL2) - Red Knobless Cylinders (RC)
Week6	Colour Tablet Box3 (COL3) - Blue Knobless Cylinders (BC) - Yellow Knobless Cylinders (YC)
Week7	Green Knobless Cylinders (GC)
Week8	Triangular Box 1 (TB1)
Week9	Large Hexagonal Box 2 (TB2)
Week 10	Small Hexagonal Box 3 (TB3)
Week11	Geometric solid Solid with Cards (GS) - Six Circle Drawer with Cards (CIR-D)
Week12	Six Rectangle Drawer with Cards (REC-D) - Rectangular Box
Week13	(TB4)
	Six Triangle Drawer with Cards (TRE-D) - Rectangular Blue
Week14	Box 1 (TB5)
Week 1 5	Four Curvilinear Drawings and Cards (OVAL-D)
Week 16	Six Regular Polygon Drawer with Cards (6REG-D)
Week 17	Four Quadrilaterals Drawer with Cards (4 QU-D)
Week 18	DRAWING PAPER
Week 19	All materials
Week 20	All materials
Week 21	All materials
Week 22	All materials
	All materials
	See Appendix 5.9: A Brief Description of the MSM

The teachers and I reviewed the Montessori Method [see Montessori, 1965] of presenting the materials to children in a separate room. T1 and T2 presented the MSM in the morning circle (the morning circle is an assembly point where the children gather at the start of the day), and children began to play with the materials during free play time. The morning-circle and free-play-time schedule of T1 differed from that of T2, which helped the researcher to observe and video record both classes. The teachers started to introduce the Montessori sensorial materials to the experimental groups after the matched pairs had settled down (see section 5-8-3) and started to video and record the children's interaction with their friends, teachers and the researcher, to observe how they played with MSM in different ways. In addition, the researcher observed T3 and T4’s classrooms once weekly and video recorded the control group children on three different occasions to make sure that they did not play with Montessori sensorial materials.

In this research, children were recorded daily at free play time in both experimental groups. I video recorded them during their play with Montessori sensorial materials during the two academic semesters (Saudi Arabia has two academic semesters). By the end of the second semester, the sample took the BAS-II as a post-test to compare their development at general problem solving. The qualitative data collection (ethnographic study) helped the researcher to discover differences in creativity between the experimental children and helped to answer the second research question.

5-8-2 Data Collection Methods in Relation to the Second Research Question

Triangulation methods were used in this research, namely observation, multiple data sources (video, recording, audio, photography and field notes), interviews and informal discussion. Different sources were drawn on (children, parents and teachers) to enhance validity and reliability.

Table 5.5: Research questions with related data collection methods

Research Question	*Source of data*	*Methods*	*Quantity*	*Purpose*
2- How does interaction between children and their teachers during play with the MSM impact on children creative problem solving approach compared to those who do not receive support from their teachers?	Teachers and children	Audio, Video Recording, field notes, interviews and informal discussion	22 weeks	To find evidence to answer the research question about whether MSM help to improve children's creative problem solving and the effect of social interaction on children's solutions.
a. What are the differences or similarities in children's methods of solving their own problems creatively playing with the Montessori Sensorial materials between children who do, and do not, receive support from adults?	Children	Audio, video recording, field notes, interviews and informal discussion	22 weeks	To find evidence to support the research state that MSM help to improve children's creative problem solving.
b.What is the difference or similarity between the two experimental groups in the three creativity skills?	Children	Audio, video recording, field notes, interviews and informal discussion	22 weeks	To find evidence to support the research state that MSM help to improve children's creative problem solving.

5-8-2-1 Video Recording

During the pilot study in summer 2006 and in the first week of research, I experimented with a compact digital video camera (Canon-PAL-MV750i). I needed a convenient size camera, giving reasonable sound and image quality, manoeuvrability and a side opening monitor allowing the researcher freedom of movement. The teachers suggested a number of places to fix the camera. The children moved around, so the camera should not obstruct them in any way (see Appendix 5-10).

The camera was part of the classroom from the first day of school. The children had questions about the camera and both the teachers and I answered their questions and explained to them that the researcher needed their help to video them during their playing time at the centres in order to learn about their interaction and how they played with the Montessori sensorial materials. The children got excited, but by the second week of the experiment they had familiarised themselves with it as part of their classroom materials, so it was treated with less awareness. All the sessions were recorded with the Canon camera on the Sony tripod. It was always placed next to the Toy-table shelf during the academic year. Usually the researcher turned the camera on and left it to video the target children. However, when the target children moved to another place, the researcher moved the head of the standard to video them or moved the camera closer to them.

A second camera, a Sony DCR-HC26E, was used, with a second Sony tripod from the fifth week of the experiment. This was because by then nine Montessori sensorial materials had been administered to the children, in three different places and using one camera would have resulted in some data loss.

Despite the high audio quality on the video recording, ambient sound made the children's voices inaudible, so it was deemed necessary to make separate audio recordings.

5-8-2-2 Audio Recording

I used an MP3 player to record the children's voices from the first week and when applying the BAS and finding the matched pairs. I used two types of MP3 player. The MP3s were fastened by neck straps and worn by the target children. In the first two weeks, I had four MP3 players - two for girls and two for boys. However, sometimes all six target children played with the MSM at the same time and this required more than two MP3 players. So I obtained two more Logical grey MP3 players. Thus there were six MP3 players used in total.

However, in spite of this, not all of the children’s conversation was distinct on the audio recordings, partly due to the children's low voices or unclear speech, as well as ambient noise. So I put the Sony ICD-P320 recorder on the Toy-table centre or where the target children played in order to enhance clarity (see Appendix 5-10). On a daily basis, the researcher downloaded the children's recordings onto a computer and put every child's voice in a separate folder. However, if the child talked with other children, the researcher saved it on the computer as a separate entry under the child's name, the day, and the other children's names.

In addition, written notes on the children's conversations and speech were sometimes also entered in the Field Notes.

5-8-2-3 Digital Camera

The cameras recorded the children's interactions as they played in just two of the locations. I used a digital camera to cover the third area instead of an additional video camera for two reasons. Firstly, three cameras in one classroom might have distracted the children too much from their play. Secondly, purchasing a third camera would have been difficult in terms of budget. I used a Sony DSC-W50 digital camera. The Sony camera can capture 240 pictures in just one session (see Appendix 5-10).

I took pictures of all the children at the beginning, and not just of the target children, because all the children wanted pictures taken. However, by the third day of using the Sony camera, the children became familiar with it. The pictures were the third data collection resource.

5-8-2-4 Field Notes

During the pilot study, I experimented with two methods of taking field notes, using standard observation [Sylva *et al.*, 1980] and also using unstructured notes. The observational sheet was designed to record each child's interactions every minute for 10 + minutes (see Appendix 5.6). During the first week, I played with the children and kept the Field Notes close on the shelf. I put my notes into simple words. After the play session had ended, I completed the full description of the children's play. Furthermore, unstructured notes allowed me more flexibility in adding details related to the children's play and interaction and in noting activities outside the range of the video lens, also recording the teachers' comments during play.

The video time code was written next to each field note, both of them coded thus: W1, meaning week 1 of the experiment; day (Saturday); date (28-04-07); H or R (Teacher 1 or Teacher 2, experimental groups); 0001, meaning from the first camera, i.e. Canon or 0002, meaning from the Sony camera. For example: W1, Saturday, 28-04-07, R -0001.

The video and field note codes were an invaluable reference during the transcription and analysis, clearly showing my reflections and other thoughts pertaining to the data.

5-8-2-5 Interviews with Teachers

Patton [2002: 320] defines interviews as a supplement to observation, as researchers cannot observe all events or how people have been organised, and so researchers have to ask questions about these matters.

O'Leary [2004: 162] defined interviews as a method of asking open-ended questions which, in Glesne and Peshkin's [1992] words, means:

> 'The process of getting words to fly… you want your… questions to stimulate verbal flights from the important others who know what you do not. From these flights come the information you transmute into data.'
>
> [Glesne and Peshkin, 1992: 63]

Flewitt [2003] says that the interviewer is the "author of questions and instigator of the interview", who has "unquestionable authority" and can gain access... to the interviewee's "knowledge and perceptions". Interviewees may be "intimidated by the interview process, and tailor their answers to their perceptions of 'correct' answers" rather than having the confidence to express their opinions [Flewitt, 2003:109-110].

The interviews stimulated exchanges of experiences between the researcher and the teachers. They also offered the teachers the opportunity to reflect upon children's improvement in problem solving. Interviews were used to gain background information about the teachers' views on the children's interaction with the Montessori sensorial materials (MSM). The interviews also aimed to check the teachers' views on how the children improved and developed their problem solving creatively from using the MSM in different ways. In addition, the interviews with the teachers confirmed the order in which the MSM had been introduced, what was used from the children and children's interactions with MSM with their teacher or alone (see Appendix 5.11). I interviewed the teachers regularly throughout the research and recorded the interviews. Conversations were held with members of staff and their comments were written as field notes, including comments on every child's improvement and their opinions of MSM.

The interviewer should choose the questions carefully and put them in a rational order. Furthermore, the interviewer must be able to adapt to the interviewee's needs and responses to accomplish the research aims. In this case, I used both semi-structured interviews and unstructured conversation. According to Robson [2002], the semi-structured interview has predetermined questions, but the order can be modified according to the interviewer's perception of what seems most appropriate. Face to face interviews allow specific lines of questioning, resulting in interesting responses that would not have been possible in postal questionnaires.

5-8-3 Preamble to the Application of this Research

As discussed in section 2-4, the quality of the learning environment may have an effect on children's development, so it is essential to assess the learning environment as a first step.

5-8-3-1 Identifying and Assessing the Learning Environment

According to Moss, Dahlberg and Pence [2003], a process of interaction of a certain quality occurs in the learning environment. A question arises as to whether the environment affects the development of problem-solving skills.

The National Institute for Early Education Research pre-school programme [Espinosa, 2002] can be rated on two elements of quality: process and structure. Process quality measures interaction, activities, learning opportunities and health and safety. It is typically measured by observing children’s experiences in the classroom areas, teacher-child interaction, type of instruction, room environment, materials and relations with parents. In addition, I define the quality in early childhood programmes [based on other researchers’ definitions presented in section 2-4], in terms of capability to develop children's abilities in a prepared environment with a capable teacher, in order to achieve the goal of readiness for school. Based on the literature, it seems that a high quality learning environment can have positive effects on cognitive and language performance and other aspects of a child’s development.

The General Administration of Pre-school (GAP) in Saudi Arabia had recommended eight high quality pre-schools for the research. I randomly chose one school and went to it and took the first step in applying this research: I measured the quality of the school I chose via the Early Childhood Environment Rating Scale-Revised (ECERS-R). A Masters student applied the ECERS-R with my assistance (the Masters student had applied ECERS-R in her own research). The Masters student and I observed the school’s environment in the four different classrooms. It took ten hours during the first week of the academic year (2006-07) to measure classroom quality and three different meetings in the second week to complete the ECERS-R and ensure that the school had a high quality setting.

5-8-3-2 The Early Childhood Environment Rating Scale-Revised

The original ECERS [Harms and Clifford] was published in 1980. It contained seven subscales and 37 items. The revised ECERS [Harms, Clifford and Cryer, 1998] also contained seven sub-scales with 43 total observational instrument items. Each item is rated from 1 (inadequate) to 7 (excellent) based on indicators, which are descriptions of quality listed below the 1, 3, 5, and 7 ratings. The seven sub-scales are: Space and Furnishings (8 items); Personal Care Routines (6 items); Language Reasoning (4 items); Activities

(10 items); Interaction (5 items); Programme Structure (4 items); and Parents and Staff (6 items). Subscale scores are created by averaging across each of the items within a subscale, and the overall score is created by taking an average of all the items. I chose the ECERS-R scale because it had been applied in Saudi Arabia by another researcher, who agreed with its suitability [Al- Ameel, 2002].

The measurement employed was the observational rating scale ECERS-R [Sylva, Siraj-Blatchford and Taggert, 1998]. The ratings are based on a minimum 3-hour observation in one classroom and a short interview to establish a number of ECERS-R factors. The mean total score on the ECERS-R was 5.37 (S.D= 0.091). The ECERS-R means score was in the "very good" range (these ranges were given in the ECERS-R test). Table 5.6 presents the mean total and sub-scale scores.

Table 5.6: Mean total and subscales on ECERS-R

ECERS-R	Mean	S.D.
1- Space and Furnishing	5.36	0.244
2- Personal Care Routines	5.55	0,298
3- Language and Reasoning	5.45	0.181
4- Activities	5.37	0.372
5- Interaction	5.32	0,241
6- Program Structure	5.39	0.105
7- Parents and Staff	5.13	0.142
Total	5.37	0.091

5-9 Strengths and Limitation of the Research

This sample in this research is limited to one pre-school because of the research design and the Montessori sensorial materials. Random sampling was not an option because of the matched pairs method employed to collect the research data. The Montessori sensorial materials were in two classrooms and each classroom has one copy of each material.

In addition, the study related to a small sample of children in one pre-school setting. As Hallam, Ireson and Davies [2004] argued, there are limitations to the conclusions with all case study research that can be drawn from the findings. However, the study provides an up to date case study of one the most common forms of education setting in Saudi Arabia. The MSM was not an unusual or novel material, and the classrooms were typical classrooms, which can be found in other schools. With the small sample, the study provides in depth analysis of children's process of creative problem solving with or without social interaction. The strength of this study lies in the level of analysis associated with a representation of children's processes of creative problem solving and the influence of social interaction with Montessori sensorial materials. The study's value lies in the way in which it into question and resonates with other research, builds upon previous conclusions of others and adds to the dynamic body of knowledge (as referred to throughout the body of thesis) [Adams, Alexander, Drummond and Moyles.,2004; Aubrey, 2004; Flewitt, 2003; Payler, 2005; Siraj-Blatchford, Sylva, Muttock, Gilden, and Bell, 2002].

The use of a specific material is another important feature of the experimental method. Voutsina [2002] argued that manipulation of materials and the child's action upon them reveals to the researcher information about the child's thinking when verbal responses seem to be obscure; which is the case in this research. Children in this research manipulated the MSM without speaking unless the adult intervenes and prompts them. In designing situations that involve not only verbal questions, but also provide concrete materials to play with, the researcher, as Ackermann [1995: 346] argued, "…sets the stage in which the playing will take place. To do so, he or she designs an experiment, or microworld, that is both conceptually rich and meaningful to the child. It can be a puzzle, a mechanical gadget, or a computer-based game". The freedom that this gives the researcher is the opportunity to incorporate more activities; changing or adding materials constitutes one of the great advantages of this method. The children had freedom in combining materials or playing with the MSM with other materials in the classroom and this helped to assess children's creative problem solving.

It is worth mentioning in this research the problem with the video recording. It was difficult to video teachers in the classroom during their play with the children because of religious and cultural reasons. The two teachers and I took full responsibility for the video. Without videoing children in their setting, it would have been difficult to capture the children's development in their creative problem solving skills which is a tool in collection of qualitative data.

5-10 Summary

In this research, qualitative and quantitative methodologies were combined. According to Morse [1991], triangulation not only maximises the strength and minimises the weaknesses of each approach, but strengthens the research results and reflects more closely the process of the research "back and forth between inductive and deductive models of thinking" [Creswell, 1994: 178]. This study adopts a fixed design (an experimental strategy) followed by a flexible design (an element of ethnographic study).

Longitudinal experimental-element of ethnographic-case-study research provided this research with a detailed understanding of how 24 five year-olds' solve problems in different creative ways when playing with Montessori sensorial materials. The methodological approach offered flexibility but also involved spending considerable time with the children during the academic year. The children were observed daily during different phases of play with the MSM.

According to Stake [1994] the case study researcher usually gathers data according to the following factors: the nature of the case, its historical background, and the physical setting. The current research studied the children in their natural physical learning environment playing with educational materials including Montessori Sensorial Materials.

Qualitative methods were helpful in observing the children's interaction with the environment around them. In addition, according to Patton [1980],

> 'Qualitative data consist of detailed descriptions of situations, events, people, interaction, and observed behaviours; direct quotations from people about their experiences, attitudes, beliefs, and thoughts; and excerpts or entire passages from documents, correspondence, records, and case histories.'
>
> [Patton,1980: 68; cited in Merriam, 1988]

An element of ethnographic case study allows finer issues of the phenomena to be studied. In addition, experimental methods and sample criteria were selected to study the influences of MSM on children’s creative problem solving skills. Furthermore, I applied this study at a private school because no teachers in government schools wanted to be videoed, and it is difficult to get permission to video women in Saudi Arabia. Without the teachers' support and their volunteering to be filmed, this research would have been very difficult to undertake.

Chapter 6

Children's Performance on the British Ability Scale II

6-1 Introduction

The first research question in this study focuses on Does play with Montessori sensorial materials develop children's skills in solving problems? The research adapted the matched pairs quasi-experimental method to assess children's skills. This was to ensure that the influences occurred by the MSM, and not by other factors.

6-2 Procedures to Define the Research Sample

I as a researcher sent the questionnaire to the children's parents to check on date of birth, their social life, and whether they had played with Montessori materials before. The entire sample comprised children living with their parents. All parents answered "No" to the question about whether the children had previously played in or entered a Montessori school, or whether parents had had any experience or ideas about the MSM. Children with previous experience of MSM would have been excluded from the sample.

After matching for age and nationality, I as a researcher used the British Ability Scale II (BAS-II) to assess the children's general problem solving skills. All children were assessed at entry to the study, using four BAS-II subscales: Block Building (BB), Picture Similarities (PS), Pattern Construction (PC) and Copying (C) (see Appendix 5-1). The four sub-scales are non-verbal. 108 children were tested individually in a quiet room at pre-school, free from distractions. If a child was seen to become restless or disinterested, then the testing was stopped at that point and the remaining test was completed in a later session the same day. All the children were assessed over one session (35 minute duration), except one child, who was unable to complete the test in one session and completed it during a second session. The children showed a range of abilities in the four subscales.

It is difficult to find matched pairs of children by comparing scores on every BAS-II sub-scale. Several discussions were held about this issue with two professors who had used the BAS-II in their research at the University of Southampton, and it was agreed to find matched pairs by totalling the scores from all four sub-scales.

The BAS-II data for 108 children were used to find matched pairs and define the research sample. Children who had a higher score or lower score in the BAS-II were excluded from the research sample for reasons of internal and external research validity. Twenty-four children (12 boys, 12 girls, Mean = 5.12 years) were used as the research sample. The children were divided into two groups: the control group and the experimental group. The experimental group was divided into two sub-groups: Child-Teacher-Interaction (C-T-I, interaction with the teacher), and Child-Materials-Interaction (C-M-I, no interaction with teacher,).

The matched pairs of the Control Group-1 (CG1) and the C-T-I pre-test results for BAS-II in the four sub-scales are shown in Table 6.1 and the matched pairs of the Control Group-2 (CG2) and the C-M-I pre-test results are shown in Table 6. 2. As already stated, it was difficult to find matched pairs on every sub-scale, so the mean score for every child is used to match the pairs. For example, Sara from the experimental group C-T-I had a mean score of 112.25, which matched Tala from Control group 1. On the basis of these scores in Table 6.1 and 6.2, the children from the two groups (control and experimental) were not statistically different, and began from approximately the same level of problem solving. This enables me to compare their performance after the experimental groups had played with the MSM.

Table 6.1: C-T-I Matched pair performance in the four BAS-II sub-scales

Name	Experimental Group BAS-II C-T-I Pre-test				Total	Mean	Name	Control Group1 BAS-II Pre-test				Total	Mean
	BB	PS	PC	C				BB	PS	PC	C		
Sara	140	103	100	108	451	112.25	Tala	140	97	105	108	450	112.5
Lulu	131	88	76	115	410	102.5	Haifaa	131	85	83	93	392	98
Hala	123	79	90	108	400	100	Norah	131	82	83	105	401	100.25
Saud	123	97	79	105	401	100.25	Mageed	131	85	90	91	397	99.25
Shenafee	118	92	85	108	403	100.75	Tareeq	140	85	86	102	413	103.25
Nowaaf	123	92	81	88	384	96	Naif	123	85	87	105	400	100

BB= Block Building, PS= Picture Similarities, PC= Pattern Construction, C= Copying

Table 6.2: C-M-I Match pair performance at the four BAS-II sub-scales

Name	Experimental Group BAS-II C-M-I Pre-test				Total	Mean	Name	Control Group2 BAS-II Pre-test				Total	Mean
	BB	PS	PC	C				BB	PS	PC	C		
Soso	140	85	90	119	434	108.5	Balques	131	103	95	99	428	107
Teefa	131	85	83	93	392	98	Galleeh	131	88	81	83	383	95.75
Madawe	131	97	96	93	411	102.75	Hyff	153	92	88	93	426	106.5
Soluman	153	92	92	88	425	106.25	Azoz	140	92	103	96	431	107.75
Aziz	131	81	92	88	392	98	Naif.G	108	85	92	99	384	96
Oufee	123	85	87	105	400	100	Mo	153	85	88	102	428	107

BB= Block Building, PS= Picture Similarities, PC= Pattern Construction, C= Copying

The research matched the mean for every child in the experimental group with children from the CG1 and CG2 to define the research sample. The equivalence between the two groups (C-T-I and CG1) is shown in Table 6.3. The mean of BAS-II performance for the C-T-I group was 102.21 (SD = 5.66) and for the control group 1 the mean was 102.21 (SD = 5.33). They did not differ significantly (t-value = 0.05, p = 0.959), which means that the two groups were equivalent in the pre-test.

I used matched pairs to study the influences of Montessori Sensorial Materials on children's creative problem solving as opposed to any other factors (as discussed in Chapter 4). According to Howitt and Cramer [2005] and Einspruch [1998], the t-test is used to assess the statistical significance of the differences between the mean of two groups. Furthermore, the t-test is used if the researcher uses a matching procedure to match pairs of people with similar characteristics. Due to the small sample of children, Ansari, Donalan, Thoma, Ewing, Peen and Karmiloff-Smith [2003], Reed, Osborne and Corness [2007], and Quah [1998] used the BAS-II to assess children's cognitive level and used the t-test to analyse their data. Also, Sylva *et al.*

[2006] used the t-test with their quasi-experimental research to analyse children's performance using the BAS-II test.

Table 6.3: The equivalence between means of C-T-I and CG1

Tests	Group	N	Mean	Std. Deviation	T-Value	Sig.	Sig.
Block Building	Experimental C-T-I	6	126.33	7.89	1.52	0.159	No Sig.
	Control Group-1	6	132.67	6.47			
Picture Similarities	Experimental C-T-I	6	91.83	8.13	1.35	0.208	No Sig.
	Control Group-1	6	86.50	5.28			
Pattern Construction	Experimental C-T-I	6	84.67	9.25	0.86	0.412	No Sig.
	Control Group-1	6	89.00	8.27			
Copying	Experimental C-T-I	6	105.33	9.11	0.99	0.343	No Sig.
	Control Group-1	6	100.67	7.01			
Total	Experimental C-T-I	6	102.04	5.66	0.05	0.959	No Sig.
	Control Group-1	6	102.21	5.33			

In addition, the equivalence between the C-M-I and CG2 is shown in Table 6.4. The Mean of the BAS-II performance of the C-M-I group was 102.50 (SD = 4.47) and for the CG2 was 103.33 (SD = 5.79). They did not differ significantly (t-value = 0.28, p = 0.786), which means that the two groups (C-M-I and C-T-I) were equivalent in the pre-test. As can be seen from Tables 6.1, 6.2 and 6.3, the children in the two groups (control and experimental) were at the same BAS-II pre-test level of problem solving skills, which they were matched.

Table 6.4: The equivalence between the C-M-I and CG2 means.

Tests	Group	N	Mean	Std. Deviation	T-Value	Sig.	Sig.
Block Building	Experimental C-M-I	6	134.83	10.40	0.14	0.888	No Sig.
	Control Group-2	6	136.00	16.90			
Picture Similarities	Experimental C-M-I	6	87.50	5.86	0.92	0.382	No Sig.
	Control Group-2	6	90.83	6.74			
Pattern Construction	Experimental C-M-I	6	90.00	4.52	0.33	0.750	No Sig.
	Control Group-2	6	91.17	7.47			
Copying	Experimental C-M-I	6	97.67	12.16	0.41	0.690	No Sig.
	Control Group-2	6	95.33	6.77			
Total	Experimental C-M-I	6	102.50	4.47	0.28	0.786	No Sig.
	Control Group-2	6	103.33	5.79			

When matched pairs were found, I began collecting the main data and the teachers (1 and 2) were introduced to the Montessori Sensorial Materials as shown in Table 6.2.

6-3 The Result of the Quasi-Experimental Aspect of the Research

The experimental groups were presented with the Montessori Sensorial Materials (MSM). The researcher gave the materials to the teachers (T1 and T2) and the teachers presented them to the children. The teachers had Montessori Diplomas which they knew how to present the materials for the children. Also, the two teachers and I practised presenting the MSM in a separate room.

All the materials were presented to the children in a manner consistent with the Montessori Method. All the materials were left on the Toy-table area for the children. The children had free choice and access to play with MSM or with other materials. I observed the target children playing with MSM. In addition, I observed the children's interaction with the materials, the teacher, and with the other children.

The teacher-2 assigned to the C-M-I group did not interact with the children during their free time play with MSM, and, if one of the target children asked for assistance, the teacher-2 suggested that he or she should ask another child for help, or the teacher-2 would assist them but not help them in solving the MSM problems. When a child found a solution using the MSM, both teachers (1 and 2) asked the child about the solution and both teachers asked the child if he/she could do something else using the materials or if the child wanted to play with other materials.

The children in the experimental groups played with the sensorial materials for 22 weeks (one academic year). They had the same head teacher and their classroom had the same materials in other areas, apart from the MSM. The teachers had schedules that needed to be followed to present different themes and unite for the children. This schedule was designed by the teachers themselves with cooperation from the head teacher. At week four, T1 (C-T-I) asked to have more space for the children to play with the MSM and discussed that with me as the researcher. T1 let the children play with the MSM on the morning circle (MC). Also, I told T2 (C-M-I) to let the children play with the MSM in the morning circle to have more space as well to control this threat. The children in both groups (C-T-I and C-M-I) should have the same space during play to avoid any bias and experience the same events. Also, there were no meetings to discuss the children's improvement using the MSM with the experimental groups' teachers, and the four teachers' breaks were different. I as a researcher had also a schedule to follow. This schedule allowed me to attend both experimental classrooms in the free play time to observe the target children and video them. I was with the children for a full day. If the children played with the MSM other than in free time I was there to video them. However, no child played with the MSM at any time other than in free play.

In addition, the children exhibited similar physical developmental changes during the research period (because all of them in the same age) but only the MSM were used for the experimental group. No child was distinguished as being higher or lower at the BAS-II to control the regression threat and the children were not distinguished as being in the control or experimental groups.

By the end of the academic year, I gave the experimental children the BAS-II post-test in the same room, in order to answer the first research question, and investigate the influence of the MSM on children's problem solving. The mean scores for the post-test of the BAS-II from the C-T-I and CG1 in each of the sub-scales are shown in Table 6.5, and the mean scores for the post-test of the BAS-II from the C-M-I and CG 2 are shown in Table 6.6.

Table 6.5: C-T-I Matched pair Post-test performance at the BAS-II four sub-scales

Name	Experimental Group 1 BAS-II C-T-I Post-test				Total	Mean	Name	Control Group1 BAS-II Post-test				Total	Mean
	BB	PS	PC	C				BB	PS	PC	C		
Sara	163	111	136	152	562	140.5	Tala	140	97	108	125	470	117.5
Lulu	163	103	126	161	553	138.25	Haifaa	140	88	96	139	460	115
Hala	163	97	130	147	537	134.25	Norah	140	103	94	118	455	113.75
Saud	163	103	123	147	536	134	Mageed	163	103	105	114	485	121.25
Shenafee	163	103	118	139	523	130.75	Tareeq	131	103	94	114	442	110.5
Nowaaf	153	111	123	118	505	126.25	Naif	153	103	90	114	450	112

Table 6.6: C-M-I Matched pair Post-test performance in the four BAS-II sub-scales

Name	Experimental Group 2 BAS-II C-M-I post-test				Total	Mean	Name	Control Group 2 BAS-II post-test				Total	Mean
	BB	PS	PC	C				BB	PS	PC	C		
Soso	163	111	136	133	543	135.75	Balques	140	119	111	120	490	122.2
Teefa	163	103	114	139	519	129.75	Galleeh	115	97	120	105	437	109.25
Madawe	153	119	126	133	531	132.75	Hyff	131	92	107	125	455	113.75
Soluman	163	111	126	139	539	134.75	Azoz	153	97	103	128	481	120.25
Aziz	163	111	121	130	525	131.25	Naif.G	153	97	104	103	457	114.2
Oufee	163	111	119	136	529	132.25	Mo	140	103	94	118	455	113.75

Children from both groups (control and experimental) began at approximately the same level in the pretest, but there was a significant difference in the mean scores in BAS II of each child between the two groups with regard to measures of their problem skills (Tables 6.5 and 6.6). Children in the C-T-I and C-M-I groups made significant gains and showed that MSM have influences on their problem solving skills. This study contributes to the literature and provides evidence on the benefits to children on combining the MSM with SLC.

The results in Table 6.7 indicate that the mean average of the Picture Similarities performance of the experimental C-T-I group was 104.67 (SD= 5.43), whereas the mean of CG1 was 99.50 (SD= 6.12) and did not differ significantly (t-value= 1.55, p 0.153). However, the Block Building, Pattern Construction and Copying sub-scales showed significant differences between C-T-I and Control group1.

Table 6.7: T-test of BAS-II post-test for C-T-I and CG1

Tests	Group	N	Mean	Std. Deviation	T-Value	Sig.	Sig.
Block Building	Experimental C-T-I	6	161.33	4.08	3.39	0.014	0.01
	Control Group-1	6	144.50	11.47			
Picture Similarities	Experimental C-T-I	6	104.67	5.43	1.55	0.153	No Sig.
	Control Group-1	6	99.50	6.12			
Pattern Construction	Experimental C-T-I	6	126.00	6.29	7.30	0.000	0.01
	Control Group-1	6	97.83	7.06			
Copying	Experimental C-T-I	6	144.00	14.64	3.41	0.007	0.01
	Control Group-1	6	120.17	8.86			
Total	Experimental C-T-I	6	134.00	5.12	7.23	0.000	0.01
	Control Group-1	6	115.50	3.62			

As can be seen also from Table 6.7, for the Block Building sub-scale, the mean score of the C-T-I group was 161.33 (SD= 4.08), whereas the CG1 was 144.50 (SD= 11.47). For the Pattern Construction sub-scale, the C-T-I group's mean score was 126.00 (SD= 6.12), whereas the CG1 was 97.83 (SD= 7.06). Additionally, for the Copying sub-scale, the C-T-I group's mean was 144.00 (SD= 14.64), whereas the CG1 was 120.17 (SD= 8.8). The t-value for these sub-scales was t-value = 7.23 (p= 0.01).

According to this result, the experimental C-T-I results were significantly higher than that of the children from control group 1, and this demonstrates that the Montessori Sensorial Materials have a positive influence on children's general problem solving. Children who played with MSM and interacted with their teacher showed significant differences from control group 1 in three sub-scales of the BAS-II, but there was no difference between both groups on the Picture Similarities sub-scale.

Moreover, Table 6.8 shows that, for the Block Building sub-scale post-test, the C-M-I group's mean was 161.33 (SD=4.08), whereas the mean for CG2 was 138.33 (SD= 14.38). For the Pattern Construction sub-scale post-test, the experimental C-M-I group's mean was 123.67 (SD= 7.55), whereas the mean for CG2 was 106.50 (SD= 8.69). For the Copying sub-scale post-test, the experimental C-M-I mean was 135.00 (SD= 3.63), whereas the mean for CG2 was 116.50 (SD= 10.33).

Table 6.8: T-value of BAS-II post-test for C-M-I and CG2

Tests	Group	N	Mean	Std. Deviation	T-Value	Sig.	Sig.
Block Building	Experimental C-M-I	6	161.33	4.08	3.72	0.004	0.01
	Control Group-2	6	138.67	14.38			
Picture Similarities	Experimental C-M-I	6	111.00	5.06	2.30	0.044	0.05
	Control Group-2	6	100.83	9.56			
Pattern Construction	Experimental C-M-I	6	123.67	7.55	3.65	0.004	0.01
	Control Group-2	6	106.50	8.69			
Copying	Experimental C-M-I	6	135.00	3.63	4.14	0.006	0.01
	Control Group-2	6	116.50	10.33			
Total	Experimental C-M-I	6	132.75	2.21	7.85	0.000	0.01
	Control Group-2	6	115.63	4.86			

The t-value for Block Building, Pattern Construction, and Copying was significant (t-value = 0.01) which means that the experimental C-M-I group was significantly higher than CG2. For the Picture Similarities sub-scale post test, the experimental C-M-I mean was 111.00 (SD= 5.06), whereas the control group mean was 100.83 (SD= 9.56).The t-value was significant (p= 0.05), which means that the experimental group C-M-I group was significantly higher than CG2. Children who played with MSM and did not interact with their teacher also showed significant differences from control group 2 in all four sub-scales of the BAS-II.

As can be seen in Table 6.7 and Table 6.8, there was no significant development in C-T-I with CG1 in Picture Similarities sub-scales whereas the C-M-I significants different from the CG2 in the same sub-scales. Both control groups results are similar (CG1, m= 99.50 and CG2, m=100.83) whereas C-M-I scored higher than C-T-I in this sub-scales.

Based on these findings, we can conclude that children in the experimental C-M-I group were significantly higher than the children in control group 2 in all BAS-II four sub-scales. The experimental C-T-I group was significantly higher than CG1 in BB, PC and C, but there was no difference in PS. The general pattern of the results shows that children playing with Montessori Sensorial Materials improve their problem solving skills, which answers the first research question and the sub-question (see Table 6-2). The findings agree with the literature, in that the Montessori Method has a positive effect on children’s development.

Comparing the Experimental Groups (C-T-I and C-M-I) with Control Groups 1 and 2 (Table 6.9) for the Block Building sub-scale post-test, the Experimental group’s mean was 161.33 (SD=3.89), whereas the mean for the control groups was 141.58 (SD= 12.767).

Table 6.9: The BAS-II Pre-Post test for Experimental – Control Groups

BAS	Group	N	Mean	Std. Deviation	t	Sig. (2-tailed)
Pre-Block Building	Experimental	12	130.58	9.858	-.823	.419
	Control Group	12	134.33	12.324	-.823	.420
Post-Block Building	Experimental	12	161.33	3.892	5.126	0.010
	Control Group	12	141.58	12.767	5.126	0.010
Pre-Picture Similarities	Experimental	12	89.67	7.127	.367	.717
	Control Group	12	88.67	6.199	.367	.717
Post-Picture Similarities	Experimental	12	107.83	5.997	2.724	0.012
	Control Group	12	100.17	7.685	2.724	0.013
Pre-Pattern Construction	Experimental	12	87.33	7.475	-.894	.381
	Control Group	12	90.08	7.597	-.894	.381
Post-Pattern Construction	Experimental	12	124.83	6.740	7.084	0.010
	Control Group	12	102.17	8.799	7.084	0.010
Pre-Copying	Experimental	12	101.50	11.000	.925	.365
	Control Group	12	98.00	7.135	.925	.367
Post-Copying	Experimental	12	139.50	11.205	5.019	0.010
	Control Group	12	118.33	9.374	5.019	0.010

A t-test for BB indicates that there is a significant difference (p= 0.02). For the Picture Similarities sub-scale post-test, the experimental group's mean was (M=107.83, SD= 5.99), whereas the mean of the control groups was 100.17 (SD= 7.69). The t-test for the PS is significant (p= 0.012). For the Pattern Construction sub-scale post-test, the experimental group's mean was 124.83 (SD= 5.96.749), whereas the mean of the control groups was 102.17 (SD= 8.79). The t-test for the PC is significant (p= 0.01). For the Copying sub-scale post-test, the experimental group's mean was 139.50 (SD= 11.21), whereas the mean of the control groups was 118.33 (SD= 9.37). The t-test for Copying is significant (p= 0.01). These results indicate that there was a significant difference between the two groups (control and experimental) in the BAS-II post test.

This experimental research used the matched pairs technique to study the influences of MSM on children's problem solving. The children in the experimental groups who played with the Montessori Sensorial Materials showed significant improvement in their problem solving skills in the four sub-scales of the BAS-II compared with the control groups.

Table 6.10 compares the experimental children C-T-I group post-test with C-M-I group in their BAS-II post-test. The t-value for BB, PS, PC and C for the C-T-I group did not significantly differ from the C-M-I group. The BAS-II does not show any differences between C-T-I and C-M-I in terms of their creativity.

Table 6.10: T-test for the BAS-II post –test for C-T-I and C-M-I

Tests	Group	N	Mean	Std. Deviation	T-Value	Sig.	Sig.
Block Building	Experimental C-T-I	6	161.33	4.08	0.00	1.000	No Sig.
	Experimental C-M-I	6	161.33	4.08			
Picture Similarities	Experimental C-T-I	6	104.67	5.43	2.09	0.063	No Sig.
	Experimental C-M-I	6	111.00	5.06			
Pattern Construction	Experimental C-T-I	6	126.00	6.29	0.58	0.574	No Sig.
	Experimental C-M-I	6	123.67	7.55			
Copying	Experimental C-T-I	6	144.00	14.64	1.46	0.175	No Sig.
	Experimental C-M-I	6	135.00	3.63			
Total	Experimental C-T-I	6	134.00	5.12	0.55	0.595	No Sig.
	Experimental C-M-I	6	132.75	2.21			

The research needs more data to answer the second research question which is related to children's creative problem solving. The qualitative case study and cross case analysis allowed me to answer the second question.

6-4 Summary

Comparing the Experimental Groups (C-T-I and C-M-I) with Control Groups 1 and 2 on the four BAS sub-scales showed a significant difference between the two groups (experimental and control) on the post-test. These differences show that the Montessori Sensorial materials have a significant influence on the development of children's general problem solving skills playing with these materials.

Yet the result does not illustrate any differences in children's creative problem solving, when comparing the C-T-I group post-test with C-M-I group post-test. Therefore the research used triangulation methods in the form of qualitative case studies to provide an account of the children's development when using the MSM. Qualitative data helped the researcher to uncover any differences in creative problem solving between the two experimental groups of children and helped to answer the second research question.

Chapter 7
Cases of Creative Problem Solving

7-1 Introduction

This study adopts the Creative Problem Solving (CPS) framework designed by Isaksen, Droval and Treffinger [2000] to analyse in detail children creatively solving problems playing with the Montessori sensorial materials. The aim was to monitor children's development in creative problem solving longitudinally during one academic year, in order to address the second research question. I selected each child's first creative solution as the basis for analysis (this occurred during weeks 5-6 of the experiment). I then selected one episode every four weeks when matched pairs played with the same material in the same week. This helped to monitor differences and similarities between matched pairs and their social interaction with an adult. The analysis did not focus on interaction between children and their peers because such interaction happened in both classes being studied. Rather, the analysis focuses on children's interaction with adults during problem solving. I adopted Rogoff's [1990] definition of tacit and explicit teaching to analyse children's social interactions with adults in the child-teacher-interaction (C-T-I) case.

This chapter is divided into three parts: first, the rationale behind the study of the episodes; second, the cases of groups: Saud, and Sara (C-T-I) and Soluman, and Soso (C-M-I), finally, a cross-case analysis revealing similarities and differences between the pairs, linking these with the instances of adult interaction to assess the impact of guidance on the children.

7-2 The Rationale behind the Study of Episodes

For in-depth analysis, two sets of matched pairs were selected at random. The two pairs of children for comparison were Saud and Sara from the C-T-I group and their matched pairs, Soluman and Soso from the C-M-I group. The two matched pairs were chosen randomly by placing the children's names in a bowl, with each of the matched pairs together on the same piece of paper (Saud-Soluman, Sara-Soso…etc). Four episodes are presented in the analysis, but every child had multiple episodes of interaction with the MSM during the full academic year. The rationale is explained below.

The first four weeks were not subject to analysis because the children did not reach any creative solutions playing with B1-B2-B3-B4, all of which have a single or convergent solution. From week five, the children began to produce creative solutions. The researcher selected the children's first creative solutions as the basis for a first analysis of episodes for each child (this occurred during weeks 5-6 of the experiment schedule).

Every four weeks, starting from week five, a time period was selected. I chose one episode every four weeks under the condition that the matched pairs played with the same material in the same week. This helps to reveal the differences and similarities between the matched pairs. Both children from the experimental group played with the same material in the same time period, so that their improvement could be studied and research bias could be controlled.

The first time period (weeks 4-8) produced the first creative solution. In the second period (weeks 9-12) and the third period (weeks 13-16), the two matched pairs played with the same materials (TB and colour cylinders, respectively). The final creative solutions happened before the end of the experimental period (weeks 19-22). To assess the data, the researcher selected four episodes for every case (see Table 7-1).

Table 7.1: The four episodes for the two matched pairs.

	W 4-8	**W 9-12**	**W13-16**	**W17-22**
Montessori Sensorial Materials(MSM)	**First Creative Solution**	**TB**	**CYLINDERS**	**Final Creative Solution**
SAUD (C-T-I)	W6-Sun-Episode-22	W11-Sun-Episode-42	W15-Sat-Episode-59	W19-Tues-Episode-78
SOLUMAN (C-M-I)	W5-Mon-Episode-19	W11-Mon-Episode-43	W14-Wed-Episode-58	W21-Mon-Episode-85
SARA (C-T-I)	W4-Tues-Episode-16	W12-Sun-Episode-46	W16-Mon Episode-65	W20-Mon Episode-80
SOSO (C-M-I)	W5-Mon Episode-19	W12-Sat Episode-45	W15-Sat Episode-59	W19-Tues Episode-78

The aim is to present these children's development in creative problem solving longitudinally during the academic year, to answer the second research question. I chose two episodes which included interaction between adults and children to explain how the interaction influences the children and two that involved no adult-child interaction to explain how the interaction influences the children when they play alone. The purpose of choosing each episode is to show the children's skills in solving the problem alone and the impact of social interaction with an adult on solving the problem creatively.

The episodes are numbered according to the school day. There are five days in the school week, and on each day there was one episode: so, for example, the episodes are called Saturday-Episode-1, Sunday-Episode-2, and so on, for all twenty-two weeks.

7-2-1 Reporting the Cases

For each case a brief outline is provided before the analysis is presented. Each case has four episodes. The full transcript of each episode is provided in Appendices 7-1 to 7-16. In the analysis below, the stages of the CPS are shown in bold.

As this research is looking for creative or different solutions, a creative solution is taken as one that differs from the expected Montessori solution. The four creative skills are: fluency, flexibility, elaboration and originality. Fluency is the number of solutions that the child comes up with. Flexibility is the number of different ideas. Elaboration is the ability to add detail that develops the solution, and originality is an unusual solution that no-one has come up with before (see section 4-3-2). These skills provide a quantitative view of children's creative solutions.

With regards to flexibility, the children came up with different solutions and ideas. The two teachers and I put the children's solutions into categories (see Appendix 4-1); for example, aeroplane, car, and bus are in one category called transportation. After the experiment finished, I gave all the solutions' names to T1 and T2 and they created their own categories and I created mine.

We compared our categories and agreed on several of them, like human (face, man, women, girl, etc.). We disagreed on some solutions in terms of which category we should put them in. We discussed them until we reach an agreement on all solutions and categories.

Torrance [1974] defined originality as the number of uncommon ideas and Isaksen et al. [2000] and Isaksen et al., [2010] defined originality as the ability to generate unusual or unique options. Torrance compared a child's answer against previous response/solutions to score the originality. Children in this research were divided in two groups C-T-I and C-M-I. In the current research often children play together, sharing their solutions and copying from each other. For this reason, this research is not looking for novelty of solutions, and so the researcher has eliminated originality from the four creative skills. This study is looking for fluency, flexibility and the elaboration of creative skills.

Other researchers have also focused on examining specific skill not all four creative skills. For example, Mengping [1998] conducted research comparing the originality of fifth grade students playing with Lego as a group and compared them with a control group, whereas Al-Sulaiman [1998] compared the originality of each individual in her research sample. In addition; other researchers, like Gustafson [2001], studied flexibility only based on the four skills of creativity. Mumford, Supinski, Baughman, Costanza and Threlfall [1997] studied the originality of an undergraduate student, Runco [2001] studying the flexibility and originality in children's divergent thinking. Al-Sulaiman studied the flexibility, fluency and originality of female high school students. The four skills of creativity have been selected by researchers for their studies.

7-3 Saud from the C-T-I Case

Saud was a member of a full C-T-I classroom of twenty children. He liked to play in a small group with his friends, especially in three areas, namely the art area, the Toy-table area and the unit area (T1's observation record, Episode-

25).

T1 recognised that Saud liked to persist in playing with material until he had mastered how to play with it (observation note, Episode-25). Saud was an active child who learned through discovery and exploration and during social interaction with an experienced adult (T1's record-Episode-55).

7-3-1 W6-Sunday-Episode 22, Saud's First Creative Solution

Saud's first creative solution with the MSM was with the Colour tablets box-3 (Col3). In Episode-22, Saud produced three solutions: an aeroplane and a pillow, which showed similarities in the way he made them, and a mountain solution. I select the aeroplane and the mountain solutions to avoid the repetition of using the CPS framework to analyze every solution (see Appendix 7-1 for full transcript of the episode).

Saud **constructed** this opportunity by choosing the Col3 amongst the other materials at the Toy-table area, which presented him with different opportunities. He began with a basic Montessori Col3 solution, which is arranging the tablets in order from darkest to lightest. When I suggested to him to put the tablets in different positions, I wanted to assist him to move from the problem **framing** stage, which was by asking him: "How about if you put the tablets on top of each other?" to generate creative ideas (Appendix 7-1, line 2). The adult suggested a new position for the tablet (tacit direction from the adult to put the tablets on top of each other, which is different from the Montessori solutions). However, Saud did not follow the suggestion and continued to place the tablets in the same way.

I rephrased my suggestion and asked him in an indirect way: "Is there another way to add the tablets?" (rather than directly saying put the tablets on top of each other). The implicit suggestion gave cues that may have structured Saud's way of solving the problem. Saud began to alter his way of adding tablets. He **framed** the problem differently by placing a tablet upright for the first time. This move led him to **generating** an idea and he focused on building a vertical tower (line 5) by adding one tablet vertically with two horizontal tablets. The **generation** of this idea led him to produce another possible response to the tablet problem. He placed one tablet horizontally, then two vertically, and **developed** his solution with me (line 6), because he worked on his idea to refine and transform it into a possible solution. He **developed** it by adding another horizontal tablet and **accepted** an aeroplane solution by telling me about it (line 7) which pushed him to complete the task and seek feedback (Figure 7-1). In this case the tacit suggestion to frame the problem differently had generated a new result.

Figure 7-1: Aeroplane solution

Saud mixed up the tablets to **frame** a problem, indicating that he had **generated** an idea about two tablets on top of each other vertically, which differs from the Montessori solution (line 20). Saud had shifted his play from the horizontal to the vertical. I suggested in this attempt to put the fifth tablet horizontally with the four vertical tablets. My intention was to teach him that he could combine dimensions places in one solution to develop his play. He **developed** the problem in accordance with my suggestion by changing from vertical to horizontal positions (lines 22). Saud **developed** the solution by taking two tablets and putting them perpendicularly on top of the fourth horizontal tablet (line 23).

Saud **developed** his solution by adding another two tablets perpendicularly on top of the third horizontal tablet to develop his solution. Saud **developed** his solution by adding another horizontal tablet on top of the first perpendicular tablet; then he added two more perpendicular tablets on top of the first tablet (Figure 7-2). He called it a mountain solution and **accepted** it by telling me (line 26). He **developed** the solution by making the same moves and created another mountain next to it. By telling me, he checked his findings and by building the second mountain he reinforced his solution. His interaction with me illustrated his acceptance of my help.

Figure 7-2: Mountain solution

As regards scoring for creativity in the solutions in this episode (See Table 7-2), Saud generated three different solutions: an aeroplane, a pillow and a mountain, which gave him a score of three for fluency in this episode. These three solutions were in different categories (Transportation, Home furnishing, and Landscape), so the total score for flexibility was three. Saud's development of the aeroplane and mountain solutions gave him a score of two for elaboration.

Table 7.2: **Saud's score in the three Creative Skills with the Colour Tablets**

Fluency	Flexibility	Elaboration
3	3	2

In sum, Saud deals with a situation requiring clarification and identification of important data on how to play with the materials differently during his social interaction with an adult. Tacit teaching by an adult assisted Saud in framing the problem and exploring new positions, which is from the understanding component of the CPS, and that led him to develop his capacity in generating solutions to solve the problem differently. He used all positions with assistance from an adult as starting points to find many other productive and creative solutions. An adult helped Saud to start from his own move, without copying the Montessori solution, as an initial step to solve the tablet problem. Saud engaged fully with the CPS process by going through three attempts to produce three creative solutions.

7-3-2 W11-Sunday-Episode 42, Play with Triangle Boxes (TB)

When T1 introduced TB1 in week 8, Saud did not copy the Montessori solution. On the observation sheet, T1 noted that Saud was not copying the Montessori solutions any more, but producing his own creative solutions:

> "*At the beginning, I thought the TB was boring and the children would do anything with it, but then I saw Saud's creative solution and he seemed to understand how to play with these triangles. At the beginning, he looked like any child in the classroom needing our support to discover a new way to play with them and then to produce a creative solution, but now I don't think Saud needs this support. He needs his own imagination to create different solutions"*

[T1-Field note-Episode 32]

In week-11-episode-42, Saud began by **constructing an opportunity,** choosing to play with the TB3 (line 1, detailed description of the episode in Appendix 7-2). He gathered five equilateral triangles (QTs), but then he **framed** the problem (line 3) by putting two isosceles obtuse triangles (IOTs) together by their hypotenuse, instead of the sixth QT, to make a diamond shape to **generate an idea**. He **developed** the solution by adjusting the triangle positions, removing them from the top of his shape to the bottom and placing them at an angle (line 3). By adding two more IOT triangles horizontally, Saud **developed** the solution and reached a kite solution and **accepted** it by telling me (line 7) (Figure 7-3).

Figure 7-3: Kite solution

Saud wanted to **develop** his kite idea and **generated** a boy idea by telling me about it (line 8). I made an indirect suggestion, by adding QTs at different positions without stating what I was doing. This prompted Saud to **frame** the problem (line 10). He **developed** his solution by putting two IOTs side by side at an angle with the diamond shape and by adding two more IOTs as a rhombus shape down in his pattern (line 11). Saud **accepted** the boy solution (line 15) (Figure 7-4). Saud then **generated** a girl idea (line 17) and tried to achieve it by action, and **developed** his solution by moving the grey QTs around to different places. He **generated** different ideas and applied them by action as solutions, during tacit interaction with me. I moved the triangles around without saying where he should put them, except in the cat solution, when I directed him to move the triangles. He made a cat solution (Figure 7-5), another cat solution (Figure 7-6), a lamp solution (Figure 7-7) and a spaceship solution (Figure 7-8) and **accepted** them all by telling me.

During the cat solution, I directed Saud to move the last three triangles (line 22) and he asked me: "How?" to clarify where he could add them. I showed him where to add them. The direct (explicit) teaching assisted him in his development of a solution. When he reached the lamp solution, I suggested to him to put back the last four QTs, but in different places, without saying where he could add them, and I asked him to try by himself. This prompted him to frame the problem to generate another solution (line 31). Saud added the triangles and moved them to different places to generate the spaceship solution.

Figure 7-4: Boy solution

Figure 7-5: Cat solution

Figure 7-6 : Lamp solution

Figure 7-7: Cat solution

Figure 7-8: Spaceship solution

He started from scratch by taking one grey QT from his previous solution and placing it at the hypotenuse of the red IOT, which is different from Montessori, to **frame** the problem of creating a Japanese man solution (Figure 7-9).

Figure 7-9: Japanese man solution

Saud **framed** the problem when he gathered two red IOTs at one corner, which was a new position for Saud and different from Montessori, to **generate** a new idea (line 56). Saud **developed** it by adding one grey QT between the two red IOTs, making a rhombus shape with two red IOTs and adding them to his shape (line 59). He **developed** it by adding two more QTs on two sides of his shape and three grey QTs at the top of his shape (line 61). When Saud wanted to **develop** his solution further, he **explored** the data by discovering a possibility for the material. This was another position for the IOT adding it with just one corner touching at an angle (line 63) (Figure 7-10). Saud **accepted** the spaceship solution by telling me (line 66).

Figure 7-10: spaceship solution

In this episode, Saud generated nine different solutions (see Table 7-3): kite, boy, cat, another cat, lamp, spaceship, Japanese man, lamp-2 and another spaceship, and that gave him a score of nine for fluency in this episode. Although Saud failed to find a girl solution, he showed evidence of his creative skills in solving the Montessori sensorial triangle problem differently from the

Montessori solution. The boy solution and Japanese man are classified in the Human category, scoring one for flexibility. The cat and second cat are classified in the Animal category, giving him a further score of one. The same was for the two lamp solutions (Equipment category) and the spaceship (Outer space category), scoring one each. Finally, the kite solution scored one (Toy category). The total scored for flexibility was five points. Saud developed all his solutions, except the lamp-2 solution, which gave him a score of eight for elaboration in this episode.

Table 7.3: Saud's score in the three Creative Skills at the TB3

Fluency	Flexibility	Elaboration
9	5	8

Saud had played with the triangles before (TB1-TB2), which helped him to develop his experience of exploring different positions and different types of triangles (Episodes 27-32). In this episode, I interacted with Saud during the boy and lamp solutions, tacitly offering suggestions to try different positions. In the girl solution, Saud asked clearly for help by saying: "How?" (How could he add the triangles to produce a girl solution?). I taught Saud explicitly by showing him how to add the triangles, which helped us to produce the cat-2 solution instead of the girl solution. In the spaceship solution, I tacitly offered him a suggestion by returning the triangles from his previous solution to recreate a new one, and Saud added them, but in different places. This social interaction between Saud and the adult gave him a clue that there could be more solutions to find, and he produced three more solutions alone. Thus, we can see the adult interaction as a prompt to Saud's divergent solutions. In summary, Saud was still exploring data with tacit teaching from an adult. However, when Saud asked for help, the adult taught him explicitly how to solve the problem. Saud discovered another approach to solving the Montessori problems compared to the previous episode.

Saud's initial technique was not to copy any Montessori solution; he found two approaches. The first approach was to create a solution and develop ideas to create another, which he did six times. The second approach was to produce each solution separately, which he did in the last three solutions. It could be said that he reduced his capacity to create more creative solutions because he did not use some types of triangles, especially the big yellow QT in any of his solutions, and he persisted with the same bottom shape.

7-3-3 W15-Saturday- Episode 59, Playing with the Colour Cylinders

At the same time as the Triangle box (TB) was being introduced to the children, the colour cylinders were also introduced (see Figure 4-1, the weekly schedule of the MSM). Saud produced eight solutions. I selected the Boy and TV, Cat and Petrol station solutions.

In Week 15, Episode-59 (see appendix 7-3 for full analysis of the episode), Saud began by **constructing an opportunity,** by choosing to play with the green, red and blue cylinders (GC-RC-BC). There was no adult interaction in the following two episodes, to show the impact of previous interaction on Saud's creative problem solving.

Saud indicated that he was **framing** the problem by adding GC2-3 horizontally to **generate** a new idea. It was the first time he had attempted this (line 2) and this was Saud's first attempt at combining two dimensions to solve the cylinder problem. Saud **developed** his solution by adding more cylinders, but then he used the rolling moves in his solution and **explored** a way to stop the rolling by blocking with another cylinder (line 4). Saud **accepted** the Boy and TV solution (Figure 7-11) by telling T1.

Figure 7-11: The Boy and TV solution

Saud directly put one GC and RC parallel on top on opposite sides of the cylinder box to **frame** the problem to **generate** another idea, which was also a different position from Montessori (line 7). He **developed the solution** by putting two green rolling cylinders on top of one side of the box, but the cylinders rolled off (line 8). Then he **explored** the data by exchanging the cylinders with others of smaller diameter (line 9) to stop them from rolling. He discovered that small cylinders can lie in a stable state on the edge of the box. Saud reached a level of knowing which cylinder could be expected to remain on the lid of the box, and managed with that. Saud **accepted** his idea by telling me that he had made a cat with the cylinders and the box (Figure 7-12) (lines 10-11). The beauty of Saud's ideas was that he gave life to his creative, imaginative solutions. In this instance his interaction with adults was primarily to reinforce acceptance of his solutions and also represented his satisfaction about his solutions.

Figure 7-12: Cat solution

Saud started **generating** another idea by telling his friend about it and named his solution a building (line 20) (Figure 7-13). Saud then **developed** his solution further by taking BC4, holding it perpendicularly and putting BC1 and 2 next to it on either side. He **developed** the solution by rolling the BC like a car and by adding more red and green cylinders, and called it a petrol station (Figure 7-14). He **accepted** the building by telling me about it (line 22). This was Saud's final solution in this episode. Then he put the cylinders back in their box.

Figure 7-13: Building solution

Figure 7-14: Petrol solution

In this episode, Saud generated a boy and TV, building1, boy, fountain, cat, sea, building2 and petrol station solutions, scoring eight for fluency (see Table 7-4). His first solution derived from everyday experience, as did the building solution. However, he used imaginative ability to generate the petrol station and cat solution, using the box and two cylinders. The boy-TV and boy solutions are all in the human category, scoring one. The buildings also score one. The fountain and sea are in the View category, scoring one. The cat and petrol station are in different categories (Animal and Service categories), scoring one each. Saud scored five in total for flexibility in this episode. Saud's flexibility showed in some interesting movement of the cylinders, rolling one as a car, and the cat solution. His varied his use of the cylinders and his creative solutions stood him out in his work with Montessori solutions. In addition, Saud developed all his own solutions, which gave him a score of eight for elaboration. He was original in his play with the cylinders, using them in different ways and moving from structural solutions (tower and building) to more imaginative solutions (petrol station and cat).

Table 7.4: **Saud's score in the three Creative Skills at the Colour Cylinders**

Fluency	Flexibility	Elaboration
8	5	8

In sum, Saud scaffolded his experience with the Montessori Sensorial materials for fifteen weeks, but in this episode he played individually. He was still exploring more data and developing his solutions by adding detail, which was different from his previous episode. The difference also in this episode was in combining the Montessori materials together to produce more creative solutions. The similarity was in using the same two approaches he used in the previous episode to solve the problem. Saud's capacity to control the cylinders led him to decide which cylinder was better suited to the task. Saud used the two approaches in this episode (creating one solution and developing it to create another creative solution and finding a new solution by starting again from the beginning). Saud showed more flexibility in his solutions, producing six creative solutions from six different categories.

7-3-4 W19-Tuesaday-Episode 78, Saud's Final Creative Solution Playing with the TB

By week 16, Saud had experience in mixing different materials in his play. At Week 19, Episode-78, Saud **constructed an opportunity** by playing with TB4-5, RC and GC (The analysis of the episode is in Appendix 7-4.). He **framed** the problem by taking out two QTs and putting them on top of each other, which indicated that he **had generated** an idea (lines 2). Saud **developed** his solution by adding more yellow QTs. Instead of putting the triangles on top of each other, he **developed** the solution by attaching one angle of the QT to the right angle side of the IOT and by adding the green cylinders (line 4). Saud rolled the cylinders on top of his solution and asked me to look at his solution, thus **accepting** it (Figure 7-21). He did not give a name to his solution, but I suggested the name 'cylinder slide' (line 5) and Saud showed an acceptance by moving his shoulder. This interaction is not classified as any form of teaching because I just gave the name and did not teach him.

Figure 7-15: Cylinder slide solution

Despite interruptions and interference from his friend, Saud remained in control of his play and independence. Saud **framed** another problem using and generating the aeroplane-1 and aeroplane-2 solutions (Figure 7-16 and 7-17).

Figure 7-16: Aeroplane-1 solution

Figure 7-17: Aeroplane-2 solution

Saud **framed** the problem to **generate** another idea by taking the square shape (line 20), and developed his solution by adding two green RATs to make a rectangular shape (line 21). He **developed** his solution by placing the narrow point of the yellow RAT on one side of the square and added a red IST similarly to the opposite side (line 22). He **accepted** the building by telling his friend, calling it a 'fat boy' solution (line 24). He **developed** it further by adding more detail, for example legs, mouth and eyes. He used the triangles and cylinders (lines 25-26) (Figure 7-18) and **accepted** it, calling it 'Nothing' (line 35) (Figure 7-19). Saud **developed** it further and called it a spaceship.

Figure 7-18: Fat boy solution

Figure 7-19: Nothing solution

Saud mixed the shape and **framed** the problem to **generate** a balancing game and a rocket solution (Figure 7-20 and 7-21).

Figure 7-20: Balancing solution

Figure 7-21: Rocket solution

By mixing the shapes and structuring the two blue RATs, Saud began to **frame** the problem to **generate** another idea (line 49), finding another way to play with the blue RATs adjacent to the box (lines 50-51). He **developed** the solution by putting four blue RATs on the four sides of the box, adding four more to make an equilateral triangle using two blue RATs on each side of the box (line 55). The child showed unusual improvement in using the material surrounding him. He also **developed** his solution by adding yellow triangles at the corner and a GC inside the box with the girl doll. He **accepted** the 'maid's house' construction (Figure 7-22) by telling T1 and me (as a teacher) about it (line 58).

Figure 7-22: Maid's house solution

Saud's solutions were in five different categories, giving a total score of five for flexibility. The categories were transport (three aeroplane solutions), the human category (boy solution), the building category (maid's house), play equipment (see-saw) and outer space category (space ship and rocket).

Saud elaborated solutions in a practical way with attention to detail. He added detail with original use of cylinders, the box and the doll, to bring life to his solutions.

Table 7.5: **Saud's score in the three Creative Skills with TB4-5 and Colour Tablets**

Fluency	Flexibility	Elaboration
8	5	8

Saud's solutions indicated his creativity in solving Montessori problems in multiple ways. One main difference from previous episodes was that Saud did not explore further data in this episode. He combined MSM to produce creative solutions and used his imagination to roll cylinders as part of the solution. He developed his capacity to change or transform from one solution to another. Saud developed his creative capacity further in using other materials from another area, such as using the doll as part of his solution in the Maid's house which he did in the third episode, using the box as part of one solution.

T1 also agreed that Saud knew how to play with the triangles and create solutions that differed from his friend's. T1 recorded the following:

> "I wrote a note in Saud's record that he played mostly with TB and cylinders and I also noted his solutions were absolutely different from his friend's. At the beginning, he discovered how to play with TB but amazingly he kept generating a number of ideas in a short time, which I think is an improvement in Saud's problem solving ability in different ways."
>
> [T1, Interview 5, p 3]

Saud's friends were influenced by his solutions and some of his friends came to play with him during his final solution, which they admired (line 61).

Saud played with the TB with more confidence and he was the leader of his own solutions, completing them despite the continual interruptions of his friends, who tried to take materials from him or even mix up his shape. Saud controlled his play and focused on generating different solutions. He generated eight solutions: aeroplane-1, aeroplane-2, aeroplane-3, fat boy, spaceship, see-saw, rocket and maid's house (see Table 7-4). He scored eight for fluency in this episode. Saud elaborated all his eight solutions. He also scored eight for elaboration in this episode.

7-3-5 Summary of Saud's C-T-I Case

In conclusion, over the twenty-two weeks of the experimental period, Saud, like the other children, copied the Montessori solutions in initial attempts to explore the different possibilities of the materials. At week 6 (see section 7-3-1), he generated his first creative solution with assistance from an adult. When the adult made a suggestion tacitly, she helped Saud to frame the problem, generate an idea and exploring data (using the tablets differently to Montessori in two different CPS components). After being repeatedly offered suggestions to explore new positions and start differently from the Montessori solution as the initial step, Saud recognised that there were different possibilities for solutions; new information and new approaches to solving the Montessori problems were available and he managed to produce some creative solutions. Social interaction during explicit and tacit teaching contributed to making him aware that there were alternative approaches of using the materials. At the first episode, Saud explored more data in developing his solutions.

Saud completed the cycle of all three components of the CPS framework (section 4-3). He went through the three stages of the Understanding Component and was able to generate creative solutions that would support him in moving forward to reaching the Generating Ideas Component. The social interaction with the adult supported his progress from one component to the next and in moving towards the third component, Preparing for Action. He framed the problem by starting from his own move as an initial step in solving the problem to explore more data and combine the materials together.
In the second episode (week-11, section 7-3-2), Saud played with the TB3 and directly started to frame the problem by designing a diamond shape to generate a kite solution. An adult interacted with him tacitly to generate more creative solutions by suggestion (tacit teaching), to move the QTs around and generate five creative solutions. When Saud had the girl idea and did not know how to apply it, he asked clearly for explicit teaching by saying "How?". Then the adult suggested to him to add other triangles and taught him tacitly to achieve another creative solution.

Tacit teaching occurred in framing the problem to generate ideas, and to encourage him to find more creative solutions. The similarity between Saud's first (W6) and second (W11) episodes was that tacit teaching occurred in framing the problem to generate an idea. However, in W11, there was also explicit teaching besides the tacit teaching, in framing the problem to generate an idea when the child asked, and there was no tacit teaching during development of the solution phase, as there had been in the first episode. In the second episode, Saud had more approaches to solving his problem creatively playing with the Montessori materials than in the first episode. His approach to playing with the triangles developed in the design of one solution and led to more creative solutions. Furthermore, he developed another approach which was to produce each solution separately when he played alone.

Saud scored nine for fluency during this episode and gained good experience in playing with the TB. Saud scored in all three creative skills (producing eight solutions); his creativity was enhanced and consolidated by playing with the MSM. Tacit and explicit teaching occurred in exploring the data stage more than in other stages, and Saud developed two approaches to solving his problem creatively playing with the Montessori materials. The same approach was carried over from the previous episode, which was to produce each solution separately, and he developed a new approach, which was to design one solution, leading to more creative solutions.

In the third episode (week-15), Saud played with the Colour Cylinders alone (section 7-3-3). The purpose of choosing this episode is to show the child's skills in solving the problem alone and the subsequence impact of his experience with the MSM and previous social interaction with an adult in solving the problem creatively. Saud liked to put cylinders in different positions to attempt new exploration. He used the idea of rolling the cylinders in one practical solution. No other child had used this idea, which made him stand out.

Saud was able to transfer knowledge to other materials as a part of his creative solutions, for example holding the tablets up and holding the cylinders up. He used not only the Montessori materials, but even the boxes that they were stored in. Saud combined imagination and knowledge for practical applications in his cat and petrol station solutions. Saud went through all three components of the CPS time after time with confidence, finding other creative solutions, because he understood the cylinder materials well and the different ways in which orientations and sizes could be manipulated. He was still exploring more data. He also used the same two approaches in solving the Montessori problems, but the change was in using other materials with the MSM.

Saud did not seem in this episode (section 7-3-3) to need further help from an adult to create a solution, because he had developed his understanding and skills in previous interactions with teachers. However, he needed some engagement in the exploration of new possibilities that could change his approach to playing with the MSM and help to find new creative solutions.

In Saud's final creative solution in week 19 (section 7-3-4), he had still not used a big yellow triangle. On the one hand, he seemed to be uninterested in using it; but on the other hand, this might have limited his exploration of more varied solutions. Saud understood how to combine more materials together imaginatively, connecting them in different orientations. He changed his solutions fluently and flexibly from one idea to another; and continued thinking practically, as in the maid's house idea. Saud attained the capacity to frame the problem and generate an idea and then changed it by framing the problem again and generating another idea, closer to his way of thinking than the previous one. The development in Saud's capacity in this episode was that he added details to his solution and combined materials together, also teaching his friend to solve the Montessori problem.

In the last two episodes of play (section 7-3-3 and 7-3-4), he increased the complexity of the solutions by developing them and adding more materials. Saud visited the exploring data stage just once and then completed framing the problem, generating a solution, developing it and accepting it. The similarity between the four episodes was that Saud went through the three components and all stages of the CPS.

7-4 Soluman from C-M-I Case

Soluman was a member of a full C-M-I classroom of nineteen children. Beyond introducing the children to the materials, T2 did not interact with children in the C-M-I case, because of the research design. Soluman is the matched pair with Saud from the C-T-I. He, like Saud, liked to play in a small group and mostly individually (T2- Observation Field-Episode-55). He liked to play at the Toy-table area, the discovery area and the unit area (T2's Observation record, Episode-26).

7-4-1 Week-5-Monday-Episode-19, Soluman's First Creative Solution

When T2 presented the colour tablets to the C-M-I group, Soluman was interested in playing with them and he found creative solutions. Soluman's first creative solution was with Col2 (see Appendix 7-5 for full analysis). He had played with this material before (in Episode-17), and copied a Montessori solution, which is to match two tablets.

In Week 5, Episode-19, he was **constructing opportunities** by selecting to play with Col2 out of a variety of materials in the Toy-table area (line 2). Soluman's initial move was to put the colour tablets in line, which was still copying the Montessori solution (line 2). By repeating what was presented to him, Soluman revealed that he was intrigued with regularities and repetitions. His solutions were dependent on what was presented to him, which had shown in his play in previous episodes and at the beginning of this episode too. He needed to extend possibilities, as a result of T2's encouragement at the beginning of this session, when she asked all children to make something different. When Soluman added two tablets at angles next to the first one, he **framed** the problem to **generate** an idea which was absolutely different from the Montessori solution, and this produced another possibility for the task. He also **explored** an angle position using the colour tablets, which was one possibility (line 3). He used his position of exploration in producing a creative solution.

He **developed** his solution by (improving the goal of transforming the idea into a possible solution), reorganizing the tablets in the shape of sunshine, making another line that related to his sunshine solution (line 7-8). Soluman added more tablets and made other lines by copying his initial moves. Soluman **accepted** the sunshine building (Figure 7-23) by telling his friend about it (line 9), as a completed act solution. He returned the material to the shelf and left the area.

By creating the sunshine solution, Soluman used the COL materials differently from Montessori and solved the problem creatively, which allowed him to make progress and produce more solutions. In this episode, exploring the new position assisted him in framing the problem and generating an idea. He had satisfied his curiosity by repeating the exercise, and now he was interested in searching for something new or different which is shown in his future episodes (W13-episode-51, W15-Episode-59). He went around the CPS once, and that helped him to develop his creative skills.

Figure 7-23: Sunshine solution

His one creative solution gave him a score of one for fluency (see Table 7-6). He also scored one for flexibility in the sunshine solution. Soluman developed his solution and scoring one for elaboration.

Table 7.6: **Soluman's scores in the three Creative Skills with the Colour Tablets**

Fluency	Flexibility	Elaboration
1	1	1

T2 also observed his play with the Col boxes and said:

> T2: "Soluman likes to play individually, and when he chooses the colour tablets, he plays with them imaginatively. He developed layers and different patterns, which showed his absolute understanding of them; and he was creative with this material. He knew how to manipulate it to show what he wanted to show."
>
> [T2, Interview 5, p. 4]

In sum, Soluman, like Saud, dealt with a situation requiring clarification of different data on how to play with the material by exploring new positions. By framing the problem and exploring data, Soluman managed to produce one creative solution. He started with one of the Montessori solutions then developed his skills by framing the problem and exploring the angle position of the colour tablets, which was absolutely different, and assisted him in solving the problem creatively. However, he needed to practise use of positioning in more creative solutions and also to discover other diverse positions, like holding up tablets to generate more creative solutions, like comparing him with Saud, his matched child. He did not engage as fully with the materials as Saud and was apparently satisfied by single solutions. The most important point was that Soluman in this episode was exploring new positions and applying them to creative solutions. He still copied the Montessori move as an initial step in solving the problem.

7-4-2 W11-Monday-Episode-43, Playing with TB

Over a number of sessions Soluman advanced his skills in playing with the Triangle Boxes (TB). He started by copying the Montessori solutions, but moved a step further to produce creative solutions. He seemed to be seeing the problem from different points such as combining the triangles from different sides and angles [W9-Episode-34 and W8-Episode 31], which required him to become aware that having a different perspective on the materials could produce more creative solutions.

In week 11, Episode-43, Soluman **constructed an opportunity** by choosing to play with the TB1 (full analysis of the episode in Appendix 7-6). Soluman connected two red equilateral triangles (QTs) at one angle to **frame** the problem and to **generate** an idea which was different from Montessori, and then he **developed** the solution by adding the third red QT at the hypotenuse to make a trapezium shape (line 2). He **developed** the solution by moving the trapezium shape 45 degrees and by looking at it from different perspectives, and deciding how to position the complete solution. Moving the material around and around showed that Soluman also developed his capacity in adding the triangles and seeing them from different points.

He **developed** his solution by adding the fourth red QT on the top side of the trapezium shape. He added a green right angle triangle (RAT) and moved it 45 degrees twice to **explore** new positions, deciding to add it where he thought it more appropriate (line 4). Through this exploration, Soluman knew how to connect the sides of two different types of triangles. The developing steps led Soluman to explore a new position which developed his creative skills. Soluman **developed** his solution further by adding the second green RAT on the opposite side (line 6). This took Soluman several trials until he succeeded in adding the RAT in the same way as he had added the first RAT. Keeping on trying to succeed in achieving the symmetrical exploration assisted him in developing his skills in exploring new data.

He **developed** his solution by positioning the first yellow isosceles obtuse triangles (IOT's) hypotenuse on the base side of the trapezium shape (line 9). When he added the second yellow IOT to the green RAT, he **developed** the solution by taking the IOT out and putting it beside the first yellow IOT (line 10). He **developed** his solution by adding the third yellow IOT next to the other yellow IOT's. Soluman added three yellow IOTs next to each other to develop his solution. I asked Soluman about his solution and he told me that he had a bird solution (line 14) which showed that he had **accepted** it (Figure 7-24). As was mentioned previously, the interaction between the adult (as a teacher) and the children in the C-M-I can happen by asking the child about what they have produced. The bird's body was made up of red QTs, the wings of green RATs and the feathers were yellow IOTs. He took care in positioning every triangle so that his representation was simple but accurate. Soluman had realised by this exploration that new data (positions) helped him to generate a creative solution.

Figure 7-24: Bird solution

Soluman began to **frame** the problem again to **generate** another idea by altering the yellow triangles' positions (line 16) and **developed** it by removing the green triangles (line 17). Soluman **accepted** a castle (Figure 7- 25) by telling his friend about it (line 18). Soluman became aware of and interested in exploring alternative solutions for the same shape, which developed his skills and perspective in playing with this material and with all of the MSM.

Figure 7- 25: Castle solution

Soluman's friend took one red QT and put it between two yellow IOT's, but Soluman stopped him (line 21). Soluman took the red QT and put it back in the place from which his friend had taken it and added the second red QT to his shape (line 23). The difficulty in communication between Soluman and his friend (signified by refusing his friend's idea) led Soluman to prefer to work alone, which limited his experience and elaboration of his play. However, Soluman completed his play by adding the red QT to the yellow IOT in three different positions, to **develop** his solution (Figure-26), which showed flexibility. He focused on using the triangles and made some advanced moves to try to attain his solution. However, Soluman did not complete the piece and returned the material.

Figure-26: Uncompleted solution

Soluman generated three solutions (see Table 7-7): a bird, a castle and an incomplete shape, which counts for zero. The child scored two at fluency and two for flexibility, because he generated two different categories, a Bird category and a Building category. Soluman developed these two solutions, which meant that he scored two for elaboration of skills.

Table 7.7: **Soluman's score in the three Creative Skills at the TB1**

Fluency	Flexibility	Elaboration
2	2	2

In sum, Soluman used three types of triangles: QT, RAT and IOT. Soluman, like Saud, eliminated the big yellow QT from his solution. Moving the shape 360 degrees, to see it from different angles, may indicate that Soluman built up his own perspective and understanding of use of these triangles without interacting with his teacher or friends. Developing the solution helped him in reaching his exploration goals. It appeared that he explored the symmetrical method in his solutions. Soluman built his own approach which was to create one solution and develop it to reach another creative solution. He persisted with the same bottom shape in his two solutions as Saud had done with his first five solutions with the same material in week-11. However, Saud moved on to produce more solutions from scratch, but Soluman did not. Soluman needed to explore more triangle positions, such as aligning hypotenuses to produce more creative solutions, and he needed to figure out another approach to solving his problem creatively playing with the Montessori materials. Whether this can be attributed to reduced adult interaction, or just to Soluman's interest in repetition and pattern development, is considered later in this chapter. The main development for Soluman in this episode was that he explored one position and applied it in two creative solutions. Soluman worked on exploring more data from the materials he played with. The number of solutions increased. His approach in solving problems was clear. He produced more than one solution and consistently started play by copying a Montessori solution.

7-4-3 W14-Wednesday-Episode-58, Playing with the Colour Cylinders

In Week 14, Episode 58, Soluman **constructed an opportunity** by choosing the RC-GC and BC from a variety of Toy-table materials (full analysis of the episode in Appendix 7-7). The green cylinders attracted Soluman first, and he began by building a tower after comparing two cylinders (line 1) and **developed** his solution by putting them one on top of the other (line 3). He did not put the last GC on top of the tower, but instead he **framed** the problem and **generated an idea** by using RC1 instead of GC1 (line 4).

Soluman copied the moves with the red cylinders and **developed** his solution by building RC as a tower next to the green tower, and he **developed** it by putting GC1 on top of the red tower (line 8-9). He also **developed** his solution by building the blue tower next to those two towers. However, he did not succeed in building the blue tower, because he put the large cylinders on the top, which caused it to fall down twice (lines 11-13). Soluman did not **explore** the possibility of putting the largest cylinders at the bottom to build the tower.

He scored one for fluency and flexibility and also scored one for elaboration (see Table 7-8).

Table 7.8: **Soluman's scores in the three Creative Skills with the Colour Cylinders**

Fluency	Flexibility	Elaboration
1	1	1

In this episode, the material did not challenge Soluman because he had played with the colour cylinders four times, including this one and this limited his experience which he showed in producing just one solution. The element of interest in the materials affected Soluman's capacity to produce creative solutions. Solving the problem with the same solution as that presented to Soluman, when playing individually, did not allow him to explore positions for the cylinder, such as rolling it, and he played without combining materials, which also affected his capacity to solve problems creatively.

7-4-4 W21-Monday-Episode-85, Soluman's Final Creative Solution Playing with the MSM

Soluman until this point did not have experience of mixing different MSM in play like his child match Saud. In week 21, Episode 85, Soluman generated his final creative solutions with the TB2 (full analysis of the episode in Appendix 7-8). He **constructed** the opportunity by choosing to play with TB2 (line 1). He started with three yellow triangles IOT and made a large yellow triangle, which is a Montessori solution, but it remained to be seen if he could use the triangles in different ways from the Montessori solutions (line 4-5).

He looked at his shape from different angles, and then he **framed** the problem by putting the hypotenuse of the fourth yellow IOT between one side of the red IOT and the large yellow triangle **to generate** an idea which was different from Montessori (line 8). He **developed** the solution by adding more yellow and grey IOTs (lines 10-11). He **accepted** the rocket solution by telling his friend about it (line 13) (Figure-27). Also in this solution, Soluman moved physically around it twice to see it from different points of view, as he developed it and accepted it. Soluman appeared to discover how to use his previous experiences effectively in producing creative solutions, but he still started every attempt with a basic Montessori solution instead of discovering original positions or removing irrelevant ideas. However, this did not seem to affect his creativity. Soluman **developed** the rocket solution by adding more detail to it, like the plume at the base, by returning the red IOT instead of the grey triangle (line 15). He also **developed** the solution by adding the grey and yellow IOTs side by side with the red IOT (line 16-17).

Figure 7-27: Rocket solution

Soluman directly took two yellow IOTs from his previous solution and put them side by side, and **developed** his solution by choosing three different colours to make a large equilateral triangle (line 21). He **framed** the problem by repositioning the triangle and by holding the grey IOT up between the two triangles to **generate** another idea (line 22). Soluman **explored** the holding up position, which was new to him. He **developed** his solution by touching the yellow and red IOTs and placing them between the grey and yellow IOTs (line 24). Soluman **accepted** an aeroplane (Figure 7-28) by telling his teacher about it (line 28). Soluman's solution indicated his creativity as he became aware of how he could utilise different types of triangles, horizontally and by holding them up. Soluman explored different dimensions by using the IOTs in his solutions. Soluman began with a complex shape using nine IOTs in his first solution and three IOTs in the second solution. Whatever the number of triangles (moving from using nine triangles in one solution to three triangles and producing a new solution), Soluman generated creative solutions and accepted them. Soluman usually played with the triangles horizontally and this was his first attempt at playing with them vertically. He showed more imagination in his solution and made another contribution to his skills in solving the problem creatively.

Figure 7-28: Aeroplane solution

He also began to **frame** the problem by putting five yellow IOTs on top of each other to **generate** another idea (line 30) and **developed** it by making a rhombus shape with two grey IOTs (line 31). He opened and closed the rhombus shape to create a scorpion, and he said that out loud (line 33), which indicated that he **accepted** it (Figure 7-29). In this solution, Soluman shifted his creative solutions from producing in one category to another, from airplane solutions to an insect solution. In this solution, Soluman played dramatically with his shape, in a similar way to his child match Saud, who played dramatically with the slide solution and the maid's house. It appeared that he moved from just producing creative solutions to playing dramatically and using his imagination effectively in moving the two triangles to simulate the insect's movement. The development of a creative solution into creative play represents a desire to have more advanced sensory interaction with the materials.

Figure 7- 29: A scorpion solution

He looked at his shape and held the red IOT in his hand, looking around from different angles. Soluman **developed** the solution to **generate** another idea by adding the red IOTs' hypotenuse to one side of the yellow IOT (line 36) and copied this same move by adding the red IOT onto the opposite side of the grey IOT. He also copied it with another red and yellow IOT to **develop** his solution (lines 36-37). He **accepted** a spaceship construction by adding two more IOTs (Figure 7-30) and directly went to his friend, telling him that he had made a spaceship (line 38). In this solution, Soluman searched for grey IOTs to make his symmetrical solution. He searched for grey IOTs to match the red IOT in different triangle boxes.

As T2 said, that was one of the more complex solutions produced in all her classrooms (observation note, Episode 85), because of the matching colours on two sides of the shape and the effective use of the triangles on each side of the spaceship solution. Soluman then framed the problem and generated another spaceship (Figure 7-31). Producing two different types of spaceships with the same triangles showed an ability to mediate his learning experience and developed his skills by using these triangles differently in all of his solutions in this episode.

Figure 7-30: Spaceship solution

Figure 7-31: spaceship solution

After several rounds of play, Soluman focused on one approach which produced creative solutions at every attempt, but he did not develop any solution to reach another creative solution, which was one difference between him and his child match Saud, in this episode. This could perhaps be attributed to Saud being prompted through C-T-I to look for alternative foundations to his solutions. Soluman examined all adjoined triangles in all the solutions. Some of Soluman's designs were symmetrical, because he copied the same design from left to right, as in spaceships1-2, and also in the bird solution with the green triangles. On the other hand, they were complex designs, because the triangles were difficult to transfer from side to side and to arrange so as to look completely symmetrical. This approach fits with the impression that Soluman responds to patterns and exhibits an interest in repetition.

He created a rocket, an aeroplane, a scorpion, spaceship1 and spaceship2. These five creative solutions gave him a score of five for fluency (see Table 7-9). They were in three categories: rocket and spaceship are in the outer space category; the aeroplane is in the transport category and the scorpion is in the animal category. Soluman scored three for flexibility and five for elaboration.

Table 7.9: **Soluman's scores in the three Creative Skills at the TB2**

Fluency	Flexibility	Elaboration
5	3	5

Soluman mostly started as would be expected by copying the Montessori solution, and then tried to make creative solutions. He explored and focused on a symmetrical approach, which was at a higher level of difficulty than other children could achieve. He discovered the holding up position and used on creative solution for the first time. Soluman was still revisiting the exploring the data stage, which was not the case with Saud. Soluman did not mix the MSM during his play (apart from the five triangle boxes, which count as a set of materials), which would have been another way to produce more creative solutions, like Saud. Soluman had one approach to solving his problem creatively playing with the Montessori materials. He did not combine the two approaches to solving his problem creatively playing with the Montessori materials in one episode.

7-4-5 Summary of Soluman's Case

Soluman played individually in his first attempts with all of the MSM. In the first episode (week-5, section 7-4-1), he went beyond the regularities and repetitions of the Montessori solution in his exploration of the angle position (line 3). This helped him to discover a new perspective in playing with the colour tablets and enabled him to solve the problem creatively (line 9). In the developing stage, adding tablets led him to explore the data. He went through all three components of the CPS (section 4-3) and all stages in this solution. He explored the new position and knew how to apply it to a creative solution, as Saud had done. He broke away from the expected copying of the Montessori solution and moved forward to think creatively to solve the problem. Soluman at this stage of the research (in order to score more in the three creative skills) needed further attempts to develop his skills with alternative solutions and new orientations to contribute to his learning or to direct himself differently from the Montessori solution. The more Soluman produced solutions, the more his creative skills, like fluency and flexibility developed.

In the second episode (week-11, section 7-4-2), Soluman played with the TB1. He was engaged in monitoring and making sense of immediate triangle positions to frame the problem (line 2). He moved fluently from copying the Montessori solution to start with his own initial move. For the first and only time, Soluman started with his own position and not copying the Montessori solution. However, he did not take advantage of that move by doing it again and went back to copying the Montessori solution as an initial step. He developed the solution by rotating the triangles by 45 degrees (line 4). He explored a symmetrical approach which assisted him in producing the bird and castle solutions and went through the process of CPS twice (section 4-3). Soluman was still at the exploring the data stage, which led him to produce two creative solutions.

When compared with the previous episode-19, the number of creative solutions doubled in this episode, with experience with the MSM. The interest in playing with the particular material was an element in producing large numbers of creative solutions. Soluman was interested in the TB material more than the others MSM, according to T2 and research observation. His approach to playing with the triangles helped him to create a new solution, which he developed to reach yet another creative solution. This was another approach that Soluman had not used before and he did not use it again. Soluman showed development with his creative problem solving approach. In the first episode, he produced individual solutions and, in this episode, he developed one solution from another.

In the third episode (week-14), Soluman played with the Colour cylinders by copying a Montessori solution, but then he switched to two colour cylinders to reach a new creative solution. Soluman went back to playing with the MSM in regular way (with the colour cylinders), and repeated the same solution, because he was not especially interested in this material or did not have much experience in playing with it. That limited his creative problem solving skills with regard to the Colour cylinders. He chose to pay attention to some materials and ignore others, and he transferred what was available to fit his uses and interests. The interest in a particular material affected the child's creative problem solving.

In the fourth episode (week 21), Soluman made his final creative solutions with the TB2, creating five different solutions, starting with one basic Montessori solution. The number of creative solutions was rose compared to previous episodes, which showed improvement in Soluman's capacity to solve the Montessori problems in a creative way. Having experiences in playing with triangle boxes through repeating, exploring, and various experiences with triangles challenged Soluman to become skilled with TB material. He started all of his solutions with Montessori instead of starting with an original position (different from Montessori). This limited his approach when starting play with the MSM, unlike his child match, Saud, who had two approaches in establishing play with the MSM.

Soluman went through the process of the CPS framework five times. He, until now, still revisited the exploration of the data stage (holding up the triangle), which was different from his matched child who did not go through this stage any more.

He did not use the big yellow triangle in any of his solutions. When Soluman started with a solution, he always completed it and did not change his idea in the middle. His approach was to produce each solution separately. He did not produce one creative solution and develop it to produce another in this episode.

According to the teacher-2 (T2) [T2, Field Note-Episode-76], Soluman was interested in this material, and he showed significant improvement in producing more creative solutions. However, until the end of the year, he did not combine one material with other materials to broaden his use of the MSM and produce more creative solutions.

7-5 Sara from C-T-I Case

Sara is a member of the C-T-I case study group. She is a sociable girl who plays in a group with her friends [T1's Observation record, Episode-20]. She likes to play in the drama area, art area and at the Toy-table area (Observation Notes, Episode 39). She has her own "beautiful imagination", which helps her to create different solutions, which she likes to present to everyone [T1's Observation Notes, Episode-47].

7-5-1 W4-Tues-Episode-16-Sara's First Creative Solution

Sara produced four creative solutions: Cake, Cake2, Castle and Animal Zoo (Full analysis of the episode in Appendix 7-9). To avoid repetition of the analysis, I selected her first and final solutions for analysis within the CPS framework. The second and third solutions were similar to the first solution, because she only changed the top places of cubes and prisms placement, not the whole structure.

Sara **constructed the opportunity** to play with the brown stairs (BS), because she chose the material from a variety of other possibilities from the Toy-table area. She started by copying the Montessori solution; a vertical tower. She interacted collaboratively with her friend Meshoo, who started to put BS10-9 next to each other. Sara **framed** the problem when she mixed pink tower PTs with the BS by putting (10-9-8) next to each other on top of the BS (line 6), which was different from Montessori, to **generate** an idea, which might lead to a new possible solution in response to the BS and PT problem and could be considered as a creative idea. This was Sara's first attempt to combine these two materials. Meshoo and Sara **developed** their solution by adding BS6-7 vertically on top of the pink cubes (lines 7-8) because they improved their solution by adding cubes and prisms.

Sara **developed** the solution by adding more PT and BS, and Meshoo **developed it** by taking out the pink cubes that Sara had added, and put the BS6 on top of BS7 at the corner of their building (line 10). Sara **developed** the solution by adding BS8 vertically at the corner and added PT (4-3-2) on top of BS4 (lines 11-12). The girls went to T1 and Sara told her that they had made a ‘cake’. This showed that they had **accepted** their building (line 13) because they completed it and sought feedback from T1 (Figure 7-32).

Figure 7-32: Cake solution

Sara and her friends developed their solution to the level of acceptance of the second construction, cake-2, and also the castle building. Sara’s friends left the Morning Circle (MC) and she asked me (as a teacher) to play with her. I took one cube to establish another solution and **framed** the problem when I put PT10 in the middle. I **generated** another idea by placing the edge of the BS10 to one side of PT10, which was absolutely different from Montessori solutions. Sara **explored** that position with me (line 32). I taught Sara a new position tacitly, without directing her moves. Sara copied my move to **develop** the solution, laying BS9 on top of BS10, and Meshoo came back to play with her (Figure 7-33). Sara **developed** the solution by putting PT9 on top of BS10 (line 35). Sara’s friends came to play with her. Sara directed them in how to add the cubes and prisms. Sara **developed** the solution by copying her moves with her friends until all prisms and cubes were used up (Figure 7-34). Sara called the solution a bridge but Meshoo called it a zoo (line 39). Sara **accepted** Meshoo’s suggestion about the building by adding a plastic animal to it (line 40).

Figure 7-33: Zoo solution

Figure 7-34: Zoo solution

Sara commenced the episode by copying the Montessori solution. In the first three solutions, Sara participated with her friend in playing with the materials. However, Sara was the one who framed the problem, generated the ideas and accepted them by telling T1. Sara interacted with T1 in the first three solutions at the acceptance stage by naming the solutions.

In the final solution in this episode (the fourth solution), I taught Sara tacitly by positioning the PT and BS differently from the way she had done it before, but without directing her. By copying my moves in laying the PT on top of the BS without specific direction from me, Sara developed her own experience in solving the problem creatively. In this episode, the adult (teacher) guided Sara tacitly in framing the problem, generating ideas, exploring data, and developing solutions.

By the end of this episode, Sara had two approaches to solving the problem creatively. Sara's first approach was to create diverse solutions from one creative one and the second approach was to produce each solution separately.

Regarding the four creativity skills, Sara revisited the Generating-Idea Component four times in this episode. She generated cake, cake2, castle and zoo solutions, which gave her a score of four for fluency in this episode (see Table 7-10). Two of these solutions were in the same category (Food) and the other two solutions were in different categories (Building and Leisure). She scored three for flexibility. Sara scored four in elaboration, because she developed all four solutions.

Table 7.10: **Sara's scores in the three Creative Skills at the BS and PT**

Fluency	Flexibility	Elaboration
4	3	4

In sum, Sara had combined the Montessori materials before with T1 and she did it again with her friends. She generated three solutions with her friends, without exploring new positions for the cube or prisms. The combination of the materials helped her to create solutions. When she interacted tacitly with the adult, the adult helped her to combine both materials and explore new positions. The interaction helped Sara in framing the problem to generate new solutions, exploring new positions and developing them. Sara was the first child and only child who had two approaches to solving the Montessori problems at this stage of the experiment.

7-5-2 W12-Sunday-Episode-46, Playing with the TB

On this occasion, Sara began play in the free-time period with the TB3 with no interaction with adult. Sara had previous experience of playing with the triangles, for example in week 8-Episode-32. She had had several attempts at playing with the TBs, which indicated that she had familiarized herself with them by exploring different positions and producing creative solutions.

In this episode, Sara **constructed** the opportunity to play with TB3. She **framed** the problem directly by connecting two IOTs at one corner, which was different from Montessori solutions, to **generate** an idea and to show her understanding of how to manipulate the triangles (line 1). She **developed** her solution by adding two red IOTs to make a rhombus, but then she was not satisfied with her solution. She mixed up the triangles in a grumbling sort of way, and started again (full analysis of the episode in Appendix 7-10). The fact that she started again shows her interest in the shapes and her motivation to produce good solutions.

She **framed** the problem again by arranging the IOT triangles by colour (grey, red and yellow), one under another, to **generate** another idea (line 6). Sara **developed** the solution by adding more triangles in the same colour sequence (lines 7-8) (Figure 7-35). She parted the IOTs to make space for a yellow QT, then, by chance, two IOTs came together at their corners to give Sara an idea. Sara **explored** a new position of the IOTs, by placing them at one angle. She **generated** another idea by putting the six IOTs together at one angle (lines 9-10) (Figure 7-35).

Figure 7-35: Sara explored a new position of the IOTs

Figure 7-36: Sara gathered IOTs at one angle

Sara **developed** the solution further by adding three yellow IOTs and the QT (lines 11-12). I asked Sara (as a teacher) about her solution and she told me that she **accepted** it as a sun building, but then she transformed it into a flower solution (line 14) (Figure 7-37-2). She **developed** her solution by adding the grey QT from TB1 and colour cylinders (lines 16-18). Sara asked Lulu to give her three cylinders to **develop** her solution, and then Sara **accepted** her solution by telling Lulu that she had created a face solution.

Figure 7-37-1: Sun solution

Figure 7-37-2: Face solution

In this episode, Sara revisited the Generating-Ideas Component twice and created two solutions (see Table 7-11): sun and flower. She scored two for fluency and two for flexibility because the two solutions were in different categories (Weather and Plants). Sara developed both solutions and scored two for elaboration.

Table 7.11: Sara's scores in the three Creative Skills with the TB3 and Colour Cylinders

Fluency	Flexibility	Elaboration
2	2	2

In sum, when the triangles came together by chance, Sara took advantage of this exploration, and while developing one solution, she generated another idea about segments of a circle which showed her flexibility during play. Sara's initial technique was not to copy any Montessori solutions; she found her approach by creating a solution and developed it to create another solution. She showed understanding in playing with triangles by taking the same types of triangles from different boxes and using them to create her solutions. However, Sara eliminated the QT from her solution which might have affected her creative solutions. There was a similarity in Sara's interaction with me and with Lulu, in that both occurred in the acceptance stage. Sara was still at the stage of exploring the data and developing creative solutions.

7-5-3 W16-Mon-Episode-65, Playing with Colour Cylinders

Sara started the episode by **constructing** an opportunity, choosing to play with the TB3 (Full analysis of the episode in Appendix 7-11). She started to copy the Montessori solution by making the hexagon shape with the QTs during her interaction with Lulu (line 2). They **developed** the solution by putting six QTs next to each other as a first level. Lulu searched for more QTs in TB4 and **developed** their solution by making a second level with the QTs (line 4).

Sara **framed** the problem by organizing the red, green and grey QTs in a pattern (line 11) (Figure 7-38) to **generate** an idea. Sara explained how she did it to Lulu to develop their solution (line 11). Lulu **generated** an idea by adding YC-GC-BC in various ways (line 13) (Figure 7-39). Lulu **developed** the solution in adding the cylinders around the triangle shapes, by putting them in order of colour (line 14). Sara also **developed** their solution by adding the colour cylinders in order according to their diameter as well as colour and making a surrounding pattern with them (line 15-16). Sara **developed** the solution by adding RC1 and GC1 to the middle of the shape (lines 18-19). Sara **developed** the solution by adding the YCs in the middle (line 20) of the other colour cubes. Sara **accepted** a birthday cake solution by telling T1 about it (line 24) (Figure 7-40).

Figure 7-38: Sara put QTs in pattern

Figure 7-39: Adding YC-GC-BC in various ways

Figure 7-40: Birthday cake solution

Regarding to creative skills, Sara scored one for fluency, flexibility, and elaboration (see Table 7-12).

Table 7.12: Sara's score in the three Creative Skills with the TB3-1 and Colour Cylinders

Fluency	Flexibility	Elaboration
1	1	1

In sum, mapping triangles according to their colours, combining triangles with cylinders, mapping cylinders according to their diameters and putting them in order according to their colour were creative solutions presented by Sara. This showed a development in her capacity to solve problems. She knew how to put cylinders next to each other or on top of each other, but she did not combine these two positions to help her solve the problem creatively. Positioning the QTs to form hexagons and placing cylinders in lines were basic Montessori solutions, but Sara developed these positions and combined them to produce her solutions. Sara moved from the exploration of data stage to development of solutions stage. Sara's approach to solving this problem was to generate one solution, starting from a basic Montessori solution. Sara did not develop her creative skills in cylinders because she did not use the data she already had about them. For example, she did not combine two different positions into one solution.

7-5-4 W-20-Mon-Episode-80, Sara's Final Creative Solution Playing with TB

In this episode, Sara **constructed** an opportunity, playing with TB3 (Full analysis of the episode in Appendix 7-12). She started with the equilateral triangles (QTs) and made a hexagonal shape, which was a Montessori solution but she considered ways to move them to create a different solution (line 2). She **generated** spaceship and rocket ideas by identifying them and putting two isosceles obtuse triangles (IOTs) one on top of another (lines 9-13). Sara clarified her idea to me (as a teacher) and wanted my support to achieve the goal by saying: "I want to make a big rocket". We both participated in playing with the triangles to achieve the rocket solution. Sara responded well to the collaborative teaching approach as she interacts with her friends in a similar way.

Sara did not know which of the triangles to start with to create the rocket solution. I directed her explicitly to start with the big yellow QT and put it in the middle to start with (line 12). I (as a teacher) **developed** the rocket solution using two IOTs, but Sara put them underneath each other (line 15). She **developed** her solution by adding more yellow IOTs (line 18). Aziz played collaboratively with Sara and **developed** the solution by changing the big yellow QT's place and put it at the top (line 19). Sara removed it and I asked her to leave it in her solution (line 20). Aziz also wanted that. I directed her explicitly to leave the QT to develop her solution and accept her friend's view. Then she put it back to make a rocket head (line 21). Sara **developed** the solution by adding a second big yellow QT at the bottom of their solution and by adding two red IOTs on top of it (line 23) (Figure 7-41). I (as a teacher) directed Sara and Aziz explicitly to add more red IOTs telling them to make a flame for their rocket and to **develop** their solution (line 25-29). They **accepted** their building by standing looking at it (line 30). Aziz **developed** their solution by adding a grey IOT (line 31) to the big yellow QT at the head and Sara **developed** it by adding spaceship accessories (line 32) (Figure 7-43).

Figure 7-41: Sara developed her solution

Figure 7-42: spaceship solution

Figure 7-43: Sara added spaceship accessories

Sara scored two for fluency and one for flexibility and elaboration in the rocket solution (see Table 7-13).

Table 7.13: Sara's score in the three Creative Skills with the TB3

Fluency	Flexibility	Elaboration
2	1	1

In sum, when Sara clearly asked the adult (her teacher) for help to make a particular shape, the adult directed her explicitly in developing the rocket solution with her friend. Sara focused on the developing the solution stage more than other stages. She did not explore further positions with the materials. In this episode, Sara generated two ideas but applied by action a rocket solution. Sara's approach over the last two episodes was to create a solution and to try to develop it. She used the same approach of putting IOTs under each other as she did for the rocket solution. She might have restricted her capacity to find other solutions by not using other types of triangles, such as the RAT.

7-5-5 Summary of Sara's Case

Sara, like Saud (both of whom were in the C-T-I group), generated her first creative solution during interaction with a friend and an adult (her teachers). At the first episode (week-4, section 7-5-1), Sara reproduced the Montessori solution then combined the PT with the BS. Sara was the first child from the research sample to combine two materials, something which can be taken as a sign of the development of her creative capacity. Sara produced her first creative solutions during her interaction with her friends. Sara improved her own experience with the materials by generating two more creative solutions using the same type of pattern.

In the first creative solution during W4, Sara was the one who framed the problem, generated the ideas and accepted them by telling T1 (Appendix 9-line 13). Sara went through the three stages of the Understanding-the Challenge Component, the Generating Ideas-Component and the two stages of the Preparing for Action-Component three times, producing three creative solutions with her friend. Sara did not explore new positions during interaction with her friends.

In the same episode, Sara interacted with the adult (teacher), who played a tacit role in the development of Sara's skills, by exploring new positions with the materials. The tacit teaching happened with in the Understanding component and at the framing of the problem and the exploration of data stages. Sara went through the whole process of the CPS.

At the second episode (week-12), Sara played with TB3. She had gained experience of playing with TB1-2, as the boxes had the same kinds of triangles as TB3. She started playing directly by framing the problem and found out how to place triangles sideways or at an angle. She was at the exploration stage and developing solutions. She developed her play by combining this material with other Montessori materials, and inspired her solution by adding a mouth and eyes. Sara showed development in her creative skills in solving the problem by adding details to her solutions.

Sara went through the CPS twice and went through all the stages of the three CPS components. The difference between this episode and the previous one was that in this episode Sara interacted with the adult (teachers) at the acceptance stage, telling the teacher (T1 and I) about her solutions, but in the previous episode she interacted with the adult in the three components of the CPS. Sara's approach with the MSM was to generate one creative solution and develop it to generate another. She had one approach to solving the problem, unlike in like the previous episode, when she had two approaches. At this stage Sara did not copy the Montessori solution. She developed her own experience with the triangles, and that led her to start directly to produce new creative solutions. Her method was to explore one new position, produce one or two creative solutions and keep developing these.

In the third episode (week-16), Sara played with the Colour cylinders and TB3. She started with one of the Montessori solutions. Sara had two methods of solving the problem in this episode: starting from a different position from the Montessori solution or using it as an initial move towards a creative solution. There was no interaction with adults accepted in acceptance of the solution. She knew how to combine two types of Montessori material to produce a desired solution, which some of the children at that stage of the experiment could not manage; e.g. her matched child Soso.

Sara went through the three CPS components once in producing the cake solution. She went through the developing a solution stage more than the other stages. She needed to explore more orientations of the materials to help her to produce different creative solutions.

In her final creative solution (week-20, section 7-5-4), Sara used TB3. At this stage of the experiment, Sara announced loudly her intention. She framed the problem and generated an idea, and the adult (as a teacher) directed her explicitly in adding the triangle to reach her solution. The direct teaching happened because Sara asked directly for help from the adult and it happened in framing the problem stage. This was different from her first episode, when the adult interacted tacitly with her. When Sara interacted socially with her friend, the adult kept teaching both of them explicitly, to develop the solution by adding triangles until they reached the solution. The explicit teaching also happened in the developing the solution stage, which was similar to the W4 episode when the adult showed Sara how to add the cubes and prisms to develop the solution.

Sara in this episode focused on how to apply her idea in action with assistance from an adult (teacher). Sara used the same method of focusing on developing one solution rather than producing a number of creative solutions. She combined Montessori materials with other classroom materials and showed that she was expert in adding details to solutions. She used every triangle accurately to achieve the rocket solution.

Sara went through the three CPS components once. She used all the triangle types in her solutions, unlike Saud and Soluman. Her approaches were to produce each solution separately or to use a Montessori position to develop a new creative solution, which she then developed. In conclusion, Sara's style in solving the Montessori problems was to explore one position and develop it in to more creative solutions.

7-6 Soso from C-M-I Case

Soso from the C-M-I case is the matched pair of Sara from the C-T-I group. She seemed to be uninterested in the table toy area until T2 presented the Colour tablets (Col). She spent most of the free-time play in this area with the art area (observation-note, episode-19). She likes to play with the (Col) without T2 assistance and she is imaginative with these tablets and creates different solutions according to T2:

> "Soso likes playing with Col2-3, creating different patterns, but she needs our help to develop them into more complex solutions in combination with other materials. Then she shows us her imagination."
>
> [T2-Inteview 5-p5]

7-6-1 Week-5-Mon-Episode-19, Soso's First Creative Solution

Soso **constructed** an opportunity to play with Col3 (line 1), choosing the materials from a variety of possibilities from the Toy-table area. She started with the yellow tablets and chose to put them horizontally next to each other, as in one of the Montessori solutions (Full analysis of the episode in Appendix 7-13). She **framed** the problem by placing one tablet upright on a horizontal tablet, a move that could be considered as **generating** a different idea from Montessori (line 4). With this move, she also **explored** a new position for the Col because it is different from the Montessori Col positions.

Soso **developed** the solution by putting the two tablets upright and by placing one yellow tablet horizontally across them. She could not achieve this because the gap was too wide (line 8) (Figure 7-44). Soso gathered the three tablets and held them up in her hands. She wanted to start over again (line 9). She went beyond the regularity of play with the tablets and instead of repeating the same solution by exploring a new position from which to produce a creative solution.

Soso took the three tablets to **regenerate** the same idea by placing one tablet vertically and adding another one horizontally next to it, but then she went back to the previous move, positioning two upright tablets and placing one on top (line 10). She **explored** ways of laying one horizontal tablet on top, which was a discovery of the possibilities of the material's positions (line13) (Figure 7-45). Soso **accepted** the solution by telling her friend that it was a table (line 14). Soso did not give up trying to achieve this solution, trying to reach a new position, but she found the distance between the two tablets confounded her success. This situation of the tablet position required Soso to adopt new skills to solve this problem. She eventually came to realise that if she brought the two tablets closer, she could place the third one on top of them. She had acquired dramatic changes in her skills by moving the table to achieve that solution.

Figure 7-44: Soso put two tablets upright

Figure 7-45: Table solution

Soso started again by mixing the tablets and **framed** the problem by placing one tablet horizontally with one vertical tablet next to her previous solution and looked at them to generate another idea. She **accepted** it by saying ‘pillow’ in a loud voice (line 16). At this stage, Soso explored combining horizontal and vertical positions in one solution and explored the holding up position which assisted her in solving the problem creatively. Taking out the green tablets from the box, she started another solution (line 17) and **framed the problem** by putting one tablet vertically, which was different from Montessori to **generate** an idea. She **developed** the solution by placing one green tablet vertically and putting another one horizontally (line 18) (Figure 7-47). Soso probably wanted to take advantage of her exploration of the vertical position so adapted it and applied it to new solutions. Soso’s solutions were similar to each other (two horizontal tablets with one vertical). The curiosity of repeating the same positions assisted her in producing solutions in the same category and helped her clarify more data in playing with the material to develop her understanding to produce creative solutions.

Figure 7-46: Pillow solution

Figure 7-47: Soso developed her solution

Soso changed the position of the vertical tablet and laid it down to **develop** her solution (line 19). She added two more tablets, copying her previous move (Figure 7-48). Soso **accepted** it by telling T2 that she had made a table and sofa (line 22).

Figure 7-48: Table and sofa solution

Soso created three solutions (see Table 7-14): a table, a pillow, and a table-sofa solution. Soso scored three for fluency. All of these solutions were in the home furniture category. She scored one for flexibility. Soso developed two solutions, but did not develop the pillow solution. She scored two for elaboration.

Table 7.14: Soso's scores in the three Creative Skills with the Colour Tablets

Fluency	Flexibility	Elaboration
3	1	2

In sum, Soso started her creative journey by repeating a Montessori solution, as an initial move towards solving the Montessori problems, as did all the other children in this research. She explored the vertical position and applied it well in her three solutions. Soso, like the other children, worked on exploring more positions at this stage of the experiment. She also combined two different positions in one solution which showed her developing capacity to solve the Montessori problem creatively. However, she did not use the holding up position, which she had been exploring in this episode, in any of her solutions. Her approach in solving her problem creatively by playing with the MSM was to produce each solution separately. Soso's solutions were all in the same category.

7-6-2 W12-Sat-Episode- 45, Soso Playing with the TB

Soso and her friend seated next to her played with the TBs, but independently. Soso created five different solutions, an envelope, a spider's web, a flower, a blanket and bandana. In what follows, only four of them are presented to avoid repetition.

Soso had played with the TB1 before in Week-8-Tuesday-Episode-32. In this episode, she **constructed** an opportunity by choosing to play with the TB2 (Full analysis of the episode appears in Appendix 7-14). Soso copied the Montessori solution by joining two isosceles obtuse triangles (IOTs) (line 2) along their hypotenuse. She **framed** the problem when she added a QT to one side of the IOTs, which differs from the Montessori solution, **to generate** an idea (line 3). She **developed** it by adding one more IOT to make a rectangle shape and then added another equilateral triangle (QT). She **accepted** it by telling T2 'it is for mail' and T2 told her its name (Figure 7-49). She continued to **develop** this solution with another idea, adding a yellow right angled triangle (RAT) (line 9) and she **framed** another problem statement by repositioning the QTs to **generate** another idea (lines 10). Soso **developed** her solution by adding three QTs (line 11). She tried to place two QTs in her pattern but she **developed** her solution by taking them out (line 13). She **accepted** her spider's web by telling T2 about it (line 16) (Figure 7-50).

Figure 7-49: Mail solution

Figure 7-50: Spider's web solution

Soso **framed** the problem by mixing the triangles and by placing two QTs at an angle, which is different from a Montessori position, to **generate** an idea (line 18). Soso **developed** her solution by adding one more QT (line 19) to make a rhombus with the two IOTs (line 20). She **accepted** her building by telling me it was 'a flower' (line 23) (Figure 7-51). This was Soso's first attempt to position triangles at an angle, representing another perspective for understanding the material and reaching creative solutions. Soso started to copy the Montessori solution by putting one side of the IOT against one side of the big yellow QT (line 24). She **framed** the problem when she added the second IOT in a different position to indicate that she had **generated** an idea (lines 24-25). She **developed** her solution again by adding another big yellow QT, a green QT (line 26) and two IOTs. She **accepted** the blanket building by telling me about it (line 30) (Figure 7-52).

Soso clarified how different positions can be used to create similar and different types of triangles. She showed evidence of her creative skills in solving the Montessori triangle problems differently from the Montessori solutions. She also explored new positions for these triangles, but she could not apply them to her solutions, as in a previous episode. Soso needed assistance in applying her exploration of new positions to her solutions.

Figure 7-51: Flower solution

Figure 7-52: Blanket solution

Soso created five different solutions (see Table 7-15): an envelope, a spider's web, a flower, a blanket and a bandanna. She scored five for fluency. These five solutions were in different categories (Equipment, Animal, Plant, Home furniture and Human accessories), which gave Soso a score of five for flexibility. She developed four solutions other than the bandanna solution, which gave her a score of four for elaboration.

Table 7.15: Soso's scores in the three Creative Skills with the TB2

Fluency	Flexibility	Elaboration
5	5	5

In this episode, an opening move for Soso was to copy some Montessori moves, as in a previous episode, and to develop them to create different solutions. Soso explored holding up the QTs in a very creative way, but she did not apply this in her solution. She had explored the holding up position with Col before and triangle materials yet she could not apply the position to creative solutions.

She tried to make symmetry in the blanket solution, but she could not achieve that in two attempts. The main point was that Soso showed development in her exploration skills but she did not know how to use them in her solutions, as in a previous episode. She was visiting the exploration of data stage more than other stages but she had difficulty in applying her exploration. Playing alone did not help Soso in using her exploration in to creative solutions. Perhaps if she had interacted with her friends, they could have helped her in applying her exploration to solutions. Soso had two approaches in this episode: creating one solution and developing it to create another creative solution (which was new to her) and to produce each solution separately, as with her flower solution. This was the second approach Soso made during her play with the MSM. Up until that point, Soso had not combined materials together, to assist her in creating more solutions.

7-6-3 W15-Sat-Episode- 59, Soso Playing with the Colour Cylinders

Soso **constructed** this opportunity by playing with the red and yellow cylinders (RC-YC) (Full analysis of the episode in Appendix 7-15). Soso started by copying the Montessori solution and building a red cylinder tower (line 5) but she took the tower down. Soso became familiar with Montessori's solution in cylinders by repeating them with different attempts as happened at the beginning of this episode. When Soso put the RC on top of the YC, she **framed** the problem, which was different from the Montessori solutions, to **generate** an idea (line 6). Soso **developed** the solution by adding YCs-RCs in the same order as the previous cylinders (line 8) (Figure 7-53).

Figure 7-53: Soso developed solution

Soso knocked over her building accidentally with her shoulder. Then she **framed** the problem directly by putting the RC and YC next to each other to **generate** an idea (line 10). She switched her play from producing a vertical tower to produce horizontal solution. She **developed** the solution by putting more RCs and YCs in a circle (line 11). She **accepted** her cake building by telling me about it (line 13) (Figure 7-54).

Figure 7-54: Cake solution

Soso **framed** the problem by putting the RCs next to each other with the YCs to **generate** an idea (line 16). She **developed** the solution when she added more cylinders to make a vertical line (line 17), which was similar to her previous solution. Soso **developed** the solution by changing the positions of RC1-YC1 and adding YC2-3 in the middle. She also put the RC1 horizontally in the middle (Figure 7-55). For the first time, Soso added details to her solution by adding the cylinders as eyes and a mouth. Because her solution was closer to her life experience, she developed her skills giving more details.

Figure 7-55: Face solution

Soso **developed** the solution by adding the BC to close her shape (line 20) and **accepted** it as face building by telling T2 about it (line 24).

Soso generated two solutions (see Table 7-16): a cake and a face. Using the same construction and producing two different solutions showed the development of Soso's flexibility skill. She scored two for fluency and two for flexibility because the two solutions were in different categories (Human and Food categories). She also developed these two solutions and scored two for elaboration.

Table 7.16: Soso's scores in the three Creative Skills with the Colour Cylinders

Fluency	Flexibility	Elaboration
2	2	2

Soso started by repeating the Montessori solution and then shifted her play by mapping cylinders according to their diameters. That assisted her in producing creative solutions. Soso did not explore new positions for the cylinders and that created a limitation in playing with the cylinders which also happened to her matched child, Sara. She went through all the CPS stages, except the exploration of data stage. However, Soso and other children in this study produced different solutions using the circle shape. In this episode, Soso used the same approach in her play by starting with one of the Montessori solutions.

7-6-4 W19- Tuesday- Episode- 78, Soso's Final Creative Solution

In this episode, Soso **constructed** an opportunity by playing with TB3 (Full analysis at Appendix 7-16). She copied the Montessori solution by putting QTs next to each other to make a hexagonal shape (line 2). She **framed the problem** by adding two QTs to generate an idea (line 3) and **accepted** it by saying loudly 'Candy' (Figure 7-56). Just by adding two more QTs, Soso had created a new solution.

Figure 7-56: Candy solution

Soso **developed** her solution by adding cubes as eyes and an RR1 as the mouth and she took out the last two QTs (lines 5-6). Soso **accepted** the face building by telling her friend (line 7). Soso developed her flexibility skills in shifting the solution from the candy to the face solution by using the same basis but developing it.

Soso returned to the solution. Soso **framed** the problem when she added two IOTs vertically to her shape which indicated that she was **generating** an idea (line 8). Her friend Deema added one more IOT, but Soso reorganised where it should go and **developed** her solution by adding the fourth IOT as a wing for her shape (line 9). She used symmetrical exploration which was explored before in adding triangles to develop her solution. Soso showed development in using her exploration for a creative solution. She **developed** it further by putting two red QTs at the bottom of the shape (line 10). She **accepted it** by saying loudly ‘duck’ and telling T2 about it (line 11-12) (Figure 7-57). In this solution, Soso developed the candy into a duck, which gave a sign that she had controlled the approach she used in her play with the MSM. She knew how to develop basic Montessori solutions into more creative solutions. Soso developed the hexagon shape to create a new meaningful shape for her and it was clear even for an adult to recognize.

Figure 7-57: Duck solution

Soso returned to the Montessori solution when she and Deema copied the Montessori solution by gathering the IOTs and making a rhombus with them (line 13). Soso **framed** the problem by adding an IOT to **generate** an idea (line 15) and **accepted** the building by saying ‘Mountain’ (line 16) (Figure 7-58). Soso used the same approach in her final creative solution.

Figure 7-58: Mountain solution

Soso was still developing her creative skills in producing a number of solutions in different categories. Soso generated three different solutions (see Table 7-17): candy, duck and mountain. She scored three for fluency and flexibility, because the three solutions were in different categories (Food, Bird, and Landscape). She developed all these solutions and scored three for elaboration.

Table 7.17: Soso's scores in the three Creative Skills with the TB3

Fluency	Flexibility	Elaboration
3	3	3

In sum, it can be said that Soso produced all of her creative solutions by starting with a Montessori solution as an initial step. She made symmetrical shapes (candy, duck and mountain solutions) which she could not apply prior to episode-45. Soso finally applied her previous explorations (symmetrical position) to make creative solutions. She did not explore any further positions but ske knew how to use the previous ones. For the first time, Soso combined two types of MSM together (TB-RR) and used colour cubes which were not from the MSM in producing creative solutions. She added details to her solutions and showed development in producing creative solutions. She had a single approach: starting with a Montessori solution and developing it to create different solutions. She was restricted in her solutions by her selection of two types of triangles (QTs and IOTs), limiting her opportunity to create more solutions.

7-6-5 Summary of Soso's Case

Soso's initial creative solution came with the colour tablets at the first episode (week-5). She started her journey towards creative solutions by repeating the Montessori solution as an initial step to solve the problem then developed it to create solutions. She explored how to hold up the tablet perpendicularly and succeeded in using that exploration in two creative solutions, but she concentrated on that. She explored another position, but she could not apply it to a solution and returned to her previous solutions.

In the first episode, Soso completed the CPS cycle three times going through the Understanding-Component, the Generating Ideas-Component and the Preparing for Action-Component three times with all six stages. She focused on the exploring data stage by exploring two different positions rather than developing solutions. Soso's approach to solving the colour tablets problem was to produce each solution separately.

In the second episode (week-12) Soso played with the TB2. She was like Sara who had gained experience of playing with triangles before. She started with a Montessori solution, but then she framed the problem to generate a new solution. She was exploring different orientations, and for the first time, Soso connected triangles at an angle. She tried to explore how to stand a triangle up vertically using her previous experience in playing with the Col. She kept trying to apply the holding up position into creative solutions. She tried to explore the symmetrical position, but that did not work either, so she collected the triangles to create a spider web solution.

In both episodes, the main point was that she explored different positions, but could not apply her exploration to solutions. Although Soso produced a number of creative solutions, she could not apply all of her explorations to solutions. Her three creative skills increased compared with the previous episode. In addition, Soso explored a new approach to solve the triangle problem by creating one solution and developing it to create another creative solution (which did not happen in the first episode) and to produce each solution separately, which she did in the first episode.

Soso had her experiences of playing with triangles which helped her in went through the CPS cycle five times. She was learning through giving herself opportunities to build on a number of positions she already knew, in order to create new solutions. Gradually, she began to see how to fit pieces on different sides, and developed her experience with triangles. She showed improvement in developing her solutions and in exploring different positions.

At the third episode (week-15) Soso used the same approach of starting by copying a Montessori solution as the basis for a creative solution. She generated two solutions with the same idea, based on a circle shape. She did not ignore the ordinary uses of the cylinders like Sara. She knew that cylinders differ in their diameters and used this to put them in order. She knew how to put cylinders next each other or on top of each other, but she did not combine the two positions which helped her in producing more creative solutions. For the first time, Soso added details to her solution. To develop her skills in solving the problem in creative ways, she needed to explore new positions for the cylinders, which she did not do at this stage. She kept using the same method of putting cylinders next to each other like Sara. In general, she was not interested in playing with the colour cylinders like Sara and did not play with them that often.

Soso's final creative solution was with TB3 at week-19. Until the end of the experiment period, Soso's first step to start solving the sensorial problem was by repeating one of the Montessori solutions. She framed the problem and generated three creative solutions. She showed development in solving the problem creatively by combining more than one Montessori solution and developed it to generate another creative solution which was the main development in this episode. Soso moved forward by combining the triangles with other materials (for the first time) and made her design more effective by adding a mouth and eyes. She added the details into her solution in the same way that she did in the previous episode. She added more detail to the duck solution by making sea, using the blue cylinders, and grass by using the green cylinders. There were diverse ways to add details instead of copying the same way in different solutions. Soso focused in the developing stage of the CPS cycle. She succeeded in applying a symmetrical approach in all three solutions, which she had been trying in vain to achieve before but she could not.

Soso did not move beyond from copying one of the Montessori solutions to develop her skills and reach complex solutions like the duck, but she insisted on adding one or two triangles to the basic Montessori solution to create her own solution. On the one hand, these were creative solutions; on the other hand, she was not achieving her potential, in producing more complex solutions like the duck solution.

Soso went through the three stages of the CPS cycle three times, but did not go through the exploring data stage in this episode. Soso eliminated this stage and that limited her creative solutions.

Soso was interested in the colour tablets and spent most of her time playing with them. The more time Soso spent with the Col, the more creative solutions she discovered. T2 also observed her development in playing with Col, saying:

> *'Soso took time to copy the Montessori solution with the colour tablets by matching them but she developed her play and put them in line and then discovered many solutions, which absolutely showed her imaginative thinking.'*
>
> [T2 –Field Note-Episode 65]

7-7 Cross-case analysis

The research design sought to examine the effect of MSM on children's creative problem solving. Studying multiple cases made it possible to build a logical chain of evidence [Yin, 1994, Miles and Huberman, 1994], based on the CPS framework and the two classroom groups.

The second research question is: How does interaction between children and their teachers during play with the MSM impact on children's creative problem solving approach compared to those who do not receive support from their teachers? The cross-case analysis focuses on comparing the creative solutions between the C-T-I and the C-M-I groups in particular 1) The qualitative impacts of using the CPS framework, what changes occurred, and at what stage; 2) Whether or not these cases do in fact reveal differences in quantitative outcomes in the three creative skills. Three major themes (the three CPS components, the three creative skills and tacit and explicit teaching) were investigated for the second research question.

The data collected are intended to assess the similarities and differences between the child-material interaction (C-M-I) and child-teacher-interaction group (C-T-I).

7-7-1 Cross-case Analysis of the CPS and Teacher Interaction During the Four Episodes

The CPS has three components: Understanding the challenges (constructing opportunities; framing problems; and exploring data); Generating Ideas (generating ideas) and Preparing for Action (developing solutions and building acceptance). As children were often silent during play with the materials, it can be said that generating ideas happened at the same time as framing the problem in this study.

The First Episode

Soluman and Soso were in the C-M-I group. The initial move for Soluman and Soso (Week-5-Episode-19) was to reproduce the Montessori solutions playing with the Col tablets material. However, they explored new positions which helped both of them to frame the problem to generate a solution. Soluman succeeded and went around the CPS cycle once producing one creative solution, but Soso did not complete the first CPS cycle. She did not apply the 'holding up' exploration to the solution and she started the process again. Soso had another exploration, applied it well into three creative solutions and went around the CPS cycle three times repeating the same exploration in different ways. Their approach to solving their own problems creatively was to produce each solution separately.

Saud (Week-6-Episode-22) and Sara (Week-4-Episode-16) established their initial step by repeating the Montessori solution. However, the adult (his teacher) taught Saud tacitly by framing the problem to generate creative solution. The adult assisted him in exploring two new positions (exploring data stage) and Saud went around the CPS cycle three times. He explored another position alone, but could not apply it into creative solutions. In addition, Sara framed the problem to generate solutions by combining the brown stairs (BS) with the pink tower (PT) and went through the CPS cycle three times. The adult taught Sara tacitly by framing the problem and exploring the new position and she went through all the stages of the CPS. Both of the children had tacit interaction with the adult and explored new positions for the materials. The adult (teacher) guided children's understanding of how to act in producing different solutions. Sara was the first child who combined two materials together. Their approach to solving their problems creatively was to produce each solution separately. Sara had an additional approach which was to develop a solution from a previous one.

By definition, the three skills of creativity are evident when these are solutions that go beyond reproducing the Montessori solutions (see section 4-3-2). Fluency was measured by the number of solutions, flexibility was measured the differences between the solutions (see appendix 4-1), and elaboration measured by the development of the solution. In this first episode in which the children played with the MSM differently from how the materials had been presented to them, all of the children scored in the three creative skills (see Table 7-17). They showed their fluency in producing new solutions different from the Montessori solution.

All the four children scored in each of the three creative skills. The quantity of the solutions showed their differences in terms of fluency. Sara (C-T-I group) was more fluent than her matched child Soso (C-M-I group) and Saud (C-T-I group) was more fluent than Soluman(C-M-I group, see Table 7-17). Different solutions showed the children's flexibility. Sara and Saud, both in the C-T-I group, had a greater variety of ideas than their matched children. All of the children developed their solutions and scored on elaboration. They added more material until they reached their solution.

Table 7.17: The four children's scores in the three creative skills in the first creative solutions

	The Three Creative Skills		
	Fluency	Flexibility	Elaboration
Saud C-T-I	3	3	2
Soluman C-M-I	1	1	1
Sara C-T-I	4	3	4
Soso C-M-I	3	1	2

The differences between the two groups arose when an adult (teacher) assisted the children in the exploring data stage and applied these explorations to solutions which happened with Saud. The adult guided Saud and Sara (C-T-I), not only in exploring new positions, but also in defining new ways to begin playing with the MSM. The adult showed the C-T-I's children that they were free to repeat the Montessori solution as their first step and also to begin with their own moves.

At this period of the experiment, the children focused on exploring new positions which is one stage of the 'understanding the challenge' component. The children do not have to go through all the CPS cycle stages, just the stages required to solve the problem. The children explored more new positions and they apparently needed to go through the exploration of data stage to use them as creative solutions.

The children were similar in starting their initial step of the first solution by copying the Montessori solution. However, T1 guided the C-T-I children to start using their own move, not using one of the Montessori solutions. All of them had the same approach to solving the problem; to produce each solution separately. Sara (C-T-I) was the only child who had an additional approach, which was to develop one solution from another during her tacit interaction with T1.

The Second Episode

The children played with the TB in this episode. In week-11-Episode-43, Soluman (from the C-M-I group) explored a symmetrical approach and developed it to create two solutions. He went through all the stages of the CPS cycle twice, except for the exploration of data, which he went through once. He showed improvement in exploring one position and developing it to reach two different solutions. He developed another approach to solving their own problem creatively which involved generating one solution from another. Soluman doubled his performance scores by producing creative solutions which showed development in terms of the number of his solutions. His individual differences from other children appeared when he focused on exploring a new position and then applied it. He did not play with all types of triangles in the box.

In the same group, Soso (C-M-I, week-12-Episode-45) tried to explore the symmetrical and ‘holding up’ positions but she could not. She went through the CPS cycle five times without the exploration of data stage. Soso increased her quantity of creative solutions which indicated of her individual differences from the others in terms of the number of creative solutions; even though she could not use her exploration by using the same position that she explored before. She showed improvement in developing her solutions by adding more triangles than in the previous episode and showed development by finding another approach to solving their own problem creatively. Soso had two approaches in this episode: developing one solution from another like Soluman, and then producing each solution separately.

Saud from the C-T-I group (week-11-Episode-42) interacted with the adult (teacher) tacitly and created four different solutions; then he was guided explicitly when he asked how to reach a particular solution and the adult guided him explicitly to reach that solution. The adult’s role was to initially guide the child’s suggestions, but if the child was unable to achieve the solution then the adult directed the child to the solution. Saud focused on developing his solution rather than exploring new positions. He went through the CPS cycle nine times; except for the exploration of data, which he did only twice. He developed all three of his creative skills. Sara in the same C-T-I group as Saud (week-12-Episode-46) focused on exploring new positions by moving the triangles around. She created two solutions one from another and she went twice around the CPS cycle. Sara’s particular approach was to explore one position and apply it to the solution. She also took T1’s suggestion from the previous episode and added details to her solution, e.g. mouth and eyes.

All the children, Saud, Soluman, Sara and Soso, explored new positions. All of them applied their explorations to those solutions except for Soso (C-M-I group). All of them went through the three components of the CPS but in different quantity. Saud (C-T-I), then Soso (C-M-I), scored more than their matched child in the three creative skills.

The scores of Soluman (C-M-I) in the three creative skills were twice those he displayed in the previous episode; Soso's score also increased. Both of them showed improvement in their creative skills (see Table 7-18). Saud scored exceptionally high in all of the three skills, yet Sara's scoring decreased in comparison with the previous episode.

Table 7.18: The four children's scores in the three creative skills with the TB (Episode 2)

Children Name	**The Three Creative Skills**		
	Fluency	Flexibility	Elaboration
Saud (C-T-I)	9	5	8
Soluman(C-M-I)	2	2	2
Sara (C-T-I)	2	2	2
Soso (C-M-I)	5	5	5

All of the children wanted to explore more new positions, especially Saud (C-T-I) and Soso (C-M-I), whereas Soluman (C-M-I) and Sara (C-T-I) satisfied their curiosity with one exploration. Soluman and Sara focused on developing their solutions using their exploration, but Soso and Saud produced more creative solutions with (like Saud) or without (like Soso) applying their exploration to the solutions. Producing creative solutions affected Saud and Soso's fluency skills in terms of creativity. Soso did not apply her exploration in a creative solution and Saud did not use his exploration in all of his solutions. As in the previous episode; the main differences between the children were apparent in the exploring data stage-CPS and in the three creative skills. The experiences of playing with the MSM in both groups, and the interaction in the C-T-I, assisted them in producing more solutions.

As it can be seen, individual differences between the children was another element that affected their solving of the problem creativity. Soluman explored one position and kept developing it. Saud kept producing more creative solutions, Soso was an exploration person and producer of creative solutions and Sara was exploring one position and applying it to creative solution like Soluman.

The Third Episode

Soluman (C-M-I) played with Colour cylinders in week-14-Episode-58 and started his initial move by reproducing the Montessori solution. He did not explore any position. He kept repeating the Montessori solution then he framed the problem to generate a creative solution. He went through the CPS cycle once, though he omitted the exploration data stage. Soso (C-M-I) in week-15-Episode-59 started, like Soluman, by repeating the Montessori solution. She compared the cylinders by diameter but did not explore new positions for the cylinders. She went through the CPS cycle twice and eliminated the exploration of data stage in the same way as Soluman. They focused on developing the solution stage by adding cylinders. Their approach to solving their own problem creatively was to produce each solution separately. For the first time, Soso added details to her solution by adding mouth and eyes. This was an improvement in the developing stage. Both of them were not interested in playing with the colour cylinders.

In contrast, Saud (C-T-I) played with the colour cylinders in week-15-Episode-59 and went through the CPS cycle eight times, producing eight different solutions. Saud explored two positions, but he focused on developing his solutions and combining the cylinders with other materials. Saud showed consistency in producing a good number of creative solutions. He used the same two approaches towards solving their own problems creatively. Sara (C-T-I, week-16-Episode-65), like Soluman and Soso, was not interested in this material and produced one creative solution. She went around the CPS cycle once, without exploring possible different positions for the cylinders. She combined two materials together in her solutions and added details.

The two matched pairs showed that they can all solve the problem creatively but they differ in terms of the three creative skills. Saud (C-T-I) was stronger in fluency, flexibility and elaboration than Soluman (C-M-I). Soso (C-M-I) was stronger in fluency, flexibility and elaboration than Sara (C-T-I). Saud focused on developing his solutions more than exploring new positions. The key differences between the two groups were apparent in the three creative skills. They also differed in their initial steps and their approach to solving their own problems creatively. Another element that appeared in this episode related to their interest in the material. Soluman, Soso and Sara were not interested in the colour cylinders; as judged by their number of attempts at playing with the materials themselves.

The individual differences between the children appeared between Soluman (C-M-I) and Saud (C-T-I). Saud produced more creative solutions than Soluman. The two girls were similar in developing their solution and not exploring new positions.

Table 7-19: The four children's scores in the three creative skills with the colour cylinders

Children Name	**The Three Creative Skills**		
	Fluency	Flexibility	Elaboration
Saud(C-T-I)	8	5	8
Soluman(C-M-I)	1	1	1
Sara(C-T-I)	1	1	1
Soso(C-M-I)	2	2	2

The Fourth Episode

The final creative solution from Soluman (C-M-I) was in week-21-Episode-85 playing with the TB and starting with one of the Montessori solutions. Soluman kept using a symmetrical approach to his solutions, but he explored the holding-up position and applied it to a creative solutions. He went through the CPS cycle five times and through the exploration of data stage once. The quantity of his creative solution was increased when compared with the previous three episodes (see Table-7-20). The more the child created solutions the more he followed the CPS cycle. Soluman focused on developing his solutions by adding more triangles than previously. Soluman continued to go back and forth between the two stages: exploration of data and developing the solution. He played with the isosceles obtuse triangle (IOT) and did not play with the equilateral triangle (QT), but this did not affect his play in regard to producing creative solutions. He did not combine materials together or add details to his solutions. Soso in the same group (C-M-I) played with the same material in week19-Episode-78. She finally applied her exploration of symmetry in solutions in episode two. She focused on developing her solution by applying her previous exploration to solutions. She did not explore new positions, but rather combined two materials together for the first time. She used two types of triangles and neglected the rest. Both children had the same approach which was to produce each solution separately.

Saud (C-T-I, week19-Episode-78) and Sara (C-T-I, week-20-Episode-80) played with the TB and started with their own moves, not repeating the Montessori solutions. Saud did not interact with the adult (his teacher) in this episode. Saud combined materials together and added details to his solutions. He focused on developing his solutions and did not explore any new positions in this episode. He went through the CPS cycle eight times in all stages except the exploration data stage. He had the same two approaches to solving their own problems creatively. In addition, Sara (C-T-I) interacted explicitly with adults, producing one solution. The adult guided Sara by directing her in moving the triangles to achieve her solution. In all the episodes Sara showed that she could produce one creative solution and kept developing it.

Soluman (C-M-I) until that point was exploring new positions (exploring data stage-CPS) and developing his solutions (developing solutions stage-CPS) whereas Saud (C-T-I) was developing his solutions by adding details and combining materials. Saud worked more on the developing stage whereas Soluman went back and forth between the developing stage and the exploration stage. From the beginning of the experiment, the children differed in the exploring data stage. Soluman did not combine materials in the same way as Saud did. In addition, Soluman showed improvement in producing more creative solutions than before. He scored in the three creative skills, as did Saud. Saud still scored higher than Soluman and Soso scored higher than Sara.

Soso (C-M-I) explored different positions, but did not know how to apply them. She had her own experiences with trying to apply explorations from episode two, until she succeeded in episode four. She produced more creative solutions even without applying her explorations to creative solutions. Whereas Sara (C-T-I) explored one position and applied it in one or two creative solutions. Sara spent her time in developing her solution then producing a number of creative solutions which were different between the two girls.

Overall, the more the children went through the framing and generating ideas stages, the more they presented creative solutions and scored higher than others in the three creative skills. Saud (C-T-I), Soluman (C-M-I) and Soso (C-M-I) went through the CPS process more than once in every episode, which helped them to produce more creative solutions than Sara (C-T-I). Sara is a child who explores new positions and keeps developing them.

All the children in both groups showed an improvement in their three creative skills except for Sara (see Table 7-20) who was at the same level in terms of producing one or two creative solutions. The number of creative solutions affected the number of times they went around the CPS cycle and their four creative skills, which reveals the main differences between the two groups. The individual differences affected the number of creative solutions. Saud (C-T-I) explored new positions alone and with adults and had experience with using them in creative solutions. He produced a higher number of solutions than the other children and developed all of his solutions. Soluman explored one new position in the episode then he applied it in creative solutions for several episodes. Soluman (C-M-I) was an exploration and producer type. Soluman was like Saud in exploring new positions, but they differed in terms of the period of the time he took to reach a solution as Saud explored positions sooner than Soluman. Sara (C-T-I) was an exploration type of person who developed solutions. Sara explored one position and applied it to a solution, and then kept developing this solution. Soso (C-M-I) was an exploration and producer person, like Saud. She explored different new explorations and applied some but did not know how to apply the rest. She depended on her experience until she taught herself how to apply her explorations in positions. She produced more solutions using some of her explorations.

The similarity between the children was that all of them eliminated the form of the triangles from their solutions. They showed that the type of triangle did not affect their creative solution, but the type of material, as with the colour cylinder, had an effect on their creative problem solving skills.

Table 7-20: The four children's scores in the three creative skills in the final solutions

Child's Name	**The Three Creative Skills**		
	Fluency	Flexibility	Elaboration
Saud(C-T-I)	8	5	8
Soluman(C-M-I)	5	3	5
Sara(C-T-I)	2	1	1
Soso(C-M-I)	3	3	3

7-7 Summary

The second research question concerned the impact of social interactions on children's creative problem solving. When the play with the Montessori sensorial problems commenced, the guidance for the children involved reproducing the basic Montessori solution. The children guided themselves with or without assistance from an adult (their teacher) to produce creative solutions. This interaction with an adult had an impact on how the children applied their explorations to creative solutions. The T1 assisted C-T-I children in exploring new positions and applying them in creative solutions; such as Saud in the first and second episodes and Sara in the first and final episodes. The children explored new positions but sometimes did not know how to apply them to creative solutions, such as Soso (C-M-I) in the first and second episodes. T1 played the role helping children in the C-T-I group to apply their explorations into creative solutions such as the first episodes of Saud and Sara.

Another difference between the two groups when exploring new positions was the matter of time. The children in the C-T-I group explored new positions before the children in the C-M-I group and applied them in a holding-up position. For example, Saud explored the holding-up triangle position by week-12-Episode-45, while Soluman did not explore and apply it until week-21-Episode-85 (more than nine weeks between applying the same exploration). The children in the C-T-I group understood the potential of the materials more fully than their matched pairs.

The cross case analysis shows that the children differed in their initial steps; both when reaching a creative solution and when solving the Montessori sensorial problems. T1 (C-T-I) tended to prompt the children to start with their own solutions, rather than using the Montessori perspective. T1 suggested to the children tacitly and explicitly that their first step of solving the problem should be their own move, rather than reproduction of the Montessori solutions.

The children in the C-T-I groups also differed from the children in the C-M-I groups in their approach to solving problems creatively by producing separate solutions or developing one solution from another. The children in the C-T-I group used both approaches in one episode, like Sara did in the first episode, but Soso from the C-M-I group only did it once in the week-12-Episode-45.

The children in the two groups also showed differences in terms of the exploring data stage-CPS. The children differed in their methods for exploring new positions and applying them to new solutions. This affected Saud (C-T-I) who produced more creative solutions with assistance from an adult and his experience in playing with the MSM. Soso (C-M-I) had her own experiences of playing with the MSM and exploring new positions, but she did not apply them to forming creative solutions. Both of them produced more creative solutions compared with their matched pairs (see Table 7-21).

As can be seen in table 7-21, throughout the episodes the main impetus behind the ability to apply explorations creatively was related to individuality, with each of the children exhibiting differences in terms of the three creative skills. The more the children went around the CPS cycle the more they produced creative solutions. Saud and Soso scored more than their matched pairs in these skills. The factor of individual differences between the children affected their production of creative solutions. Saud and Soso produced creative solutions whereas Sara was a developer of solutions and Soluman was an exploring and developer person.

The cross case analysis shows that another element that affected the children’s creative solutions and creative skills was the types of material. Soluman (C-M-I), Soso (C-M-I) and Sara (C-T-I) were not interested in the colour cylinders, but Saud was. This limited their production of creative solutions and their three creative skills. Overall, the two groups started from the same point with respect to reproducing the Montessori solutions; they then showed their development in solving their own problem creatively playing with the Montessori Sensorial materials. They showed several differences in exploring different positions, and applying these explorations, their individual creative skills, their individual differences and their interests in particular materials.

Table 7-21 Children Performance in the Four Episodes

Child's Name	The Four Episodes					
	Fluency	**Flexibility**	**Elaboration**	**Why C-M-I Related**	**Why C-T-I Related**	**Individual Characteristics**
Soluman (C-M-I)	9	7	9	• Repeating the Montessori solution as an initial step to solving the problem. • Exploring one position and applying it to a creative solution. • Developing his solution. • Produce each solution separately.		• Exploring one position and applying it to the creative solution.
Soso (C-M-I)	13	11	12	• Repeating the Montessori solution as an initial step to solving the problem. • Exploring new positions but not applying all of them. • Producing creative solutions without making use of her exploration. • Produce each solution separately.		• Producing a creative solution without making use of exploration. • Adding details to her solutions.
Saud (C-T-I)	28	18	26		• Tacit teaching helped him start with his own move not repeating the Montessori solutions. • Tacit and explicit teaching helped with exploring new positions and applying them. • Producing a number of creative solutions with or without using his exploration. • Developing solutions by combining materials or adding details. • Has two approaches to solving the problem.	• Exploring new positions and applying them in creative solutions.
Sara (C-T-I)	9	7	8		• Tacit teaching helped her start with her own move not repeating the Montessori solutions. • Tacit and explicit teaching helped with exploring new positions and applying them. • Exploring one position and applying it to a solution. • Combining two materials and adding details.	• Exploring one position, developing it and applying it in a creative solution.

Chapter 8

Discussion

8-1 Introduction

This discussion chapter positions the findings of the current research in terms of the existing body of research, highlighting its unique findings and assessing the extent to which it supports or diverts from pre-existing beliefs within the field. Bruner [1996], Rogoff [1990], Vygotsky [1976] and Wood *et al.* [1976] argued that there is a relationship between social interaction and problem solving, yet they were not specific about the element of creativity. Other researchers, such as Besancon and Lubart [2008], have connected the Montessori Method with creativity without relating it to problem solving. In addition, Ramani [2005] determined that few studies had been undertaken to investigate creative problem solving in the context of social interaction among pre-school children. The contribution of this research is to build a bridge between previous research by connecting Montessori sensorial materials with creativity and solving problems in the context of studying the prompts provided by social interaction. The purpose of the study was to determine if the Montessori sensorial materials (MSM) have an effect on children's creative problem solving. The discussion chapter is divided into two main parts: the first part discusses the effect of MSM on children's problem solving; and the second part discusses the relationship between creative problem solving, social interaction and MSM.

8-2 Problem Solving and Montessori Sensorial Materials

There is limited previous research studying the affect of the Montessori sensorial education materials on children's problem solving skills in early years' settings (see Chapter 2). The first research question this research sought to address was "Does play with Montessori sensorial materials develop children's skills in solving problems?" and the sub-question was: "At the end of the experimental period, will children who have played with sensorial materials show a significant difference from the control group in their general problem solving using the BAS-II?" The research used the quasi-experimental method to answer this question. Participants in the study were selected according to the criteria of not having played with the MSM before, and being of the same age, and nationality. Twelve matched pairs were identified, with similar pre-test British Ability Scale II (BAS-II) scores, at the beginning of the academic year. Twelve children did not have access to the MSM (control group) and the other twelve had the materials (experimental groups) for the whole academic year. The experimental group was further divided into two sub-groups: one with the materials and interaction with an adult (first case study) and the second experimental group with the materials without interaction with an adult (the second case study). Girls and boys were involved in equal number.

The research used the four BAS-II subscales: Block Building (BB), Picture Similarities (PS), Pattern Construction (PC) and Copying (C) to assess the children's general problem solving skills. The four sub-scales are non-verbal. The BAS-II pre-test helped to define the research sample and found twelve matched pairs. Every two matched pairs had similar BAS-II scores; one matched pair in the control group and one matched pair in the experimental groups to study the influence of the MSM on children's problem solving abilities of (see section 5-8). The matched pairs design helped the researcher to limit the differences between the control group and experimental groups.

A series of independent t-tests was utilised to determine if any significant differences existed between the experimental groups and control group in terms of using the BAS-II pre-post-test. The research findings indicated that the experimental groups who played with the MSM scored higher than those children in the control group. The matched pairs design helped to reach this finding. Based on this finding, the MSM have a statistically significant effect on children's problem solving skills and that there is development in children's problem solving skills between those in the control group and those in the experimental groups because of the MSM. This finding answers the first question and sub-question: at the end of the experimental period, will children who have played with MSM show a significant difference in general problem solving, as assessed by using the BAS-II, compared to the control group? The analysis of the BAS-II data indicated no difference in the problem solving skills of the two experimental groups. This study contributes to the literature and provides evidence of the benefits to children of combining the MSM with early years' practice, particularly in developing children's problem solving skills.

The finding of the experimental of the study agreed with researchers who studied the effectiveness of the Montessori Method compared with other approaches. For example studies by Miller *et al.* [1975, 1983a, 1983b, 1984] found that boys in the Montessori school scored higher in their reading and mathematics than other students. The current research did not study the gender affect on how children developed their problem solving skills, but all children in the experimental groups sample developed their skill in solving problems, when compared with the children in the control group. Using the BAS-II test, all of them showed improvement in solving problems. This is a new finding that boys and girls show development in problem solving skills during their play with the MSM.

This finding of the effectiveness of the Montessori Method on children's problem solving skills agrees with the study by Kendall [1992] who found that children in Montessori elementary schools can solve problems more effectively when compared with other children. Stirling [1975] focused on the use of the sensorial materials by pre-school children however; Stirling studied children's approaches of solving the Montessori problems while this research explored children's creative approaches to solve their own problems using the MSM.

The BAS-II results for the two experimental groups

The BAS-II scales measures children's cognitive development and problem solving is one element of this. For example BAS-II measures the child's ability to assemble sequentially or use trial and improvement, matching, comparing, abilities in spatial problem solving, constructing patterns, sequence and orientation etc. The MSM have these elements of the sequence, constructing patterns, matching and comparing (see Appendix 1.2 and 5.2).

This study did not use any other scales to test children's problem solving for several reasons. First; while there are other scales such as the Problem Solving Scale (PSS, Centre for Cognitive Therapy, 1988) or the Affect Play Scales, the PSS is a questionnaire-based test and is designed to measure the application of self-control methods to the solutions of behavioural problems, which is not the focus of this research. The Affect Play Scales measures children solving problems in fantasy play using two dolls and three blocks. This research focused on the table-toy area, not on fantasy play.

Other reasons for choosing the BAS-II have been discussed previously (see section 5-3-1-4). The BAS-II has previously been tested in Arabic, and applied on Arabic children in order to avoid different cultural influences. The most important reason for choosing BAS-II is to measure children's problem solving skills was that both the MSM and the BAS-II measure similar problems - such as sequencing, matching, comparing and spatial problem solving (see Appendix 1.2 and 5.2).

The BAS-II is accurate for assessing both gifted and developmentally delayed children [Elliott *et al.,* 1990: 3 (Administration and scoring manual)]. Elliott *et al.* explained in detail how administration selected items for each child and the most significant difference is the item selection procedure, which was designed to identify the items that are most appropriate for each individual child [Elliott *et al.*, 1990: 15]. The administrator can stop including the items that are difficult for the child. Children in the experimental groups in the BAS-II did not show individual differences in solving the BAS-II problem. Further research to investigate the affect of children's individual difference on the BAS-II scales is recommended. This finding helped answer the first research question.

In opposition to the positive findings of much of the existing research, researchers such as Karnes *et al.*, [1970, 1983, 1986]; Fero [1997]; Reed [2000] and Tovikkai [1991] found that there was no advantage in children attending Montessori programmes compared with other programmes. However, this research has found that the combination of the MSM with the

Self Learning Curriculum (SLC) helped to develop children's creative problem solving skills. This research went beyond these studies, not only to examine the effectiveness of the Montessori Method, but also in focusing on one approach with the Montessori Method, which was that sensorial materials are connected with creative problem solving.

8-3 Creative Problem Solving, Social Interaction and Sensorial Materials

The main purpose of the qualitative analysis is to answer the second research question and reveal any similarities and differences between the two experimental groups regarding how the social interaction influenced children's creative problem solving. The BAS-II did not help in answering this question. The experimental groups, which consisted of twelve children, were divided further into two groups: six children (three girls and three boys) played with MSM and interacted with their teacher (C-T-I group) and six children (three girls and three boys) had access to the Montessori sensorial materials (C-M-I) and play with them alone without teacher interaction.

The contribution of this thesis is to answer the question: "How does interaction between children and their teachers, during play with the MSM, impact on the children's creative problem solving approach, compared to those who did not receive support from their teachers? The two sub-questions are: a) What are the differences or similarities in children's methods of solving Montessori Sensorial problems creatively among children who do, or do not, receive support from adults; b) What is the difference or similarity between the two experimental groups in terms of the three creative skills?.

Both experimental groups solved their problems by playing creatively with the MSM and went through the three components of the CPS. The analysis in Chapter 7 shows that children improved their creative problem solving by producing a number of solutions and scoring differently in the three creative skills. The qualitative findings reveal the similarities and differences between the two experimental groups in the CPS's stages. The results show that adult (as a teacher) guidance affected the Understanding the challenge component on children's creative problem solving and the process showed the differences between the individuals. There were six main findings answering the second research question:

- Adults (as a teacher) helped the children to make their own initial steps when playing with the MSM, rather than start playing by reproducing the Montessori solutions;
- Adults helped children in the exploration of the data stage to explore new positions and apply them in creative solutions;
- With the guidance of adults, children use different approaches to solve their own problems creatively using the sensorial materials;
- Adults helped the children develop solutions by adding details and combining materials;
- Children's experiences in playing with the MSM affected their creative problem solving skills;
- Childrens' individual differences influenced them when solving the problem and their interest in different types of materials affected their creativity in problem solving.

Each one of these findings will be discussed separately.

8-3-1 Social Interaction and Children's Initial Step in Creative Problem Solving

One research finding is that there was a difference between the two experimental groups in their initial step (the first move of the material) towards solving their own problem creatively playing with the MSM. Teachers from the two experimental groups told their children to play freely with the materials and they created different solutions. T1 from the C-T-I and T2 from the C-M-I encouraged the children to play differently with the materials. The children in both experimental groups during the first four weeks kept reproducing the Montessori solution. They familiarised themselves by having the experience of solving the problem with the Montessori Method. Copying one of the Montessori solutions as a first step in creative problem solving is not wrong; but if there is another way for children to start solving their own problems creatively using the MSM, why not explore it and use it instead of reproducing the same solutions as basic step?

Part of the creative problem solving definition in this research is to generate a variety of solutions rather than reproducing the same solution, or as Fisher [2005: 35] states “generating ideas”. Amabile [1989] argued that creativity requires breaking away from rigid assumptions about what can or cannot be done and getting beyond that and not inhibit new connections. This research investigated a new connection, by going beyond repeating the solutions in the same way and playing with the materials differently to generate ideas to improve the children’s creative problem solving from their first problem solving step.

Dewey argued that teachers may provide guidance for a starting point but that it is not the ending point. Dewey [1938:32] said the teacher’s suggestion is ‘…a starting point to be developed into a plan through contributions from the experience of all engaged in the learning process.’ This is in agreement with Fisher [2005: 111]: who argued that “What a child needs is a starting point of offered meaning to give him his first bearings in an unfamiliar world”. The children in both experimental groups need to go forward from reproducing the Montessori solutions to create their own problems and solve them. Treffinger *et al.* [2006: 41] argued that “It is important to look beyond the clear facts and obvious information that jump out at you right away”. Reproducing the Montessori solutions was immediately a self-evident approach for the children in both groups. The children in both groups need to go one step further by framing their own problems.

Framing the problem in this research occurs when the child plays with the MSM differently from the Montessori solution (see section 4-4-1) which is the first step to creative problem solving. Adults in the C-T-I assisted their children tacitly or explicitly in going forward to frame the problem by starting with an initial step to creative problem solving. Creativity means newness and difference as Noller argued [1979: 4] and the children in the C-T-I accomplished this from their first step towards solving the Montessori sensorial problem. However, children in the C-M-I, up until the end of the research, established their initial moves based on a Montessori solution before they framed the problem. Social interaction makes this shortcut by going directly to produce the creative solution. Findings from this present study are consistent with those in the literature relating to creativity, which suggests that teachers can play a strong role in the development of the creative thinking ability of children [Runco, 1990; Torrance, 1963, 1984].

Saud and Sara represent the children in the C-T-I group and both of them, with guidance from their teacher, explored new positions for adding the material and started with their own positions rather than from one of the Montessori positions. The adults (teachers) at the beginning helped Saud and Sara by asking them to manipulate the materials. Fisher [2005] suggested that adults can offer ideas, suggestions and help, whilst the child offers possibilities of what to do. T1 during the observation gradually left the children to play alone as they had mastered the skill of playing with the MSM differently. During the final eight weeks of the experimental period, all the C-T-I children started from their own moves and did not reproduce the Montessori solutions. The social interaction helped the C-T-I group children by providing suggestions, as Rogoff [1990] and Fisher [2005] argued, in starting from their own initial step to frame the problem directly which was different from the Montessori.

Soluman and Soso represented the children in the C-M-I group. T2 encouraged her children just as T1 did to present different solutions to those she had presented to them and left them alone. Soluman and Soso, throughout the entire research period, started with one of the Montessori solutions then framed the problem to generate ideas. The Montessori Method focuses on children's self education and how they can teach themselves. After the child has an idea of how to play with the material and has solved it under adult supervision, the decisions the child makes in the smallest matter regarding it allows that child to gradually master the materials [Dalton, 1990: 60] and as Montessori [1917] argued, without having to seek advice. The findings showed that, when the children worked with the materials without help from an adult, they kept starting with the same moves. The children learned to solve the problem but they learned to master the materials in only one way which is in the Montessori way. They did not look beyond the clear idea of reproducing the Montessori solutions as Treffinger *et al.* [2006] argued. Soluman and Soso did not have assistance from others with suggestions of starting points with the materials as Fisher [2005] and Dewey [1938] suggest, which was different from what was presented to the children in C-T-I. Not having guidance over the interaction affected the C-M-I in their initial steps to creative problem solving.

Montessori [1964] in her book "The Montessori Method" encourages children to discover their environment, but she restricts play with her materials in her method of playing with the same construction and in the same order as the materials that she presented to teachers. This method limited creativity whilst looking for diversity and finding new ways as Isaksen, *et al.* [2010], Torrance [1990] and Treffinger, *et al.* [2006] argued.

The contribution of this research is that it proposes that Montessori teachers should be encouraged to go beyond the basic Montessori solutions; after the children have first performed the solution in the way that has been presented to them and achieved the aim of the material. In this research the children, with support from their teachers, went on to explore more positions and to frame their own problems, which is in agreement with what Montessori writes in her book; i.e. that the children should explore their environment, however she did not explain this one step further [Montessori, 1964]. How the children play with the materials after they have achieved or copied the solution presented to them. Also, instead of rejecting the activity, as Montessori says, after the child reaches the solution, this research found beneficial ways to develop children's creative problem solving skills through play with the materials which making a contribution to the Montessori Method.

8-3-2 Social Interaction and Exploring Data stage

The children of the two groups differed in terms of the extent of the material exploration, the application of different positions to creative solutions and the length of time that they were applying to the same exploration. The exploration of data is one stage of the "Understanding the challenge" component. Isaksen *et al.* [2010] argued that 'data' means awareness and understanding of important elements in a situation. Data in this research refers to all the different positions that the children explore throughout their play with the materials. In addition, Stipek and Byler [1997] argued that children solve problems through manipulating objects, and according to Craft [2002], exploring around the problem.

The children in both experimental groups explored the same position of the materials, for example colour tablets (first episode). Saud (C-T-I), explored with adults (teachers), a new position and used it in creative solutions, whereas Soso (C-M-I) abandoned that exploration and did not use it but started over again. The difference that the adult's suggestions made in helping the children to go forward in developing their capacity for creative problem solving skills was not in exploring more new positions but also in applying them all. This guidance in social interaction allowed all of the C-T-I children to build a source of experience regarding learning how to explore more positions alone, and eventually learning how to structure their own explorations and apply them in new creative solutions.

Rogoff [1990, 2003] argued that social interaction can make suggestions that the children follow through, but the latter should also make moves to which their partner responds, which agrees with Dewey's proposal [1938] of showing the children the beginning and leaving them to arrive at the end. However, Montessori [1964, 1965] argued that the adult's main role is to prepare the classroom for the children and then observe them. Montessori supported a limited adult (teacher) role in children's education and focused on children educating themselves. Children need some help initially as the above researchers and this study's findings argued, and later on children could be left alone to educate themselves.

The children from the C-M-I group built their own experiences with the MSM alone without assistance from an adult. Soso from the C-M-I group explored new positions less thoroughly than Saud. The number of her explorations of new positions was high in each episode. However, Soso did not know how to apply the positions she explored and that affected her, leading to her giving up some of her explorations and not applying solutions, in contrast with what Saud was able to do with guidance from his teacher. These two enthusiastic children explored more positions than other children in their groups but Saud applied all of them whilst Soso did not.

Sara was from the C-T-I group and focused on exploring one position in each episode and then applied it to a creative solution. Soluman from the C-M-I group was similar in that he explored one position and applied it to his creative solution. Sara, like Soluman, did not show significant interest in exploring a number of positions like Saud and Soso. This variation in individuality can be seen in both the C-T-I and C-M-I groups. Both groups, contained different individuals, two children explored new positions and two were satisfied with one exploration (more explanation of individual differences at section 8-3-4). The difference that social interaction made for the C-T-I group was to enhance children's ability to apply all of their explorations to creative solutions when they worked alone, whereas children in the C-M-I failed to pursue some of their explorations.

In addition, when the children from the C-T-I group were interested in materials and wanted to explore new ways of playing with them but did not know how, the adult (teacher) assisted them. This is what Montessori [1964] called the "sensitive periods" or as Vygotsky [1962] called the zone of proximal development (ZPD). Children in the C-T-I group explored new positions before the children in the C-M-I. For example, Saud explored the holding position in week-11 whereas Soluman explored it in week-22. Both of them explored the same position, but at a different time. By breaking tasks into manageable or smaller problems, the adults helped the children to detect regularities in exploring new positions that they were unlikely to discover alone, something only the children in the C-T-I achieved, which is supported by Vygotsky's ZPD, Rogoff [1990] and Wood [2004]. According to Wood [2004: 98] "by helping the child to structure his activities, we are helping him to perform things he cannot do alone until such time", this was a benefit of the adult interaction leading the children in the C-T-I group toward the acquisition of the exploration skill. This is in agreement with the literature that argues social interaction provides the key for a child to understand how a task can be achieved [Wertsch *et al.* 1980; Wertsch, 1991; Wood, 2004; Isaksen *et al.*, 2010].

8-3-3 Children's Creative Approaches in Creative Problem Solving

Isaksen *et al.,* [2010] argued that researchers describe creativity within four overlapping themes: creative people, creative process, creative results or outcome and the context or place for creativity. However, Eason*,* Giannangelo and Franceschini [2009] argued that the finished product is not always an element in evaluating creativity, and that educators should learn the value of the process instead of the product, especially with children which is in agreement with other researchers [Davis, 1986; Isbel and Raines, 2003; Tegano *et al.*, 1991]. Davis [1983: 60] argued that the process shows us if problem solvers experience a perceptual change when a new idea or problem is produced, and it also shows the strategies or techniques that creative people use to produce new outcomes. Sometimes children begin to solve one problem and then change their thinking, choosing to solve another problem; these changes can be seen to reflect children's processes of creative problem solving and are not seen in their products. These researchers argued for the importance of the process more than the product in children's creative problem solving.

The two experimental groups produced two different approaches: producing each solution separately, or creating one solution from another. At the beginning of the children's play with the MSM, the two groups started by producing each solution separately in their play (Episode one). However, Sara was the only child who started with the second approach, which was to create one solution from another. The other children used the second approach in the second episode. The difference in the two groups was that the children in the C-T-I combined these two approaches together in one episode, such as Saud in the second episode, whereas children in the C-M-I did not combine these two approaches except for Soso who did so in only one episode (Episode 45- the second episode analysing Soso).

The process of solving the problem creatively showed the differences between the children in the framing the problems stage and with exploring different data as discussed above. The process also showed other elements which affect children's creative problem solving, such as children's experiences playing with materials and their individual differences which will be discussed. These elements have appeared in studying children's process of creative problem solving, whereas the outcome and children's solutions did not show these differences which agreed with the literature. However, the children in this research produced many different creative solutions which should be taken into consideration in the explanation because Torrance [1963, 1965, 1972, 1984 and 1990] has argued that these outcomes show differences in children's creative skills.

Torrance's [1963: 90] definition of creativity argued for the importance of the process in creativity "the process of sensing gaps or needed missing elements; of forming ideas or hypotheses concerning them; of testing these hypotheses; and of communicating the results, possibly modifying and retesting the hypotheses". The approaches that children use to solve problems creatively are important, and their outcomes are also important. Isaksen *et al.,* [2000, 2010] argued that the creative process and outcomes are two of four essential aspects of creativity which is in agreement with Torrance. Torrance [1963] discussed four characteristics of outcomes: fluency, flexibility, elaboration and originality. Arieti [1976] agreed with Torrance that these four characteristics are elements of creative thinking. Creative products or outcomes can be the result of the efforts of individuals or groups, and they may vary in degree of novelty, usefulness or meaning for the individual.

Children in both experimental groups showed differences across these three creative skills with eliminated the originality skill. Saud scored better in these creative skills than his matched pair Soluman and Soso scored more than Sara. All of them solved their problems creatively when playing with the MSM, but they differed in the number of creative solutions reached during each episode and in terms of the different categories that their solutions related to. Torrance [1963] argued that these skills represent differences in personal creativity and this research showed that all of the children are creative but differ in their application of the three creative skills.

Isaksen *et al.*, [2000: 15] argued that there are researchers who refer to creative product as “Innovation”, because of the focus on product rather than process, but researchers like Isaksen, Treffinger, Droval and Noller [2000] have argued that innovation is considered to be “commercialization of new ideas”, and they see this as a part of creativity. Children throughout this research presented their ideas by playing and producing different solutions and different approaches, which agreed with Isaksen’s findings [2000] and others that producing solutions or outcomes is a part of creative problem solving. Children’s approaches and outcomes of their creative problem solving also varied between the two experimental groups. Again, Saud (C-T-I) and Soso (C-M-I) inspired themselves and produced a greater number of creative solutions than Soluman (C-M-I) and Sara (C-T-I).

8-3-4 Adult Interaction and Developing Solutions

The findings illustrated that the two groups differ in the developing stage. There are three types of developing solutions in this research: adding pieces of material together, combining materials together in one solution and adding details to solutions such as eyes, mouth or adding different accessories to solutions. There were similarities between the children in both experimental groups, in adding material together e.g. triangles or cubes. However, the children in the two experimental groups differed by combining materials together and adding details to solutions.

Elaboration is one skill of creativity. Adding details to a solution is important in developing solutions. T1 of the C-T-I group assessed her children in combining materials from the beginning of the experiment. Craft [2000] defined a view of creativity as ‘possibility thinking’. Fisher [1990], Mayer [1992] and Torrance [1974] argued that creative problem solving is about generating ideas and solutions and Guilford [1956, 1977] argued that divergent thinking refers to the ability to produce many different ideas as a response to a problem.

Instead of playing with the sensorial materials separately, T1 thought differently. T1 could be said to be employing possibility thinking and generated the idea of combining the two materials of the MSM together teaching this to her group of children. In the first episode with Saud, the adult showed him how to think differently when playing with the colour tablets instead of matching them, Saud used them vertically and horizontally and combined both positions into one solution. Sara was the first child who combined the Pink Tower with the Brown Stairs from suggestions from T1 in the fourth week of the experimental research period. Saud also combined Montessori materials with others as the data presented in Chapter-7. The adult also helped the C-T-I children with adding details; i.e. using a fish when playing with the blue cylinder when Saud used it as sea, and when Sara used a plastic rocket and airplane in her final solution in the fourth episode.

Russ [1987] argued that children's play provides the opportunity to explore new combinations of ideas and to help to develop the capacity to see old objects in new ways. In agreement with Russ' argument, T1 helped the C-T-I group with defining a new way of looking at materials. However, the C-M-I children did not combine the MSM until the end of the research process, when Soso added the Red Road to the Triangle Boxes in her final episode in the duck solution. Soluman and other children in the C-M-I never gathered two materials together.

In addition, not only gathering two materials helped to develop creative solutions but also added detail to solutions. The T1 helped their children in adding details to their solutions. Sara in the second episode was the first one from the C-T-I group who added details to her creative solutions. Similarly, Soso from the C-M-I group added details to her solution in the second episode which was during the same period of time. Soluman from the same group did not do so in any of his creative solutions compared with his matched pair Saud (C-T-I) who added details to his solutions. By adding details to their solutions, the children revealed another sign of creativity in solving the problem, which centres on developing solutions.

Developing solutions was one stage of the Prepare for action component of the CPS and elaboration is one skill of creativity. Children in the C-T-I group, with suggestions from an adult (their teacher), went one step further to be more creative in their thinking. The adult enhanced a new connection and helped them combined other classroom materials in their solutions with the MSM. The use of the material in new ways, such as using a red cylinder from the MSM as a candle, was creative according to the definition of creativity [Noller 1979; Torrance 1984; Treffinger *et al.*, 2006].

8-3-5 Children's Experiences

Fisher [2005: 98] said 'a child constructs an individual understanding of the world through an interaction of experience.' He added [2005: 100] 'A problem-solving approach is … ongoing activity'. Varying views on children's learning approaches have different implications for what one expects from children. One would expect, in this research, a different level of experiences in solving children's own problems creatively playing with the MSM, depending on children's actions, their interaction with adults and the transfer of those experiences from one problem to another. The children in this research established the single solution to solving the problem like the cylinder blocks, then they employed their own experience to solving all the MSM by Montessori Method then they used the MSM to create their own problems and solve them creatively. The children have different experiences playing with different MSM and playing alone or with adult guidance. Every child in this research had has his own experiences in playing with the MSM, which agreed with Brown's [1986] argument.

Brown [1986: 25] argued that learning experiences are important for children to use in activities involving construction. The C-T-I groups had their experiences with the MSM prompted by social interaction whereas the C-M-I group had their own experiences without interaction with their teacher during the same period of time. The children's experiences are continuing to develop, which is considered to be what Dewey defined [1944: 29] as "Every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after". According to

Dewey, experience is educational if it tends toward growth. However, Kahney [1986] and Robertson [2001] argued that children are not very good at bringing their previous experience to bear on solving related problems.

When Saud (C-T-I) had his experiences with the colour cylinders previously with an adult (his teacher), he knew how to use them for the Cat solution or in the Gas station solution (Second episode) when he played alone. Saud built his experience from solving the colour cylinders with the Montessori Method and then applied this experience to creating his own problem and solving it creatively with guidance from an adult. Soso (C-M-I) also had her own experience which went through the exploration stage but she did not show improvements in using her explorations as Kahney [1986] and Robertson [2001] suggested. Soso did not use her explorations in creative solutions until such time as she became familiar with the demands of the task in hand. The experience Soso had and the length of time she spent playing with the sensorial materials helped her determine how to apply her explorations in the final episode. She built on her experience and developed it to apply some of her exploration into creative solutions. However, the period between the explorations, for example symmetrical position (second episode) and applying these (fourth episode) to a creative solution was more than seven weeks. Children’s experiences and elapsed time are another element affecting their creativity in solving the problem.

Each of the children had their own experience in playing with the MSM and solving problems creatively, but guided participation made a difference between the two groups in terms of applying explorations and the difference in time when applying the same exploration. This is in agreement with Vygotsky [1978] and Rogoff [1990] who argued that children with help from adult can perform concepts that they cannot achieve on their own. Bruner [1972], Piaget [1962] and Vygotsky [1978] have argued that children construct their learning by action, and as Ericsson and Charness [1994] and Mieg [2001] argued that learning is acquired from first-hand experience which this research showed that children can be seen as active learners in solving problems creatively during their play with the MSM.

In addition, Barron and Harrington [1981] and Russ [1987] argued that experiences occur when children interact with materials and provide much to draw on when attempting to develop novel solutions (original solution). Feist [1998] connected creativity with individual experiences and Rawlings, Twomey, Burns and Morris [1998] found a relationship between fluency ability of creativity and individual experiences. The researchers connected individual experiences with fluency and originality in the skills of creativity. In addition, Guilford [1980] argued that learners have different experiences and because of that they have variable individuality. Guilford connected personal experience with their individuality. This research did not study from the affects of individual experience on the three creative problem solving skills. It might be that individual differences affected children's individual experiences in playing with the MSM. There might also be a relationship between individual experiences, individual differences and creative problem solving, for which more research in this area is recommended.

8-3-6 Children's Individual Differences and Creative Problem Solving

An additional element of the research findings is the effect of individual differences in children's approach to solving problems creatively. Side by side, the issue of individual differences and social interaction influenced children's ability in creative problem solving. The children's individuality affected their process of moving towards creative problem solving and the integration of the three creative skills, as the analysis in Chapter 7 presented. Individual differences and social interaction elements are overlap in the C-T-I and each of them has an effect on the children's creative problem solving.

Research into creativity and creative problem solving has been conducted from various vantage points: studies attempt to evaluate the creativity of product, others evaluate cognitive processes in creative problem solving and other researchers try to describe the individuality of creative people [Isaksen *et al*., 2010; Treffinger *et al.*, 2006]. The results found that each individual child has their own approach to solving problems creatively. Isaksen *et al*. [2010] and Sebley *et al.* [2002] argued that individual differences relate to the ways people plan, produce ideas, prepare for action and reflect the way they prefer to behave when solving problems.

Individual differences are seen in this research in terms of approach; the children processed their solutions differently when acting by framing the problem to generate ideas, preparing for action and accepting their solutions. McEwen [1986] argued that learners have varying creativity because they have different capacities and individual skills and interests. Individual differences affected problem solvers' production of creative solutions or as Isaksen *et al*., [2000] and Treffinger *et al.*, [2006] argued; there is a link between the person and the process when solving a problem creatively.

For example, Saud (C-T-I) and Soso (C-M-I) sought to explore different positions to create many unusual solutions, Soluman (C-M-I) explored one position and produced different solutions using the same position, and Sara (C-T-I) kept developing one solution using one exploration. The individual difference can be more consistent across problem solving [Isaksen *et al.*, 1993]. During the research observation for one year, the four children represented their groups in different individuality and they showed that they were consistent in their approach in solving their own problem creatively. This is an agreement with Witkin [1962] who argued that each individual has his own style or approach regarding creative problem solving and that individuals tend to be self-consistent in their performance. The children in both the experimental groups presented stylistically consistent approaches when solving problems creatively, which is one finding of this research. The children have different individualities for solving problems creatively, which appears to be an agreement with Isaksen *et al.* [2010]. The researchers argued that no individual difference is valued more or less than any other and as this research showed all of the children contribute to solve their own problem creatively playing with the MSM. Furthermore, their individual differences affected their capacity with regards to producing a number of creative solutions which affected the four creative skills.

Puccio [1987] highlighted the relationship between children's scores in the four creative skills and their individuality. Puccio [1987] argued that the higher the children's scores in fluency, the more this means they challengers and not developers. Regarding Puccio's argument, it can be seen that Saud and Soso have explorative personalities and Sara is a developer, whereas Soluman's scores showed that he is challenger and developer in his approach of creative problem solving. We can interpret this result, as it is appears to be an interaction between individual differences and the three creativity skills. However, this study did not use any test to measure children's three creative skills which is a limitation of this research.

The results revealed that adult guidance affected the Understanding the challenge component of children's creative problem solving processes and that these processes showed variation between individuals. From the analysis data in Chapter 7, the adult (teacher) in the C-T-I setting understood the children's differences and also that each individual should be encouraged to solve problems creatively in their own way. T1 understood Saud's interest and motivation and his enthusiasm for producing more solutions, exploring more positions, combining materials and assisted him in producing more creative solutions, whereas Sara from the same group showed that she was the opposite temperamentally from Saud, as she wanted to focus on exploring one position and then keep developing it.

The second sub-question of the second research question is; what is the difference or similarity between the two experimental groups in terms of the three creative skills? The experimental groups of children varied in terms of their three creative skills of creative problem solving because of their individual differences, and also varied in the process of framing the problem and exploring data stages because of the adult (teacher) guidance. In addition, individual differences varied according to which of the problems that they were interested in. Benbasat and Taylor [1978]; Garfield, Taylor, Dennis and Satzinger [2001]; Huber [1983] argued that the variation between individuals is affected by the problem they solve. Children's individuality affected their interest in the materials. The next section presents the relationship between type of task and children's creative problem solving.

8-3-6-1 Children's Interest in the Material and Creative Problem Solving

Montessori created some of her materials and developed other materials that Eduard Segon (1866) and Jean Itard (1801) had designed. Montessori [1965: 70] argued that if a child is interested in solving problems s/he can repeat the task thirty or forty times without losing interest. Also, the Montessori sensorial materials move from simple to more complex problems; Montessori [1965: 80] argued that "A little later we shall see that the children interest themselves in a much more difficult exercise". Montessori [1965: 83] proposed that the materials should be attractive to the child to play with and that "The ability of a thing to attract the interest of a child does not depend so much upon the quality of thing itself as upon the opportunity that it affords the child for action" [1948/1997: 106]. According to Montessori, children are interested in a material because of that material, the complexity of solving the problem and the opportunity this offers the child for action. This research found that children were interested in all of the MSM except the coloured cylinder material.

The Montessori philosophy agreed with researchers [Saracho, 1990; Saracho and Spodek, 2003; Torrance, 1972, 1984] that the classroom environment should be rich with problem solving activities that enhance children's interest and curiosity and provide opportunities for questioning. Rogoff [1990] agreed with Montessori [1964] that adults are responsible for enhancing children's learning by arranging a learning environment full of activities that children are interested in. Johnson, Christie and Yawkey [1999] argued that the complexity of cognitive activity depends on the type of materials and how children play with them. Rogoff [1990] suggested that children are active in choosing their own activities and that they insist in engaging in some activities and refusing some because of their interest. The type of activity is important for enhancing children's learning.

Researchers studied the relationship between the materials and creative thinking; however there is limited research discussing the interest in particular materials, and how they affect children's creative problem solving skills. Lloyd and Howe [2003] suggest that there is little information about children's performance in playing with different types of materials or the ways they engage with the materials or how these factors are linked to children's thinking performance. They also argued that they do not know if there is a correlation between children's play with particular materials and their creative thinking. This research showed that children's interest in the types of materials affected their creative problem solving skill when playing with all of the MSM and producing creative solution, except for the coloured cylinders. When children in both experimental groups play with the coloured cylinders, they did not produce creative solutions using this material; Saud was the only exception as he was interested in this material and produced creative solutions. It can be said that the type of material affected children's creative problem solving.

8-4 The Contribution to Theory

This thesis scrutinises the influences of the Montessori sensorial materials on children's creative problem solving skills and how social interaction impacts on children's creative problem solving. There are three components to the Montessori Method: the child, the prepared environment and a knowledgeable and sensitive adult. Montessori designed and prepared the environment carefully, creating her own materials for children to use.

One component of the Montessori Method is the child. Montessori [1964:17] argued that the child in her programme is self-educated and the main role of the Montessori teacher is to prepare the environment (classroom). Montessori suggested the method for which the teacher should present each material to the child and that the child should not be restricted to producing the same solution using the same method. This seems to be a contradiction between the child being self-educated and guided by their teacher in producing the Montessori solution. The Montessori teacher also presents all the materials in a three lesson period (see appendix 2.1). The Montessori teacher guided the children in their learning at the beginning then the child guided himself in his continued learning.

Montessori related creativity to children being free to choose their own activity [Feez, 2010:34]. The sensorial materials should be presented to the child in the same order that Montessori presented them. The children in the Montessori classroom should be free to choose their activity as a part of self-education, but the child should be restricted with the order of the materials and not free to play with them in their own way, but in the Montessori way. Creativity as Noller [1979] argued is an element of newness but the children in the Montessori environment reproducing the Montessori solutions, are not allowed to play with the materials freely or choose any materials not following a particular schedule. This research ensured that the children were free to choose any of the MSM, not following any order, and then solve their own problems creatively by playing with the MSM either alone or under the guidance of adults.

Montessori [1964, 1965] argued that once a child shows an interest in something and begins to concentrate, the child should not be interrupted. She also argued that each set of materials has an exact use to limit confusion. Montessori [1948/1967: 102-5] promoted a "…straight and limited road which leads to goal and keeps the learner from wandering aimlessly about". This is in contradiction to child self-education, which focuses on the child's freedom and creativity. This research showed that when the child is interested in playing with MSM with Montessori Method or in other ways, the adult (teacher) helped the child to solve problems creatively. An example of this occurred with Saud when he asked for assistance from an adult in the second episode to achieve the boy solution, or with Sara in the fourth episode for achieving the rocket solution. The adult as a teacher did not limit the children's freedom with playing with any of the MSM but assisted them in developing their creative problem solving skills.

Montessori also said 'When the child with evident security places each piece in its proper place, he has outgrown the exercise, and this piece of material becomes useless to him' [1964: 171]. Montessori said: "Little children … have repeated the exercise up to forty times without losing their interest in it" [1965:70]. There is contradiction between the two Montessori statements. This research showed that children can use materials in different ways, creating their own problems and solving them creatively. This research found that the MSM can be used beyond the original Montessori Method and support children's creative problem solving. Montessori also controlled the teacher's role in the classroom, however teachers play a bigger role in children's learning in this research environment.

Rogoff's concept of "Guided participation" [1990] has made clear the need for providing instruction and help whilst ensuring the child remains active in the processes. Rogoff [1990, 2003] explained what she meant by explicit and tacit teaching in different contexts, but she did not give an exact definition of what she meant by these two instructions. Rogoff raised two important issues in the guided participation which are the environment and tacit and explicit teaching. The current research indicates that social interaction helped the children in framing problems, applying their explorations to creative solutions, combining materials and combining different approaches to creative problem solving during each episode. Teacher interaction plays an important role in developing children's creative problem solving skills.

The CPS framework by Isaksen *et al.*, [2000] is used for training or teaching people in developing their skills in creative problem solving. This framework came from the observation of people during their creative problem solving process. Isaksen *et al.* [2000] argued that this model is suitable for all ages including children. I used this framework to analyse children's creative problem solving in a natural setting, to identify the differences between the two experimental groups and study the impact of social interaction in children's creative problem solving when playing with the MSM.

This research did not train the children in applying the CPS to their problems. Rather it integrated two stages which are the framing of the problem and the generating of ideas during data analysis. Children of this age do not talk during their play and do not make problem statements to frame the problem. The children established their playing by taking the material from the shelves. From the research data, when T1 asked their children at the beginning of their play; “What do we want to do?”. The children did not answer and kept playing without talking. The framing ideas stage and generating ideas stage and components overlapped. The children did not talk about their problem statement and did not indicate clearly when they generated ideas. As a result of this I integrated these two stages into one stage or two follow up stages when the children used the material differently from the Montessori Method. This different position showed that the children make no problem statement when generating an idea and want to achieve results by action.

In addition, the children in this research did not plan to produce new solutions. They went forward to playing and generating ideas again without speaking. Nevertheless, the CPS framework should have been explained at every stage, even when the participants did not speak, because the CPS framework came from observation which should help in identifying when each stage happened with or without commentary especially from children.

This research did not use the “Planning your approach” component in analysing this research data and eliminated it from the analysis because the children did not show signs of planning or designing their solution before they started to play. With five year old children who did not talk during their play, the Planning your approach component was not considered as a relevant part of the CPS framework.

The CPS framework was sensitive or helpful in terms of picking up the differences and similarities between the two experimental groups and helped further this research by showing the impact of social interaction on children’s creative problem solving, which the BAS-II did not show. Tacit and explicit teaching happened at all the CPS stages but made a difference in the children’s understanding component with the two stages of framing the problem and exploring data.

8-5 The Contribution to Methodology

This research used mixed methods to answer the two research questions. The research used the British Abilities Scale II (BAS-II) as a quantitative method to assess children's general problem solving skills because as the literature review in Chapter 2 discussed, there are limitations when using instruments to test Montessori children's skills especially in with problem solving or creative problem solving skills. It was difficult to find two matched pairs with the same score on the four sub-scales of the BAS-II to put one matched pair in the control group and one matched pair in the experimental group; to study the impact of social interaction on children's creative problem solving playing with the MSM. However, matched pairs were achieved with similar scores of the four sub-scales. The difficulty of finding four children with the same score on the four BAS-II sub-scales at the same school is a limitation of this research

The BAS-II helped the researcher with finding differences on the four sub-scales between the control group and experimental groups using a matched pair design. However, the test did not help with showing the difference between the two experimental groups and presenting the impact of social interaction on children's creative problem solving, in this case the CPS framework by Isaksen *et al.*, [2000] was used to analyse the qualitative data.

The ethnographic-case study and cross-case-study helped this research study in depth and presented the similarities and differences between the two experimental groups in answering the second research question by comparing the two cases over the four episodes. There are no guidelines for conducting a cross-case-analysis, with children, in the education field. Looking at one experimental group and comparing them with the other experimental group helped with answering the second research question. Mixing methods helped to construct a picture of children's interaction with their teachers in creative problem solving play with Montessori sensorial materials.

8-6 Summary

This research has contributed to our knowledge by identifying the impact of social interaction on children's creative problem solving play with Montessori sensorial materials, especially in the early years setting. The BAS-II helped to answer the first research question by finding a significant difference between the children in the control group and the children in the experimental groups in terms of developing their skills of problem solving.

Both experimental groups, the Child-Teacher-Interaction group (C-T-I) and the Child-Materials-Interaction group (C-M-I), in the cross-case-analysis showed differences with solving problems creatively when playing with the Montessori sensorial materials. The research findings show that social interaction affected framing the problem and applying children's exploration to creative solutions, using different approaches and combining these approaches and developing solutions by adding details or combining materials. The findings show that individual differences influence them in their creative problem by solving the children's approach to solving the problem creatively, which affected their three creative skills and their experience of playing with the MSM.

In addition, the research findings recommended the usefulness of employing the MSM in different ways, in addition to the Montessori Method, and to extend the teacher's role in the Montessori environment. Montessori argued the uselessness of the material after the child has achieved and solved it using her method. However, this research found that MSM can be used in different ways to develop children's creative problem solving. The Montessori Method focuses on children's self-education and the teacher's role in preparing the environment for the children. However, this research found that adult or social interaction has another responsibility besides preparing the classroom for the children. The research found that social interaction develops children's understanding in solving problems creatively, especially in framing problems and applying their exploration to creative solutions. The social interaction helps children in combining materials and their approaches to creative problem solving. The findings show that the individual differences affected children in their approach to solving the problem creatively and to affecting the three creative skills.

The research found that the CPS is suitable to analyse the research data. Based on the research data, the research integrated the framing the problem and generating ideas stages together because the children did not speak during their creative problem solving. In addition, the researcher eliminated the Planning approach component from the analysis because the children did not verbalise or otherwise indicate their planning activities.

Chapter 9
Conclusion

9-1 Introduction

This thesis examines the influence of Montessori sensorial materials, and the effect of social interaction on children's creative problem solving. The research addressed two questions: Does play with Montessori sensorial materials develop children’s problem solving skills? and How does interaction between children and their teachers during play with the MSM impact on their creative problem solving approach, compared to those who do not receive support from their teachers? The research adopted Rogoff’s [1990] two aspects of social interaction guidance (learning environment and explicit and tacit instruction); the CPS framework [Isaksen *et al.*, 2000] was used for the analysis of the research data.

9-2 Overview of Research Theories and Methodology

Play is an essential process in a child’s growth and development and is itself a form of learning [Piaget, 1962; Montessori, 1912; Vygotsky, 1962]. Montessori [1912] believed in the importance of play in children’s development and designed her own materials to develop children’s learning. Children learn by playing and using their senses during their play. Play is an umbrella word for everything children do in their pre-school setting. Montessori created her materials to let the children play (or as Montessori liked to call it, work, Feez, 2010:32) and learn problem solving at the same time. This project integrated Montessori sensorial materials with the Self Learning Curriculum to study the influence of the materials on children’s creative problem solving during their interaction in social context.

Montessori concentrates on children and how they can learn by themselves in an appropriate environment, with a teacher’s first duty being to watch over that environment [Montessori, 1912/2003]. Montessori limited the teacher’s role to preparing the environment, whereas other researchers showed that teachers can help children in developing their learning, for example Vygotsky

[1976]. Rogoff [1990] extended the zone of proximal development in 1990 and linked this to learning with problem solving during social interaction.

This research combined the Montessori Method, which focused on the importance of children's individuality, with the theory of social interaction between children and their teachers; and discovered a connection between the Montessori sensorial materials and creative problem solving in the context of social interaction.

This project used mixed methods by combining a quantitative method, using the British Ability Scale-II (BAS-II) to test children's problem solving skills and qualitative approach (elements of ethnographic case study), to observe children in the classroom during their play with the Montessori sensorial materials (MSM).

To analyse the qualitative data, this thesis adopted the CPS framework of Isaksen *et al.* [2000] which contained three components and six stages. The first component is the Understanding the challenge component which has three stages: constructing opportunities; framing problems and exploring data. The second component is Generating Ideas including the same stages and the last component is Preparing for Action which has two stages: developing solutions and building acceptance. The researchers put these three components in a cyclical framework because the problem solving can start with any of these components or stages.

9-3 Overview of Research Findings

The research sample consisted of twelve matched pairs: twelve children were in the control group and twelve children in the experimental group. There was a significant difference in the mean scores in British Abilities Scale-II (BAS II) of each child between the control and experimental groups, with regard to the measures of their problem skills in the post-test. Children in the experimental groups made significant gains and showing that MSM have an influence on children's problem solving skills.

The research project that I undertook achieved its aims. The thesis shows evidence that children developed their general problem solving skills by playing with MSM. Montessori [1964] argued the materials were obsolete after children knew how to play with them in the same way that had been presented to them, however, this research found effectiveness and value in playing with the MSM in different ways to develop children's creative problem solving skills.

This thesis contributes to the literature and provides evidence of the benefits of introducing the MSM in the pre-school classroom, in developing children's problem solving skills by tracking changes over time and in children's sustained interest in playing with the MSM in the classroom. This study has gone some way towards explaining how social interaction assists children in creative problem solving. The CPS framework showed us at what stage the social interaction results in a difference between the two experimental groups.

Children in both experimental groups familiarised themselves with the materials by having the experiences of solving the problem with the Montessori Method. This thesis offers a more detailed exploration of when the change occurred between the two experimental groups, during their play with the MSM and solving their own problems creatively. Most importantly, the results of this thesis showed, through the process of creative problem solving, that adult guidance affected the "understanding of challenge" component of children's creative problem solving and revealed differences between individuals. There were six main findings:

- Adults (teacher) assisted children to frame problems and make their initial steps to creative problem solving starting with their own moves. Children from the C-M-I group, up until the end of the experimental period, started with one of the Montessori solutions, whereas children from the C-T-I directly framed their own problems to solve them creatively.
- Adults (teacher) helped the children in the 'exploration of data' stage by guiding their exploration of new positions and application of these

positions to all creative solutions. Children from the C-T-I group received assistance from their teacher to apply all of their explorations of new positions when playing with the MSM in creative solutions, whereas children in the C-M-I did not apply all of their exploration to creative solutions and gave up on some of them.

- Adults (teachers) helped children in combining the two approaches (create one solution from another and create each solution separately) of solving the problems creatively in one episode, whereas children in the C-M-I group did not combine these approaches at all.
- Adults (teachers) helped the children in developing solutions by adding details or combining materials together.
- Children's individual differences influenced them during their creative problem solving.
- The level of children's interest in the type of the MSM affected their creative problem solving.

This project has contributed to our knowledge that Montessori materials have an effect on children's learning, especially in their creative problem solving skills. The research findings are in line with previous research findings for example studies by Karne *et al.* [1970, 1983, 1986]; Fero [1997]; Reed [2000] and Tovikkai [1991].

Past research did not connect the Montessori sensorial materials with creative problem solving to study the influence of social interaction. The contribution of this research is to build the bridge between these three areas, and indicate at what stage the social interaction makes differences to children's creative problem solving.

In addition, this study explored new ways of playing with the MSM after the children achieved Montessori's solution using her method. The materials were not useless and the children developed their creative problem solving skills by playing with the MSM. This study demonstrated how materials can be used for play in many different ways to help develop the children's creative problem solving skills.

Playing with the MSM and social interaction makes a difference to the "understanding the problem" component especially in framing the problem directly and applying all of the explorations. Social interaction showed the children that they are free from copying other people solutions, even the Montessori solution, and able to be creative from the first move of the materials. Creativity means newness in the way of using things. Creative problem solving is a new approach to problem solving from the first step, until the end, which Isaksen *et al.* [2000, 2010] presented in the CPS framework. The qualitative data support Rogoff's [1990] arguments on guided participation during creative problem solving. Social interaction increases the effectiveness of learning in framing problems, applying explorations to creative solution, combining approaches in solving problem, adding details to solution and combining materials. The influence of social interaction in assisting children during their problem solving agreed with findings by other researchers [Vygotsky, 1978; Burner, 1996; Wood, 1986] particularly in terms of this study and solving problems creatively.

Social interaction also helped children with combining different approaches to solving their problems creatively and not applying one approach in each episode. Again creativity is being free from limiting yourself to using one approach to creative problem solving. Montessori has her own constructed approach to solving her problems and the children explored their approaches to solving their own problem creatively using her materials. Furthermore, flexibility and fluency contain elements of creativity [Torrance, 1966]. Using a different number of approaches contributes to flexibility and fluency.

This research also found that children's individual differences have an influence on solving the problems and on the three creative skills which is also supported by Isaksen *et al.* [2010]. More research should be undertaken to study in depth the relationship between children's individual differences, sensorial materials and creative problem solving. This was not the focus of this research. The research found that the children's' experiences of playing with the MSM also had an effect on their creative problem solving.

9-4 Recommendations for Further Studies

Future research could be informed by the influence of Montessori sensorial materials on children's creative problem solving and focus on questions such as:

- What is the influence of social interaction (Teacher-Child-Interaction) on the Montessori environment?
- What is the influence of free play with other Montessori materials after the children play with them using the Montessori Method?
- What is a more effective approach (tacit or explicit teaching) in developing children's creative problem solving during their play with the MSM, or there is no difference?
- What other skills can play with the MSM develop besides creative problem solving skills?
- Children in this research did not show their planning stages in solving problems creatively because they were not talking. How can be asking children during their solving problem creatively show their planning?

The list of possible questions for future research is much longer than the list given above. The entire question focused on MSM, creative problem solving and social interaction as did this study.

9-5 Educational Implications

The study needs to close with implications related to practical education. This thesis showed that Montessori sensorial materials can be introduced and used differently from the Montessori Method, within other pre-school settings and that the MSM influence children's creative problem solving. The findings of this research support the effectiveness of the Montessori Sensorial Materials and the influence of social interaction in developing children's creative problem solving. Thereupon, studying the influence of social interaction in the Montessori environment is an interesting possibility for future researchers to explore.

9-5-1 The Contribution to Teacher Education

This study began with an idea based on my observation, that children did not spend much time in the Toy-table area as compared with other areas. When the study introduced the MSM to the area, the area was filled with children and, according to Teacher 1 and Teacher 2, they had not previously seen this area full of children daily. Teachers need help to develop their knowledge about effective ways of addressing children's needs and encouraging them to be interested in playing in this area. Teachers can become accustomed to using the MSM initially with the Montessori Method then by guiding children in exploring different ways of playing with the materials. Teachers should not restrict children's play to always fit with the way of introducing materials. Although this study used only the Montessori sensorial materials to develop children's creative problem solving skills, teachers can use the materials in the reading and writing area, or they can use different Montessori materials in different areas in Self Learning Curriculum to develop different skills.

9-5-2 The Methodological Contribution

The methodological contribution of the present research can be highlighted in:

- Integrating the two stages of framing the problem to generate ideas in the CPS framework, which might be of value to future studies in the same area of research, especially with children who did not talk during their play.
- Using the CPS framework to analyse the qualitative data helped the researcher to explore how the children represent differences in their approaches to develop their creative problem solving skill with or without support from their teacher. This framework might help teachers in spending more time with children in developing their understanding of problems more than other components.

9-5-3 Implication for the Self Learning Curriculum in the Early Years in Saudi Arabia

One general goal of the Self Learning Curriculum in Saudi Arabia (Appendix 1.1) is to develop children's creativity and problem solving skills. It can be said that MSM made a revaluation of the Toy-table area in terms of developing children's skill in creative problem solving. In addition, the research found that social interaction assisted children in framing problems and applying their explorations. According to this research finding, in this area, children needed to interact with their teacher more than playing alone to develop their understanding of solving problems creatively.

This research can be used to contribute to the SLC in several ways:

- Adding Montessori Sensorial Materials to the SLC in the Toy-table area to develop children's creative problem solving.
- Encouraging teachers to interact with children in this area to help them to frame the problem to generate ideas which help the children thinking in divergent ways instead of thinking on one way.

9-5-4 Implications for Theories of Play, Creativity and Problem Solving

Children, as the literature argued, learn by play. Children teach themselves or by guidance from adult practice solve problems during their play. The creative element comes in assisting children in moving the further step from producing one solution to a variety of solutions during different process and approaches. For example, children can start their solutions in their own way without copying one of the Montessori solutions. The children did not need to restrict themselves to one method in their learning as proposed by the Montessori Method. This research moved children by playing with the MSM smoothly from problem solving to creative problem solving, from producing the Montessori solution to producing their own creative solutions. The research finding shows that Montessori materials are not useless and can be used in different ways creatively when playing with them freely. The research findings also show that we can focus on children's processes of creative problem solving and on their outcomes or solutions.

This research revealed that:

- Children should not be restricted to play with materials in the way these were initially presented to them.
- Children’s creative problem solving develops during their play which is an important and ordinary tool in children’s learning in the early years setting.
- Teachers or other helpers should choose play materials carefully when preparing the classroom environment.
- Children can develop their creative problem solving skills by playing with the MSM and with assistance from their teachers.
- Children show different levels of different interest in types of material. Teachers should be sensitive to different children benefit from different materials in their learning.

9-6 Final Remarks

This chapter marks the end of the thesis so it is important to say that the two research questions have been answered. The research found different approaches to playing with the Montessori sensorial materials, which were different from the Montessori Method. This research has filled a gap in its field and has provided insights into how children develop their creative problem solving skills during play with Montessori sensorial materials, and how social interaction promotes creative problem solving.

References

Ackermann, E. [1995]. 'Construction and transference of meaning through form.' in Steffe, L., and Gale, J., ed. *Constructivism in Education*, Hillsdale, N. Jersey: Lawrence erlbaum Associates.

Adams, S., Alexander, E., Drummond, M., and Moyles, J. [2004]. *Inside the foundation stage: Recreating the reception year.,* London: Association of Teachers and Lectures.

Agar, M. [1986]. *Speaking of ethnography.,* London: Sage Ltd.

Agar, M. [1996]. *The professional stranger: An informal introduction to ethnography.,* 2nd ed.*,* San Diego: Academic Press.

Ahlberg, A. [1998] *Meeting mathematics: educational studies with young children.,* Goteborg: ACTA University Gothoburgensis.

Al-Ameel, H. [2002]. *The effects of different types of pre-school curricula on some aspects of children's experience and development in Saudi Arabia.*, unpublished thesis (PhD). Cardiff University.

Alder, P., and Alder, P. [1987]. *Membership roles in filed research. ,* Newbury Park, CA: Sage.

Alderson, P. [2000]. 'Children as researchers: the effects of participation rights on research methodology.' In Christenson, P., and James, A, ed. *Research with children: perspectives and practice*, London: Falmer Press.

Aldridge, A., and Levine, K. [2001]. *Surveying the social world: principal and practice in survey research. ,* Buckingham: Open University Press.

Al-Otaibi, M., and Al- Swilam, B. [2002]. *The analysis of early childhood education objectives in Saudi Arabia.*, Research Centre in Education College: King Saud University.

Al-Sulaiman, N. [1998]. *Creative thinking abilities and specific characteristics of the classroom environment of female high school students in Saudi Arabia*, unpublished thesis (PhD). The George Washington University.

Amabile, T. [1989]. *Growing Up Creative.,* New York: Crown Publishing Group, Inc.

Amabile, T. [1996]. *Creativity in context.,* Oxford: Westview Press.

American Anthropological Association. [1998]. 'Code of ethics of the American Anthropological Association. ', Available at www.aaanet.org/ethcode.htm. [accessed February 19, 2011].

American Sociological Association. [1997]. 'Code of ethics.', Available at www.asanet.org. [accessed February 22, 2011.].

Anderson, G. [1998]. *Fundamentals of educational research. ,* London: Falmer Press.

Anning, A., and Edwards, A. [2006]. *Promoting children's learning from birth to five: developing the new early years professional.,* 2nd ed.*,* Buckingham: Open University Press.

Ansari, D., Donalan, C., Thoma, M., Ewing, S., Peen, T., and Karmiloff-Smith, A. [2003]. 'What makes counting count? Verbal and visuo-spatial contributions to typical and atypical number development.', *Journal of Experimental Child Psychology,* 85, 50-62.

Arieti, S. [1976]. *Creativity: The magic synthesis.,* New York: Basic Books.

Ashley, J., and Tomasello, M. [1998] 'Cooperative problem solving and teaching in pre-schoolers.', *Social Development,* 7, 143–163.

Atkinson, P., and Hammersley, M. [1994]. 'Ethnography and Participant Observation.' In Denzin, N., and Lincoln, Y ed. *Handbook of Qualitative Research*, London: Thousand Oaks, Calif: Sage.

Aubrey, C. [2004] 'Implemening the foundation stage in reception classes', *British Educational Research Journal,* 30(5), 633-656.

Auth, P. [2005]. *Assessing the use of creative problem solving skills and generic influences on learning in clinical reasoning by physician assistant students.*, unpublished thesis (PhD), Drexel University

Badawood, A. [2006]. *Relationships between shyness and language development in sample of pre-school children in Saudi Arabia.*, unpublished thesis (PhD), Cardiff University.

Bagby, J. [2002]. *The characteristics of problem solving transfer in a Montessori classroom.*, unpublished thesis (PhD), Baylor University, Waco, Texas.

Balka, D. [1974]. 'Creative ability in Mathematics', *Arithmetic Teacher,* 21, 633-636.

Baker-Sennett, J., Matusov, E., and Rogoff, B [1993]. 'Planning as developmental process.' In Reese, H., ed. *Advances in child development and behaviour.* , New York: Academic Press.

Baroody, A. [2000]. 'Does mathematics instruction for three to five years really make sense? ', *Young Children,* 55(4), 61-67.

Barron, F., and Harrington, D. [1981]. 'Creativity, Intelligence and Personality', *Annual Review of Psychology,* 32, 439-476.

Bassey, M. [1984]. ' Pedagogic Research: On the Relative Merits of Search for Generalization and Study of Single Events.' In Bell, J., Bush,T., Fox,A., Goodey, J., and Goulding, S. , ed. *Conducting Small-Scale Investigations in Educational Management.* , London: Harper and Row.

Becker, H. [1986]. *Writing for Social Scientists.,* Chicago, IL: University of Chicago Press.

Bedrova, E., and Leong, D. [1996]. *Tools of the mind: the Vygotskyian approach to early childhood education. ,* Englewood Cliffs, NJ: Prentice-Hall.

Beetlestone, F. [1998]. *Creative children, imaginative teaching. ,* Buckingham: Open University Press.

Benbasat, I., and Taylor, R. [1978]. 'The impact of cognitive styles on information system design', *MIS Quarterly,* 2, 43-54.

Bennett, N., Wood, E. and Regers, S. [1997]. *Teaching though play: Teachers' thinking and classroom practice. ,* Buckingham: Open University Press.

Berk, L., and Winsler,A. [1995]. *Scaffolding children's learning: Vygotsky and early childhood education.* , Washington, DC: National Association for the Education of Young Children.

Besancon, M., and Lubart, T. [2008]. 'Differences in the development of creative competencies in children schooled in diverse learning environment.', *Learning and Individual Differences* 18, 381-389.

Besemer, S., and O'Quin, K. [1986]. 'Analyzing creative products: Refinement and test of a judging instrument. ', *Journal of Creative Behavior,* 20, 115-126.

Best, J., and Kahn, J. [1998]. *Research in education. ,* 8th ed.*,* Boston: Allyn and Bacon.

Bink, M., and Marsh,R. [2000]. 'Cognitive regularities in creative activity. ', *Review of General Psychology,* 4, 59–78.

Blau, D. [1999]. 'The Effects of child care characteristics on child development. ', *Journal of Human Resources,* 34, 786-822.

Blaxter, L., Hughes, C. and Tight, M. [2006]. *How to research.,* 3rd ed., England Open University Press.

Bowling, A. [2002]. *Research methods in health: investigating health and health service. ,* 2nd ed., Buckingham: Open University Press.

Bracht, G., and Glass, G. [1968]. 'The external validity of experiments', *American Educational Research Journal,* 5 537-574.

Brand, H., and Welch, K. [1989]. *Cognitive and social- emotional development of children in different pre-school environments.*, 65, Psychological Report.

British Psychological Society. [1991]. *Code of conduct, ethical principles and guidelines.* , Leicester, UK: The British Psychological Society.

Britten, N., and Fisher, B. [1993]. 'Qualitative research and general practice. ', *Br J Gen Prac,* 4, 270-71.

Britten, N., Jones, R., Murphy, E., and Stacy, R. [1995]. 'Qualitative research methods in general practice and primary care.', *Family Practice,* 12 (1), 104-114.

Brog, W., and Gall, M. [1983]. *Educational research. ,* 4th ed., New York Longman.

Brooks-Gunn, J. [2003]. *Do You Believe in Magic? What We Can Expect From Early Childhood Intervention Programs?.* , 17, SRCD Social Policy Report.

Brown, P. [1986]. 'Developing an integrated unit for kindergarten. ' in Spodek, B., ed. *Educationally appropriate kindergarten practices*, Washington National Education Association of the United States., P 23-40.

Bruner, J. [1972]. 'The nature and uses of immaturity.', *American Psychologist,* 27, 687-708.

Bruner, J. [1973]. *Beyond the information given: Studies in the psychology of knowing,* New York: Norton.

Bruner, J. [1996]. *The culture of education.,* Cambridge, MA: Harvard University Press.

Bryman, A. [2008]. *Social research methods.,* Oxford: Oxford university Press.

Burchinal, M., Peisner-Feinberg, E., Bryant, D., and Clifford, R. [2000]. 'Children’s social and cognitive development and child-care quality: testing for differential associations related to poverty, gender, or ethnicity. ', *Applied Developmental Science,* 4 (3), 149-165.

Caldwee, C., Yussen, S., and Peterson, P. [1981]. 'Beliefs about teaching in Montessori and Non-Montessori pre-school teachers. ', *Journal of Teacher Education,* 32(2), 4-44.

Campbell, D., and Stanley, J. [1963]. 'Experimental and quasiexperimental design for research on teaching.' In Gage, N., ed. *Handbook of research on teaching.* , Chicago: Rand McNally.

Campbell, D., and Stanley, J. [1966]. *Experimental and quasiexperimental design for research. ,* Chicago, ILL: Rand -McNally.

Carr, L. [1994]. 'The strengths and weaknesses of quantitative and qualitative research: What method for nursing?. ', *Journal of Advanced Nursing,* 20 (4), 716–721.

Centofanti, J. [2002]. *A single-subject multiple baseline and feminist intextual deconstruction of gender differences among kindergartners in learning the alphabet using clay and a tactually kinesthetic multiple intelligence and Montessori pedagogy.*, unpublished thesis (PhD), Texas Tech University.

Chattin-McNichols, J. [1998]. *The Montessori controversy.,* New York: Delmar Publishers Inc.

Chin-Quee, D., and Scarr, S. [1994]. 'Lack of longitudinal effects of infant and pre-school child care on school-age children's social and intellectual development.', *Early Development and Parenting,* 2, 103-112.

Christensen, P. [1998]. 'Difference and similarity: how children's competence is constituted in illness and its treatment. ' In Hutch, I., and Moran-Ellis, J., ed. *Children and social competence: Arenas of action.*, London: Falmer Press.

Christensen, P., and James, A., (ed). [2000]. *Research with children: Perspectives and Practices.,* 2nd ed., London: Routledge.

Christensen, P., and James, A., (ed). [2000a]. *Research with children: perspective and practice. ,* London: Falmer Press.

Christensen, P., and Prout, A. [2002]. 'Working with ethical symmetry in social research with children. ', *Childhood*, 9, 477-496, available: http://chd.sagepub.com/cgi/content/short/9/4/477 [accessed July 1, 2008].

Christensen, P. [2004]. 'Children's participation in ethnographic research: Issues of power and representation.', *Children and Society,,* 18, 165-176.

Clarke-Stewart, K., Vandell, D., and Burchinal, M . [2002]. 'Do regulable features of child-care homes affect children's development?.', *Early Childhood Research Quarterly,* 17, 52-86.

Cohen, L., and Manion, L. [1994]. *Research methods in education.,* 4th ed., London: Routledge.

Cohen, L., Manion, L., and Morrison, K. [2000]. *Research method in education.,* 5th ed., London: Routledge

Cohen, L., Manion, L., and Morrison, K. [2007]. *Research method in education. ,* 7th ed., London: Routledge Falmer.

Coltman, P., Petyaeva, D., and Anghileri, J. [2002]. 'Scaffolding learning through meaningful tasks and adult interaction.', *Early Years,* 22(1), 39-49.

Cook, T., and Campbell, D. [1979]. *Quasi-experimentation: Design and analysis issues for field setting.,* Chicago: Rand McNally.

Corsaro, W. [1997]. *The sociology of childhood. ,* Thousand Oaks, CA: Pine Forge Press.

Craft, A. [2000]. *Creativity across the primary curriculum.,* London: Routledge-Falmer.

Craft, A. [2002]. *Creativity and early years education: a life wide foundation. ,* 3rd ed., London: Continuum the Tower Building.

Craft, A. [2005]. *Creativity in schools: tensions and dilemmas. ,* New York: Routledge.

Creswell, J. [1994]. *Research Design: Qualitative and Quantitative Approaches.,* London: Sage.

Cunnigham, J. [1997]. ‘Case study principle for different types of cases.', *Quality and Quantity,* 31(4), 401-423.
Daly, K. [1992]. ‘The fit between qualitative research and characteristics of families. '. In Gilgun, J., Daly, K and Handel, G (eds),. *Qualitative method in family research.*, London: Sage.
Dalton, M. [1990]. *A descriptive/comparative investigation of the pedagogical design of Grace H. Pilon, S.B.S*, unpublished thesis (PhD), Bowling Green State University.
Damon, W., and Phelps, E. [1989]. 'Critical distinctions among three approaches to peer education.', *International Journal of Educational Research* 13, 9-19.
Daniels, H. [2001]. *Vygotsky and pedagogy.,* London: Routledge Falmer.
Davis, G. [1986]. *Creativity is forever.,* 2nd ed.*,* Dubuque, IA: Kendal/Hunt Publishing Company.
Davis, G. [1992]. *Creativity is forever. ,* Dubuque, Iowa: Kendall/ Hunt Publishing Company.
Deater-Decker, K., Pinkerton, R., and Scarr, S. [1996]. 'Child care quality and children’s behavioral adjustment: a four year longitudinal study. ', *Child Psychology,* 36(8), 937-948.
DeCorate, E., Greer, B., and Verschaffel. L. [1996]. 'Mathematics teaching and learning. ' in Berliner, D., and Calfee. R., ed. *Handbook of education psychology.* , New York: Macmillan.
Demert, W., and Towner, J. [2003]. *A review of the research literature on the influence of culturally base education on the academic performance as native American students.* , Portland: Northwest Regional Education Lab.
DeVries, R. [1987]. *Programs in early education: a constructive view. ,* New York: Longman.
DeVries, R., and Kohlberg, L. [1987/1990]. *Constructivist early education: overview and comparison with other programs. ,* Washington, DC: National Association for the Education of Young Children.
Dewalt, K., and Dewalt, B. [2002]. *Participant observation: a guide for fieldworkers.,* Oxford Altamira Press.
Dewey, J. [1938]. *Experiences and education,* New York: Macmillan.
Dewey, J. [1944]. *Experience and Education,* New York Macmillan.
DiCarlo, C., and Vagianos, L. [2009]. 'Preferences and play. ', *Young Exceptional Children,* 12(4), 31-39.
Donaldson, M. [1978]. *Children’s mind,* London: Fontana.
Douglas, F. [1993]. *A study of pre-school education in Republic of Ireland with particular reference to those pre-school which are listed by Irish pre-school playgroups association in Cork city and county.*, unpublished thesis (PhD), Hull University.
Drew, C., Hardman, M., and Hart, A. [1996]. *Designing and conducting research: Inquiry in education and social science.,* 2nd ed.*,* USA: Allyn and Bacon.
Dreyer, A., and Rigler, D. [1969]. 'Cognitive performance in Montessori and nursery school children.', *The Journal of Educational Research,* 62(9), 411-416.
Duranti, A. [1997]. *Linguistic anthropology.,* Cambridge: Cambridge University Press.

Eason, R., Giannangelo, D. and Franceschini III, L. [2009]. 'A look at creativity in public and private schools', *Thinking Skills and Creativity,* 4, 130-137.
Edward, A. [2001]. 'Qualitative designs and analysis.' in MacNaughton, G., Rolfe, S., and Siraj-Blatchford, I., ed. *Doing early childhood research: International perspectives on theory and practice.* , Buckingham: Open University Press.
Edwards, A., and Kinght, P. [1994]. *Effective early years education teaching young children. ,* Buckingham: Open University Press.
Edwards, C. [2002]. 'Three approaches from Europe: Waldorf, Montessori, and Reggio Emilia.', *Early Childhood Research and Practice,* 4(1).
Einspruch, E. [1998]. *An introductory guide to SPSS for Windows.,* London: Sage.
Elliott, C. [1990]. *Differential ability scales.,* San Diego: Harcourt Brace Jovanovich.
Elliott, J. [1990]. 'Educational research in crisis: performance indicators and the decline of excellence.', *British Educational Research Journal,* 16 (1), 3-18.
Elliott, C., Smith, P., and McCullough, K. [1990]. *British Ability Scales II: Administration and scoring manual,* Great Britain: nferNelson: understanding potential.
Ellis, C. [2004]. *The ethnographic I: A methodological novel about autoethnography,* Oxford: Rowman and Littlefield Publishers, Inc.
Ellis, S., and Rogoff, B. [1982]. 'The strategies and efficacy of child versus adult teachers', *Child Development,* 43, 730-735.
Ericsson, K., and Charness, N. [1994]. 'Expert performance: Its structure and acquisition', *American Psychologist,* 49, 725-747.
Espinosa, L. [2002]. *High Quality pre-school: why we need it and what it looks like.* , 1, National Institute for early education research (NIEER).
Essa, E. [1996]. *Introduction to early childhood education.,* 2nd ed.*,* USA: Delmar Publishers.
Faust, R. [1984]. *Define and examining areas of criticism concerning the pedagogical of Maria Montessori with emphasis on the critics and their criticsm from 1910-1925.* , unpublished thesis (PhD).
Feez, S. [2010]. *Montessori and early childhood,* USA: SAGE Publications Ltd.
Feist, G. [1998]. 'Ameta-analysis of personality in scientific and artistic creativity', *Personality and Social Psychology Review,* 2, 290-309.
Feldhusen, J., and Treffinger, D. [1985]. *Creativity and thinking in problem solving for gifted education.,* Dubuque, IA: Kendall-Hunt.
Fero, D. [1979]. *Seriation skills in three-years-old children: A training study using Montessori materials.*, unpublished thesis (PhD), University of Houston.
Fero, J. [1997]. *A comparison of academic achievement of students taught by the Montessori method and by traditional methods of instruction in the elementary grades.*, unpublished thesis (PhD), Montana State University.
Finke, R., Ward, T., and Smith, S. [1992]. *Creative cognition: Theory, research, and applications.,* Cambridge: MIT Press.
Fisher, R. [1990]. *Teaching children to think.,* Oxford: Basil Blackwell Ltd.
Fisher, R. [1995]. *Teaching children to think.,* Cheltenham*:* Stanly Thornes.

Fisher, R. [1998]. *Teaching Thinking: Philosophical enquiry in the classroom. ,* 2nd ed., London Continuum.
Fisher, R. [2005]. *Teaching Children to Think. ,* 2nd ed., Cheltenham: Stanly Thornes.
Flewitt, R. [2003]. *Is every child's voice heard? : longitudinal case studies of 3-year-old children's communicative strategies at home and in a pre-school playgroup.*, unpublished thesis (PhD), University of Southampton.
Flewitt, R. [2005]. 'Conducting research with young children: some ethical consideration.', *Early Child Development and Care,* 175(6), 553-565.
Fluehr-Lobban, C. [1998]. 'Ethics.' In Bernard, H. R., (ed). *Handbook of methods in cultural anthropology.*, Walnut Creek, CA: AltaMira.
Fraser, S., Lewis, V.; Ding, S.; Kellett, M. and Robinson, C. , (eds). [2004]. *Doing research with children and young people.,* London Sage.
Gans, H. [1968]. 'The participant-Observer as human being: Observations on the personal aspects of field work. ', In Becker, H. S., (ed). *Institutions and the person: Papers presented to Everett C. Hughes* Chicago Aldine.
Gans, H. [1999]. 'Participant observation in the era of “ethnography”. ', *Journal of Contemporary Ethnography,* 28, 540-548.
Gardner, H. [1993]. *Creating minds : an anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham and Gandhi.,* New York: Basic Books.
Garfield, M., Taylor, N., Dennis, A., and Satzinger, J. [2001]. *Research report: Modifying paradigms individual differences, creativity, techniques, and exposure to ideas in group idea generation*, 12, Information Systems Research.
Geertz, C. [1973].` *The Interpretation of Cultures,* New York: Basic Books.
Gitter, L. [1971]. *The Montessori Approach to Special Education. ,* Washington, D.C: Mafex Associates.INC.
Glesne, C., and Peshkin, A. [1992]. *Becoming qualitative researchers: An introduction.,* New York: Longman.
Gliner, J., and Morgan, G. [2000]. *Research methods in applied settings:an integrated approach to design and analysis.,* Mahwah, NJ: Lawrence Erlbaum Associates.
Goetz, J., and LeCompte, M. [1984]. *Ethnography and qualitative design in education research.,* Orlando, FL: Academic Press.
Goldenberg, C. [1991]. ' Instructional Conversations and their Classroom Applications. ', available: http://escholarship.org/uc/item/6q72k3k9 [accessed 18 March, 2008].
Gomes, J. [2005]. *Using a creativity-focused science program to faster general creativity in young children: a teacher action research study.*, unpublished thesis (PhD), Fielding Graduate University.
Gönen, M., Uzman, S., Akcin, N. and Özdemir, N. [1993]. 'Creative thinking in five and six-Year-old kindergarten children.', *International Journal of Early Years Education,* 1 (3), 81-87.
Gopnik, A., and Graf, P. [1988]. 'knowing how you know: young children’s ability to identify and remember the sources of their beliefs. ', *Child Development,* 56 1366-1371.

Greenwald, D. [1999]. *Pikler and Montessori: A theoretical dialogue.*, unpublished thesis (Master), Pacific Oaks College.
Greenwood, D., and Levin, M. [1998]. *Introduction to action research: social research for social change.,* Thousand Oaks, CA: Sage.
Greetz, C. [1973]. *The interpretation of culture.,* New York: Basic Books.
Guliford, J. [1956]. 'The structure of intellect.', *Psychological Bulletin,* 53, 267-293.
Guilford, J. [1964]. ' Creative thinking and problem solving.', *Education Digest* 29, 21–31.
Guilford, J. [1968]. *Intelligence, creativity and their educational implications ,* San Diego: Knapp.
Guilford, J. [1977]. *Way beyond the IQ: Guide to improving intelligence and creativity.,* Buffalo, NY: Bearly Limited.
Guilford, J. [1980]. 'Some changes in the structure of intellect model', *Educational and Psychological Measurement,* 48, 1-4.
Gustafson, M. [2001]. *The role of conceptual flexibility in reading comprehension: the moment-to-moment case of selection meaning*, unpublished thesis (PhD). University of Minnesota.
Hadeed, J., and Sylva, K. [1999b]. 'Center care and education in Bahrain: Does it benefit children's development?.', *Early Child Development and Care,* 157, 67-84.
Hallam, S., Ireson, J., and Davies, J. [2004]. 'Primary pupils' experiences of different types of grouping in school', *British Educational Research Journal,* 30(4), 515-533.
Hammersely, M., and Atkinson, P. [1983]. *Ethnography. Principles in Practice. ,* 1st ed.*,* London: Tavistock.
Hammersely, M. [1992]. *What's wrong with ethnography?.* London: Routledge.
Hammersely, M., and Atkinson, P. [1994]. *Ethnography: principles in practice.,* London: Tavistock.
Hanapi, M. [2006]. *Promoting Creativity in early childhood education in Brunei.*, unpublished thesis (PhD), University of Western Australia.
Harms, T., Clifford, R., and Cryer, D. [1998]. *Early Childhood Environment Rating Scale-Revised.,* New York, NY: Teachers College Press.
Harris, M. [2004]. *Differences in mathematics scores between students who receive traditional Montessori instruction and students who receive music enriched Montessori instruction.*, unpublished thesis (PhD), University of Windsor.
Hausfather, S. [1996]. 'Vygotsky and schooling: creating a social contest for learning. ', *Action in teacher education,* 8, 1-10.
Hayes, S., and Wilson, K. [2003]. 'Mindfulness: Method and process', *Clinical Psychology: Science and Practice,* 10, 161–165.
Hedegaard, M. [1999]. 'The influence of societal knowledge traditions on children's thinking and conceptual development.' In Hedegaard, M., and Lompscher. J., ed. *Learning activity and developmental.*, Oxford Aarhus University Press.
Hinton, A. [1987]. *Research awareness: the ethnographic perspective,* Southampton: Ashford.
Hokanson, B. [2007]. 'By measure: Creativity in design.', *Journal of Industry in Higher Education*, 352-359.

Holland, J., Mauthner, M. and Sharpe, S. [1996]. *Family matters communicating health messages in the family.* , Family Health Research Reports., London: Health Education Authority.
Homan, R. [1980]. 'The ethics of covert methods.', *British Journal of Sociology,* 31, 46-59.
Hood, S., Kelley, P., and Mayall, B. [1996]. 'Children as research subjects: a risky enterprise.', *Children and Society,* 10, 117-28.
Howitt, D., and Cramer, D. [2005]. *Introduction to SPSS in Psychology for 10,11, 12 and 13.,* 3 rd ed., England: Pearson Prentice Hall.
Huber, G. [1983]. 'Cognitive Style as a Basis for MIS and DSS Designs: Much Ado About Nothing?', *Management Science,* 29(5), 567-579.
Huckstep, P., and Rowland, T [2000] 'Creative Mathematics: Real or Rhetoric? ', *Educational Studies in Mathematics,* 42(1), 81-100.
Huckstep, P., and Rowland, T. [2001] 'Being creative with the truth? Self-expression and originality in pupils' mathematics', *Research in Mathematics Education,* 3(1), 183-196.
Humphreys, L. [1970]. *Tearoom trade: Impersonal sex in public places.,* Chicago: Aldine.
Husen, T., and Postleth Waite, T., ed. [1994]. *The international encyclopaedia of education.,* 2nd ed., Oxford, UK: Pergamon.
Ibeji, N. [2002]. *Improving early reading skills of first grade students with learning disabilities using Montessori learning strategies.*, unpublished thesis (PhD), Union Institute and University.
Isaacs, B. [2007]. *Bringing the Montessori approach to your early years practice.,* London: Routledge.
Isaksen, S., and Treffinger, D. [1985]. *Creative problem solving: The basic course.,* Buffalo, NY: Bearly Limited.
Isaksen, S., and Dorval, K. [1993]. 'Changing views of creative problem solving: Over 40 years of continuous improvement.', *International Creativity Network Newsletter,* 3(1).
Isaksen, S., Dorval, B., and Treffinger, D. [1994]. *Creative approaches to problem solving.,* Dubuque, IA: Kenddall and Hunt.
Isaksen, S., Dorval, B., and Treffinger, D. [2000]. *Creative approaches to problem solving: a framework for change.,* Dubuque, Iowa: Kendall/Hunt Publishing Company.
Isaksen, S., Dorval, B., and Treffinger, D. [2010]. *Creative approaches to problem solving: A framework for change,* 3 ed., USA: SAGE Publications.
Isaksen, S., Lauer, J., Ekyall, G., and Britz, A. [2001]. 'Perceptions of the best and worst climates for creativity.', *Creative Research Journal,* 9, 251-265.
Isaksen, S., and Treffinger, D. [2004]. 'Celebrating 50 years of reflective practice: Versions of creative problem solving.', *Journal of Creative Behavior,* 38(2), 75-101.
Isbel, R., and Raines, S. [2003]. *Creativity and the arts with young children,* New York Delmar Learning.
Jeffrey, B., and Craft, A. [2004]. 'Teaching creatively and teaching for creativity: Distinctions and relationships.', *Educational Studies,* 30.
Johnson, J., Christie, J., and Wardle, F. [2005]. *Play, development, and early education.,* Boston: Pearson.

Johnson, J., Christie, J., and Yawkey, T. [1999]. *Play and early childhood development,* USA: Harper Collins.

John-Steiner, V., and Mahn, H. [1996]. 'Sociocultural approaches to learning and development: A Vygotskyan framework.', *Educational Psychologist,* 31(3/4), 191-206.

Jorgensen, D. [1989]. *Participant observation: A methodology for human studies.,* California: SAGE Publication.

Kahney, H. [1986]. *problem solving- A cognitive approach,* Milton Keynes: Open University Press.

Karnes, M., and Johnson, L. [1986]. 'Identification and assessment of the gifted talented handicapped and non handicapped children in early childhood.' in Whitmore, J., ed. *Intellectual giftedness in young children: recognition and development.*, New York: Haworth.

Karnes, M., Teska, J., and Hodgins, A. [1970]. 'The effects of four classroom interventions on the intellectual and language development of 4-year-old children.', *American Journal of Thopsychiatry,* 40(1), 58-76.

Karnes, M., Shwedel, A., and Williams, M. [1983]. *A comparison of five approaches education young children from low-income homes in as the Twig is Bent. , The consortium for longitudinal studies.,* Hillsdale, NJ: Lawrence Eribaum Associates.

Katz, G. [1993]. 'Child-sensitive curriculum and teaching.', *Young Children,* 48(6).

Kendall, D. [1992]. *The development of autonomy in children: An examination of the Montessori educational model.*, unpublished thesis (PhD), Walden University.

Kirk, J., . and Miller, M. [1986]. *Reliability and validity in qualitative research. ,* London: Sage.

Klein, E., Hammrich, P., Bloom, S., and Ragins, A. [2000]. 'Language Development and science inquiry: The Head Start on science and communication program.', *Early Childhood Research and Practice,* 2(2).

Kohen, D., Forer, B., and Hertzman, C. [2006]. 'National Data Sets: Sources of Information for Canadian Child Care Data. ', *Analytical studies Branch research paper series.*

Kolb, D. [1984]. *Experiential Learning.,* Englewood Cliffs, NJ: Prentice-Press.

Kontozisis, D. [2000]. *AD/HD, Computers and mathematics.* , unpublished thesis (Master), University of Reading.

Krathwohl, D. [1998]. *Methods of educational and social science research: an integrated approach.,* 2nd ed., New York: Longman.

Lave, J., and Wenger, E. [1991]. *Situated learning: Legitimate peripheral participation.,* New York: Cambridge University Press.

Laws, K., and McLeod, R. [2006]. ' Case study and grounded theory: sharing some alternative qualitative research methodologies with systems professionals. ', available: http://www.systemdynamics.org/conferences/2004/SDS-2004/papers/220MCLEO.pdf. [accessed 09 Sep 2009].

LeCompte, M., and Preissle, J. [1993]. *Ethnography and qualitative design in educational research.,* 2nd ed., New York: Academic Press.

Lefebvre, P., and Merrigan, P. [2002]. 'The effect of childcare and early education arrangements on developmental outcomes of young children. ', *Canadian Public Policy,* 28(2), 159–186.

LepCompte, M., Millroy, W., and Preissle, J. [1992]. *The hand book of qualitative research in education.,* London: Academic Press

Li, J. [2008]. 'Ethical challanges in participant observation: A reflection on ethnographic fieldwork.', *The Qualitative Report,* 13(1), 100-115.

Liebeck, P. [1984]. *How children learn mathematics.,* London Penguin.

Lillard, A. [2005]. *Montessori the science behind the genis.,* New Your, NY: Oxford University Press, Inc.

Lillard, P. [1972]. *Montessori: A Modern Approach.,* New York: Schocken Books.

Lillard, P. [1997]. *Montessori in the classroom.,* New York: Schocken Books.

Lillard, P., and Lillard, L. [2003]. *Montessori from the start.,* New York: Schocken Bokks.

Lioyed, B., and Howe, N. [2003]. 'Solitary play and convergent and divergent thinking skills in pre-school children.', *Early Childhood Research Quarterly,* 18(1), 22-41.

Lipps, G., and Yiptong-Avila, J. [1999]. *From Home to School—How Canadian Children Cope. Initial Analysis Using Data from the Second Cycle of the School Component of the National Longitudinal Survey of Children and Youth.*, Canada: Culture, Tourism and the Centre for Education Statistics.

Lloyd, B., and Howe, N. [2003]. 'Solitary play and convergent and divergent thinking skills in pre-school children', *Early Childhood Research Quarterly,* 18, 22-41.

Locket, A., Ginsborgt, J., and Peers, I. [2002]. 'Development and disadvantage: implications for the early years and beyond.', *International Journal of Language and Communication Disorders,* 37(1), 3-15.

Lompscher, J. [1999]. 'Learning activity and its formation: ascending from the abstract to the concrete.' In Hedegaard, M., and Lompscher, J. , ed. *Learning activity and developmental.*, Oxford: Aarhus Unversity Press.

Lubart, T. [2001]. 'Models of the creative process: Past, present and future.', *Creativity Research Journal,* 13, 295–308.

Lugt, R. [2000]. 'Developing a graphic tool for creative problem solving in design group.', *Design Studies,* 21(15), 505-522.

Magnuson, K., Meyers, M., Ruhm, C., and Waldfogel, J. [2004]. 'Inequality in pre-school education and school readiness.', *American Educational Research Journal,* 41(1), 115-157.

Magnuson, K., and Waldfogel, J. [2005]. 'Early childcare and education: effect on ethnic and racial gapes in school readiness.', *Early Childhood Care and Education,* 15(1), 1960-1969.

Malone, L., and Mastropieri, M. [1992]. 'Reading comprehension instruction: Summarization and self-monitoring training for students with learning disabilities.', *Exceptional Children,* 58, 270-279.

Mathison, S. [1988]. ' Why triangulate?.', *Educational Researcher,* 17(2), 13-17.

Mauthner, M. [1997]. 'Methodological aspects of collecting data from children: lessons from three research projects.', *Children and Society.,* 11, 16–28.

Mayer, R. [1992]. *Thinking, problem solving, cognition.,* 2nd ed., New York: W.H. Freeman and Company.

McCladdie, K. [2006]. *A comparison of the effectivness of the Montessori method of reading instruction and the balanced literacy method for inner city African American students.*, unpublished thesis (PhD), Saint Joseph’s University.

McDonnell, J. [1998]. 'Instruction for students with severe disabilities in general education settings', *Education and Training in Mental Retardation and Developmental Disabilities,* 33, 199-215.

McEwen, P. [1986]. *Learning styles: Ability and creativity.*, unpublished thesis (Master), Buffalo State College.

Meador, K. [1997]. *Creative thinking and problem solving for young learner,* Englewood, CO: Teacher Ideas Press/ Libraries Unlimited.

Mengping, T. [1998]. *The effects of logo programming and multimedia software on fifth grade students’ creativity in Taiwan.* , unpublished thesis (PhD). The University of Texas at Austin. .

Merriam, S. [1988]. *Case study research in education: a qualitative approach. ,* San Francisco, CA: Jossey-Bass.

Merriam, S. [1998]. *Qualitative research and case study applications in education.,* San Francisco: Jossey-Bass.

Mertens, D. [1998]. *Research method in education and psychology: Integrating diversity with quantitative and qualitative approaches.,* Thousand Oaks, Calif: Saeg.

Mieg, H. [2001]. *The Social Psychology of Expertise,* Mahwah, NJ: Lawrence Erlbaum Associates.

Miles, M., and Huberman, A. [1984]. *Qualitative data analysis: A sourcebook of new method.,* Beverly Hills, CA: Sage.

Miles, M., and Huberman, A. [1994]. *An expanded source book qualitative data analysis.,* Newbury Park: Sage.

Milgram, R. [1990]. 'Creativity: an idea whose time has came and gone?.' In Runco, M., and Albert, R., ed. *Theories of creativity.*, Newbury Park, CA: Sage.

Miller, L., and Dyer. [1975]. 'Four pre-school programs: their dimensions and effects. Monographs of the Society for Research.', *Child Development,* 40, 5-6.

Miller, L., and Bizzel, R. [1983]. *The louiseville experiment: a comparison of four programs.,* Hillsdale, NJ: Lawrence Erlbaum.

Miller, L., and Bizzel, R. [1983a]. 'Long-term effects of four pre-school programs: Sixth, seventh, and eight grades. ', *Child Development,* 54(3), 727-741.

Miller, L., and Bizzel, R. [1983b]. 'The Louisville experiment.' in *As the twig is bent: Lasting effects of pre-school programs.*, Hillsdale, NJ: Erlbaum.

Miller, L., and Bizzel, R. [1984]. 'Long-term effects of four pre-school programs: Ninth- and tenth-grade result.', *Child Development,* 55(4), 1570-1587.

Ministry of Education in Saudi Arabia. [2004-2005]. *Summary statistics on general education in kingdom of Saudi Arabia.*, Riyadh, SA: Ministry of Education, Computer and Information Centre, Statistics Unit.

Montessori, M. [1912, 2003]. *The Montessori Method,* New York: Barnes and Noble.

Montessori, M. [1917]. *Spontaneous activity in education (the Advanced Montessori method),* New York Frederick A. Stokes Company Publishers.

Montessori, M. [1948/1997]. *The discovery of the child,* Oxford: Clio Press.

Montessori, M. [1964]. *Maria Montessori: The Montessori Method,* New York: Random House, Inc.

Montessori, M. [1965]. *Maria Montessori : Dr. Montessori's Own Handbook. A Short Guide to Her Ideas and Materials.,* New York: Schocken Books.

Montessori, J. [1976]. 'Effects of teaching orientation on social interaction in nursery school.', *Journal of educational Psychology,* 68.

Moran, J. [1990]. 'Creativity in young children.' in *ERIC/EECE Digests.*, Urbana, IL: Eric Clearinghouse on elementary and early childhood education.

Morse, J. [1991]. 'Approaches to qualitative and quantitative methodological triangulation.', *Nursing Research,* 40(1), 120-123.

Morse, J. [1994]. *Critical Issues in Qualitative Research Methods.,* Thousand Oaks, CA: Sage.

Moss, P., Dahlberg, g., and Pence, A. [2003]. *Beyond quality in early childhood education and care: Postmodern perspectives.,* New York: Routledse Falmer.

Mumford, D., Mobley, M., Uhlman, C., Reiter-Palmon, R. and Doares, M. [1991]. 'Process analytic models of creative capacities.', *Creativity Research Journal,* 4, 91–122.

Mumford, D., Reiter-Palmon. R., and Redmond, R. [1994]. 'Problem construction and cognition: Applying problem representations in ill-defined domains.' In Runco, M., ed. *Problem finding, problem solving, and creativity.*, Westport, CT: Ablex, 3-39.

Mumford, M., Supinski, E., Baughman, W., Costanza, D. and Threlfall, V. [1997]. 'Process-Based measures of creative problem solving skills: V. overall prediction.', *Creative Research Journal,* 10 (1), 73-85.

Mundry, S., and Loucks-Horsley, S. [1999]. ' Designing professional development for science and mathematics teachers: Decision points and dilemmas.', *National Institute for Science Education Brief,* 3(1).

Murray, A. [2008]. *Public perceptions of Montessori education.*, unpublished thesis (PhD), University of Kansas.

Neuman, L. [2006]. *Social Research Methods: Qualitative and Quantitative Approaches.,* 6th ed., Boston: Pearson Education International.

Newell, A., Shaw, J., and Simon, H. [1962]. 'The Processes of Creative Thinking.' In Gruber, H., Terrell, G., and Wertheimer, M., ed. *Contemporary Approaches to Creative Thinking.*, New York: Atherton Press.

Newell, A., Shaw, J., and Simon, H. [1964]. 'The processes of creative thinking.' In Gruber, H., Terrell, G., and Wertheimer, M., ed. *Contemporary approaches to creative thinking.*, 3rd ed., New York: Atherton Press.

NICHD. [1998]. 'Redactions between family predictors and child outcomes: are they weaker for children in child care?.', *Developmental Psychology,* 34 (5), 1119-1128.

NICHD. [2002]. 'Early Child Care and Children's Development Prior to School Entry: results from the NICHD Study of Early Child Care.', *American Educational Research Journal,* 39(1), 133-164.

NICHD. [2004]. 'Father's and mother's parenting behavior and beliefs as predictors of child social adjustment in the transition to school.', *Journal of Family Psychology,* 18(4), 628-638.

Nickerson, R. [1999]. 'Enhancing Creativity.' In Sternberg, R., ed. *Handbook of Creativity.*, Cambridge: Cambridge University Press. .

Nicolopoulou, A. [1993]. 'Play, cognitive development, and the social world: Piaget, Vygotsky, and beyond.', *Human Development,* 36, 1-23.

Noller, R. [1979]. *Scratching the surface of creative problem solving: A bird's eye view of CPS.,* Buffalo, NY: DOK publishers.

Ochs, E. [1979]. 'Introduction: What child language can contribute to pragmatics' in Ochs, E., and Schieffelin, B., ed. *Developmental Pragmatics*, New York: Academic Press.

O'Donnell, M. [2007]. *Maria Montessori,* London: Continuum.

O'Leary, Z. [2004]. *The essential guide to doing research.,* London: Sage.

O'Kane, C. [2000]. 'The development of participatory techniques: facilitating children's views about decisions which affect them. ' In Christensen, P. and James, A., (ed). *Research with Children: Perspectives and Practices.*, London: Routledge.

O'Neill, K., and Gopink, A. [1991]. 'Young children ability to identify the sources of their beliefs.', *Development Psychology,* 27, 390-397.

O'Neill, K., and Chong, C. [2001]. 'Pre-school children's difficulty understanding the types of information obtained through the five senses. ', *Child Development,* 72(3), 803-815.

Onwuegbuzie, A. [2000]. *Expanding the framework of internal and external validity in quantitative research.*, November, Ponte Vedra. FL: Annual Meeting and Association for the Advancement of Educational Research (AAER)

Oppenheimer, T. [1999]. 'Schooling the imagination.', *Atlantic Monthly,* 284(3), 71-83.

Osborn, A. [1952]. *Wake up your mind.,* New York: Charles Scribner's Sons.

Osborn, A. [1957]. *Applied Imagination: Principles and procedures of creative problem solving,* Scribners.

Osborn, M., and McNess, F. [2002]. 'Teachers, creativity, and the curriculum: A cross cultural perspective.', *Education Review,* 15(2), 79-84.

Parnes, S. [1967]. *Creative behavior guidebook.,* New York: Charles Scribner's Sons.

Parnes, S. [1972]. 'Creative potential and the educational experience.', in Parnes, S., ed. *Creativity: unlocking human potential.*, Buffalo, NY: D.O.K, Annual convention of the American Psychological Association

Parnes, S., Noller, R., and Biondi, A. [1977]. *Guide to a creative action,* New York: Scribners.

Patton, M. [1980]. *Qualitative evaluation methods.,* Beverly Hills, CA: Sage.

Patton, M. [2001]. *Qualitative Evaluation and Research Methods.,* 2nd ed., Thousand oaks, CA: Sage.

Patton, M. [2002]. *Qualitative research and evaluation methods.,* Newbury Park, CA: Sage.

Payler, J. [2005]. *Exploring foundations: sociocultural influences on the learning processes of four year old children in a pre-school and reception class.*, unpublished thesis (PhD), University of Southampton

Peisner-Feinberg, E., Buurchinal, M., Clifford, R., Culkin, M., Howes, C., Kagan, S., and Yazejian, N. [2001]. 'The Relation of Pre-school Childcare Quality to Children's Cognitive and Social Developmental Trajectories through Second Grade.', *Child Development,* 72(5), 1534-1553.

Pepler, D., and Ross, H. [1981].'The effects of play on convergent and divergent problem solving.', *Child Development,* 52, 1202-1210.

Perner, H., and Ruffman, T. [1995]. 'Episodic memory and autonoetic consciousness: Developmental evidence and a theory of amnesia.', *Journal of Experimental Child Psychology,* 59, 516-548.

Phillips, S. [1991]. 'Maria Montessori and contemporary cognative psychology. ', *Journal of Education for Teaching,* 3(1), 55-68.

Piaget, J. [1928/ 1995]. *Sociological studies,* New York: Routledge.

Piaget, J. [1962]. *Play, dream and imitation in childhood.,* New York: Norton.

Piaget, J. [1973]. *To Understand is to Invent: The Future of Education. ,* New York: Grossman.

Pickering, J. [1992]. 'Successful applications of Montessori Methods with children at risk for learning disabilities.', *Annals of Dyslexia,* 42, 90-109.

Pillow, B. [1989]. 'Early understanding of perception as a source of knowledge.', *Journal of Experimental Child Psychology,* 47, 116-129.

Pole, C., and Morrison, M. [2003]. *Ethnography for education.,* England: Open University Press.

Prout, A., and James, A. [1990]. 'A new paradigm for the sociology of childhood? Province, promise and problems.' In James, A., and Prout, A., ed. *Constructing and reconstructing childhood: Contemporary issues in the sociological study of childhood*, London: The Falmer Press.

Puccio, G. [1987]. *The effect of cognitive style on problem defining behavior*, unpublished thesis (Master), State University College at Buffalo.

Puccio, G., Firestien, R., Coyle, C., and Masucci, C. [2006]. 'A review of the effectiveness of CPS training: A focus on workplace issues.', *Creativity and Innovation Management,* 15, 19−33.

Qin, Z., Johnson, D., and Johnson, R. [1995]. 'Cooperative Versus competitive efforts and problem solving.', *Review of Education Research,* 65(2), 129-143.

Quah, M. [1998]. 'Early intervention for pre-schoolers with mild disabilities.', *Early Child Development and Care,* 144, 101-111.

Ramani, G. [2005]. *Cooperative play and problem solving in pre-school children.*, unpublished thesis (PhD), University of Pittsburgh.

Ramey, S., and Ramey, C. [2000]. ' The effects of early childhood experiences on developmental competence.' in Danziger, S., and Waldfogel, J. , ed. *Securing the future: Investing in children from birth to college.*, New York: Russell Sage Foundation, 122-150.

Rawlings, D., Twomey, F., Burns, E., and Morris, S. [1998]. 'Personality, creativity and aesthetic preference: comparing psychoticism, sensation seeking, schizotypy, and openness to experience.', *Empirical Studies of the Arts,* 16, 153-178.

Reed, M. [2000]. *Comparison of the place value understanding of Montessori and non-Montessori elementary school students.*, unpublished thesis (PhD), The Ohio State University.
Reed, P., Osborne, L., and Corness, M. [2007]. 'Brief report: relative effectiveness of different home-based behavioral approaches to early teaching intervention. ', *Springer: J Autism Dev Disord,* 37, 1815-1821.
Robertson, S. [2001]. *Problem solving.,* Hove: Psychology Press
Robson, C. [2002]. *Real world research.,* 2nd ed.*,* London: Blackwell Publishing
Rodriguez, L., Irby, B., Brown. G., Lara-Alecio., R and Galloway, M. [2003]. *An analysis of a public school prekindergarten bilingual Montessori program. In: Annual Meeting of the American Educational Research Association.*, Chicago
Rogoff, B. [1986]. 'Adult assistance of children's learning.' In Raphael, T., ed. *The contexts of school based literacy.*, New York: Random House.
Rogoff, B. [1990]. *Apprenticeship in Thinking; Cognitive Development in Social Contex.,* New York, Oxford: Oxford University Press.
Rogoff, B. [1991]. 'Guidance and participation in spatial planning.' In Resnick, L., and Levine, J., and Teasley, S., ed. *Perspectives on socially shared cognition.*, Washington, Dc: American Psychological association 349-364.
Rogoff, B., Mistry, J., Goncu, A., and Mosier, C. [1993]. 'Guided participation in cultural activity by toddlers and caregivers.', *Monographs of the Society for Research in Child Development,* 58(8).
Rogoff, B. [1994]. 'Developing understanding of the idea of community of learners. ', *Mind, Culture, and Activity,* 1, 209-229.
Rogoff, B. [1995]. 'Observing sociocultural activity on three planes: participatory appropriation, guided participation, and apprenticeship.' in Wertsch, J., del Rio, P., and Alvarez, A., ed. *Sociocultural studies of mind.*, Cambridge: Cambridge University Press.
Rogoff, B. [1998]. 'Cognition as a collaborative process.' in Kuhn, D., and Siegler, R., ed. *Cognition, perception and language*, Handbook of Child Psychology, 5th ed., New York: Wiley, 679-744.
Rogoff, B. [2003]. *The cultural nature of human development.,* New York: Oxford University Press.
Rogoff, B., and Lave, J., ed. [1984]. *Everyday Cognition: its development in social context.,* Cambridge: Harvard University Press.
Ross, S., and Morrison, G. [1991]. 'Delivering your presentations at AECT', *Tech Trends,* 36, 66-68.
Runco, M. [1990]. 'Implicit theories and ideational creativity.' In Runco, M., and Albert, R., ed. *Theories of creativity*, Thousand Oaks, CA: Sage Publications, 234–252.
Runco, M. [2001]. 'Flexibility and originality in children's divergent thinking.', *The Journal of Psychology,* 120 (4), 345-352.
Runco, M., and Nemiro, J. [1994]. 'Problem finding, creativity, and giftedness', *Report Review,* 16, 235–241.
Russ, S. [1987]. 'Assessment of cognitive affective interaction in children: Creativity, fantasy, and play research. ' In Butcher, J., and Spielberger, C., ed. *Advances inpersonalily assessment*, Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Russ, S. [1998]. 'Play, Creativity, and adaptive functioning: implications for play interventions.', *Journal of Clinical Child Psychology,* 27(4), 469-480.

Saber, M. [1996]. *Problem that face the pre-school during their application of the NDC in Jeddah city.*, Makkah: The Scientific Islamic Research Centre. Um-Alqura University.

Salminen, A., Harra, T., and Lautamo, T. [2006]. 'Conducting case study research in occupational therapy.', *Australian Occupational Therapy Journal,* 53, 3-8.

Samadi, H., and Marwa, N. [1991]. *The Newly Development Curriculum for Pre-school (Self Learning Curriculum). ,* Saudi Arabia, Ryiadh: The Presidency of Girls Education.

Samadi, H., and Marwa, N. [2005]. *The Newly Development Curriculum for Pre-school (Self Learning Curriculum).* Saudi Arabia, Ryiadh: The Presidency of Girls Education.

Sammons, P., Sylva , K., Melhuish, E., Siraj-Blatchfor, I., Taggart, B., and Elliot, K. [2003]. *The effective provision of pre-school education (EPPE) project: Technical paper 8b-Measuring the impact of pre-school on children's social behavioural development over the pre-school period.*, London: DfES/Institute of Education, University of London.

Saracho, N. [1990]. 'Teaching young children: the teacher's function in early childhood curriculum.', *Early Child Development and Care,* 61, 57-63.

Saracho, O. [1990]. 'Pre-school children's cognitive style and their social orientation', *Perception and Motor Skills,* 70(3), 915-921.

Saracho, O., and Spodek, B. [2003]. *Studying teachers in early childhood setting,* Greenwich, CT: Information Age Publishing.

Scarr, S. [1998]. 'American child care today.', *American Psychologist,* 54, 95-108.

Schensul, S., Schensul, J., and LeCompte, M. ([1999].) '*Essential ethnographic method: Observations, Interviews, and Questionnaires*', 2 of the Ethnographer's Toolkit). Walnut Creek, Calif: Altamira Press.

Schirrmacher, R. [1988]. *Art and creative development for young children. ,* Albany, NY: Delmar.

Schoenfeld, H. [1985]. *Mathematical problem solving.,* London: Academic.

Schofield, J. [1993]. 'Increasing the generalisability of qualitative research. ' in Hammersley, M., ed. *Social research: Philosophy, Politics and Practice.* , London: Open University and Sage, 200-225.

Schwartz, M., and Schwartz, C. [1955] 'Problems in participant observation ', *American Journal of Sociology,* 60(4), 343-353.

Schweinhart, L., and Weikart, D. [1997]. *Lasting differences: the High/Scope pre-school curriculum comparison through age 23,* Michigan: High/Scope Press.

Scott, V. [1990]. 'Explicit and implicit grammar teaching strategies: new empirical data', *French Review,* 63, 779–789.

Seach, D. [2007]. 'Interactive play for children with Autism.' in, London: Routledge.

Sebley, E., Treffinger, D., and Isaksen, S. [2002]. *VIEW: An assessment of problem solving style.*, Sarasota, FL: Centre for Creative Learning.

Sebley, E., Treffinger, D., Isaksen, S., and Lauer, K. [2004]. *Defining and assessing problem solving style: Technical manual.*, Sarasota, FL: Centre for Creative Learning.

Sharp, C. [2001]. 'Developing young children's creativity through arts: what does research have to offer?.', In *National Foundation for Educational Research (nfer), paper present to an invitational seminar*, Chadwick Street Recreation Centre, London, 14 February 2001,

Sharpe, P. [1994]. 'Children's responses to questions about transformations and their relationship to strategies used in problem solving.', *International Journal of Early Years Education,* 2(3), 84-95.

Shrager, J., and Siegler, R. [1998]. 'SCADS: A model of children's strategy choices and strategy discoveries', *Psychological Science,* 9(5), 405-410.

Siegler, R., and Jenkins, E. [1989]. *How children discover new strategies,* Hillsdale, NJ: Erlbaum.

Simons, H. [1996]. 'The paradox of case study.', *Cambridge Journal of Education,* 26(2), 225-240.

Siraj-Blatchford, I., Sylva, K., Muttock, S., Gilden, R., and Bell, D. [2002]. *Researching effective pedagogy in the early years.*, London: Department for Education and skills.

Siraj-Blatchford, I., and Sylva, K. [2004]. 'Researching pedagogy in English pre-schools.', *British Educational Research Journal,* 30(5), 713-730.

Skinner, P. [1990]. *What's your problem?.* Portsmouth, NH: Heinemann.

Spradley, J. [1980]. *Participant observation.,* New York: Holt, Rinehart and Winston.

Springmuh, I. [1985]. *Interactive problem solving in pre-school children: when are two heads better than one?.* unpublished thesis (PhD), University of Minnesota.

Stake, R. [1978]. 'The case study method in social inquiry, in Deakin University.', *Approaches and Dilemmas in Curriculum Evaluation,* 1.

Stake, R. [1994]. 'Case Studies.' in Denzin, N., and Lincoln, Y., ed. *Handbook of Qualitative Research.*, Thousand Oaks: Sage.

Stake, R. [1995]. *The art of case research.,* Newbury Park, CA: Sage.

Standing, E. [1984]. *Maria Montessori, her life and work.,* New York: Plume.

Stipek, D., and Byler, P. [1997]. 'Early childhood education teachers: do they practice what they preach?.', *Early Childhood Research Quarterly,* 12(3), 305-325.

Stirling, K. [1975]. *The construction and utilization of Montessori Sensorial exercise kits for pre-school children.*, unpublished thesis (PhD), University of Utah.

Stodolsky, S., and Karlson, A. [1972]. 'Differential outcomes of a Montessori curriculum.', *The Elementary School Journal,* 72(8), 419-433.

Suddendorf, T., and Fletcher-Flinn, M. [1999]. 'Children's divergent thinking improves when the understand false beliefs.', *Creativity Research Journal,* 12(2), 115-129.

Sutton-Smith, B. [1986]. 'The spirit of play. ' in Fein, G., and Rivkin, M., ed. *The young child at play: Reviews of research*, Washington DC: National Association for the Education of Young Children, 3-16.

Sylva, K., Roy, C., and Painter, M. [1980]. *Child watching at playgroup and nursery school.,* London: Grant McIntyre.

Sylva, K. [1992]. 'Conversations in the Nursery: How they contribute to aspirations and play.', *Language and Education,* 6(2), 141-148.
Sylva, K., Siraj-Blatchford, I., and Taggart, B., [1998]. 'The Early Childhood Environmental Rating Scale: 4 Curricular Subscales.Assessing children's social behaviour and competence, NFER Nelson.' in Sylva, K., and Stevenson, J., (eds). *The Target Child Observation.*, London: Institute of Education.
Sylva, K., Siraj-Blatchford, I., Taggart, B., Sammons, P., Melhuish, E., Elliot; K., and Totsika. [2006]. 'Capturing quality in early childhood through environmental rating scales.', *Early Childhood Research Quarterly,* 21, 76-92.
Tegano, D., Sawyers, J., and Moran, J. [1989]. 'Problem-finding and solving in play: The teacher's role', *Childhood Education*, 92-97.
Tegano, D., Moran, J., and Sawyers, J. [1991]. *Creativity in early childhood classrooms. ,* Washington, DC: National Education Association.
Tepperman, J. [2007]. *Play early years: key to school success.* , el Cerrito, CA: Bay Area Early Childhood Funders. Policy Brief. Early Childhood Funders.
Thomas, N., and O'Kane, C. [1998]. 'The ethics of participatory research with children.', *Children and Society,* 12(5), 336-348.
Thomas, W. [1923]. *The unadjusted girl.,* Boston: Little, Brown, and Co.
Thompson, P. [2006]. *Performance creativity: the role of self, meaning and cultural significance in a Montessori environment.*, unpublished thesis (PhD), University of Denver.
Thorne, B. [1993]. *Gender play: girls and boys in school.,* New Brunswick, NJ: Rutgers University Press.
Tizard, B., Hughes, M., Carmichael, H., and Pinkerton, G. [1983]. 'Language and social class: is verbal deprivation a myth?.', *Journal of Child Psychology and psychiatry,* 24(4), 533-542.
Torrance, E. [1963]. 'The creative personality and the ideal pupil', *Teacher Collage Record,* 65, 220-226.
Torrance, E. [1965]. *Rewarding creative behaviour: experiments in classroom creativity.,* London: Prentice-Hall, INC.
Torrance, E. [1966]. 'Rational of the Torrance tests of creative thinking ability.' in Torrance, P., and White, W., ed. *Issues and advances in education psychology.*, Istica, IL: F. E. Peacock.
Torrance, E. [1972]. 'Predictive validity of the Torrance Tests of Creative Thinking', *Journal of Creative Behavior,* 6(4), 236–252.
Torrance, E. [1974b]. *Torrance test of creative thinking: Norms.Technical Manual.*, Bensenville, IL: Scholastic Testing Service.
Torrance, E. [1984]. *The Torrance Tests of Creative Thinking streamlined (revised) manual Figural A and B.,* Bensenville, IL: Scholastic Testing Service.
Torrance, E. [1990]. *The Torrance Tests of Creative Thinking Norms-Technical Manual Figural (Streamlined) Forms A and B.,* Bensenville, IL: Scholastic Testing Service.
Torrance, E., and Sisk, D. [1997]. *Gifted and talented in the regular classroom.,* Buffalo, NY: Creative Education Foundation Press.

Torrence, M., and Chattin-McNichoks, J. [2000]. 'Montessori education today.' in Roopnarine, J., and Johnson, J., ed. *Approaches to early childhood education*, Upper Saddle River, NJ: Prentice Hall.

Tovikkai, V. [1991]. *A comparison of pre-school competrncies required at Thai curriculum as realized in a United States Play-Oriented program and Montessori program.*, unpublished thesis (PhD), Texas Woman's University.

Treffinger, D. [1995]. 'Creative problem solving: Overview of educational implications.', *Educational Psychology Review,* 7(3), 301-312.

Treffinger, D., Isaksen, S., and Dorval, B. [2005]. 'Creative problem solving: History, development, and implications for gifted education and talent development.', *Gifted Child Quarterly,* 49, 342-353.

Treffinger, D., Isaksen, S., and Dorval, B. [2006]. *Creative problem solving: an Introduction.,* 4th ed.*,* Texas: Prufrock Press INC.

Treffinger, D., Selby, E., Isaksen, S., and Crumel, J. [2007]. *An introduction to problem solving style.,* Sarasota, FL: Centre for Creative Learning.

Treffinger, D. [2008]. 'Understanding problem-solving style and their implications in adolescence. ', in *The Third International VIEW Networking Conference*, Sarasota, FL,

Tudge, J. [1985]. 'The effect of social interaction of cognitive development: How creative is conflict?.', *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition,* 7, 33-40.

Tudge, J., and Rogoff, B. [1989]. 'Peer influences on cognitive development: Piagetain and Vygotskian perspectives.' In Bornstein, M., and Bruner, J., ed. *Interaction in human development.*, Hillsdale, NJ: Lawrence Erlbaum.

Tudge, J. [1992]. 'Processes and consequences of peer collaboration: a Vygotsky analysis.', *Child Development,* 63, 1364-1379.

Van der Veer, R., and Valsiner, J. [1991]. *Understanding Vygotsky: a quest for synthesis.,* Oxford: Blackwells.

Van Hoorn, J., Nourot, P., Scales, B., and Alward, K. [2007]. *Play at the centre of the curriculum.,* 4th ed.*,* New York: Macmillan.

Vance, T. [2003]. *An exploration of the relationship between pre-school experience and the acquisition of phonological awareness in kindergarten.*, unpublished thesis (PhD), George Mason University.

Vandell, D., and Wolfe, B. [2000]. *Child care quality: Does it matter and does it need to be improved?.* Report prepared for the U.S. Department of Health and Human Services, Office for Planning and Evaluation.

Vandell, L., and Corasaniti, A. [1990]. 'Variations in early child care: Do they predict subsequent social, emotional, and cognitive difference?. ', *Early Childhood Research Quarterly,* 5(4), 555-572.

Voutsina, C. [2002]. *The process of behavioural, representational and conceptual change in young children's strategies when solving arithmetic tasks*, unpublished thesis (PhD), University of Southampton.

Vygotsky, L. [1934/1987]. 'Thinking and speech.' in Rieber, R., and Carton, A., ed. *The collected works of L.S Vygotsky*, New York: Plenum.

Vygotsky, L. [1935/ 1978]. *Mind in society: The development of higher psychological processes.,* Cambridge, MA: Harvard University Press.

Vygotsky, L. [1962]. *Thought and language.,* Cambridge, Mass: MIT Press.

Vygotsky, L. [1967]. 'Play and its role in the mental development of the child.', *Soviet Psychology,* 5, 6-18.
Vygotsky, L. [1976]. 'Play and its role in the mental development of the child.' in Bruner, J., Jolly, A., and Sylvia, K., ed. *Play, its role in development and evolution.*, Harmondsworth: Penguin Books.
Vygotsky, L. [1998]. *The collected works of L.S. Vygotsky.,* New York: Plenum Press.
Waldfogel, J. [2002]. 'Child Care, Women's Employment and Child Outcomes. ', *Journal of Population Economics,* 15, 527-548.
Wallace, B. [2002]. *Teaching thinking skills across the early years: a practical approach for children aged 4-7.,* London: David Fulton Publishers.
Wallen, N., and Fraenkel, J. [2001]. *Educational research: a guide to the process. ,* 2nd ed.*,* London: Lawrence Erlbaum Associates.
Wells, G. [1994]. 'The complementary contributions of Vygotsky and Halliday to Language based theory of learning.', *Linguistics and Education,* 6, 41-90.
Wertsch, J., McNamee, G., McLane, J., and Budwig, N. [1980]. 'The adult-child dyad as problem solving system.', *Child Development,* 51, 1215-1221.
Wertsch, J. [1984]. 'The zone of proximal development: Some conceptual issues.' in Rogoff, B., and Wertsch, J., ed. *Children's learning in the "zone of proximal development".* San Francisco: Jossey-Bass.
Wertsch, J. [1991]. *Voices of the mind: A sociocultural approach to mediated action,* Cambridge, MA: Harvard University Press.
Wertsch, J. [1998]. *Mind as action.,* New York: Oxford University Press.
White, J., Dearden, R., Hirst, P., and Peters, R. , ed. [1972]. *Creativity and education: a philosophical analysis,* London: Routledge and Kegan Paul
Willkinson, A. [1991]. *A study of the emergence of phonological wareness as influenced by type of nursery school programe, parent teaching, and age (Pre acadmic, whole child, Montessori).* unpublished thesis (PhD), Bryn Mawr Colllege.
Witkin, H. [1962]. *Psychological differentiation: studies of development,* New York: Wiley.
Wood, D. [1986]. 'Aspects of teaching and learning' In Richards, M., and Light, P., ed. *Children of social world.*, Cambridge: Polity Press.
Wood, D. [2004]. *How Children Think and Learn.,* 2nd ed.*,* Oxford: Blackwell Publishing.
Wood, D., Bruner, J., and Ross, G. [1976]. 'The role of tutoring in problem solving.', *Journal of Child Psychology and psychiatry,* 17(2), 89-100.
Wood, D., Wood, H. and Middleton, D. [1978]. 'An experimental evaluation of four face-to-face teaching strategies.', *International Journal of Behavioral Development,* 1, 131-47
Woodhead, M. [1998]. ''Quality' in early childhood programmes-a contextually appropriate approach.', *International Journal of Early Tears Education,* 6(1).
Woodhead, M., and Faulkner, D. [2000]. 'Subjects, objects or participants? Dilemmas of psychological research with children.' In Christensen, P., and James, A., ed. *Research with children: Perspective and practices.*, London: Falmer Press.

Woolley, D., and Bruell, J. [1996]. 'Young children's awareness of the origins of their mental representation.', *Developmental Psychology,* 37, 335-346.

Yawkey, D., and Toro-Lopez, J. [1985]. 'Examining descriptive and empirically based typologies of toys for handicapped and nonhandicapped children', *Early Childhood Special Education,* 5(3), 47-58.

Yin, R. [1994]. *Case study research: Design and method.,* 2nd ed.*,* Thousand Oaks, CA: Sage.

Yin, R. [2003]. *Case study research, design and methods.,* 3rd ed.*,* Newbury Park: Sage.

Zamzami, F. [2000]. *Evaluation of the Newly Developed Curriculum for the presidency of girls education in Saudi Arabia.*, The Scientific Research Centers. Um-Alqura University.

Appendix 1.1

1- The Self Learning Curriculum:

1-1 Curriculum Criteria

The criteria that the curriculum follows are:

1- Play.
2- Freedom.
3- Flexibility.
4- Self learning.
5- Social interaction.
6- Respect for the child's identity.
7- Introducting the child to aspects of his or her culture.
8- Knowledge and skills.
9- Relationships with family.

1-2 New Development Curriculum Guidance Books

The curriculum is presented in seven texts:

- The basic book: a guidance manual for teachers.
- Five texts planned around different thematic units (Water Unit, Sand Unit, Food Unit, Hands Unit, and Life at Home Unit).
- The seventh text has five different synopsis units (Friends Unit, My Health and Safety Unit, Clothing Unit, Family Unit and My Book Unit).

1-3 The Basic Book

It the basic book is a guidance manual for the teacher. The teacher's manual gives the curriculum five components:

1- Goals and objectives.
2- Guidance for the child.
3- Organisation of the physical environment.
4- Daily routine.
5- Preparing the child for pre-school.

1-3-1 Goals and Objectives

There are three sections in this part: first, general objectives for early childhood education in Saudi Arabia; second, pre-school children's needs; and third, the abilities and developmental skills of pre-school children.

1-3-1-1 General Goals

The objectives of pre-school are formulated to be consistent with the overall educational policy of Saudi Arabia. These objectives are:

1- Protect the instincts of the child and assist his or her moral, mental, and physical growth in a natural environment while complying with the requirements of Islam.
2- Guide the child's religious inclination on the basis of belief in the oneness of God.

3- Teach the child good manners and help him or her to acquire the virtues of Islam. Guide the development of his or her behaviour by setting a good example at school.
4- Familiarise the child with school and prepare him or her for it by transferring him or her tenderly from the stage of self-centralisation to a joint social life with schoolmates.
5- Provide the child with a wealth of appropriate language and basic information that is suitable for his or her age and related to the environment surrounding him.
6- Train the child in physical exercises and familiarize him or her with sanitary habits. Educate his or her senses and train him or her to use them properly.
7- Encourage the child's creative thinking, polish his or her taste and give his or her energies a chance to blossom under guidance.
8- Be loyal to the child's needs, making him or her happy and educating the child without spoiling or burdening him or her.
9- Protect the child from dangers, training him or her against the early signs of bad behaviour and teaching him or her to face childhood problems in an appropriate way (Samadi and Marwa, 1991).

1-3-1-2 The pre-school child's needs

According to NDC designers, the child's needs are:

1- The child needs to know the concepts of God's abilities.
2- The child needs to be treated in a respectful way and to appreciate his or her unique nature and his or her needs.
3- The child needs to be treated and educated in a warm manner in the educational environment, making it feel similar to his or her home, thus ensuring a feeling of security.
4- The child needs to be guided by a qualified teacher who can give a good example of Islamic morals.
5- The child needs to establish a good relationship with his or her peers and with adults.
6- The child needs to be able to use language in an appropriate way.
7- The child needs to understand concepts that are suitable for his or her age and needs.
8- The child needs to use all his or her senses in play.
9- The child needs to practise good habits in a safe environment.
10- The child needs to be creative in expression.

1-3-1-3 The skills

Children need to develop the following skills:

1- A relationship with God.
2- A relationship with oneself.
3- A relationship with other children.
4- Creativity.
5- Classification.
6- Identification.
7- Matching.
8- Understanding and using language to express oneself.
9- Recognising and enhancing the small muscle skills.

10- Enhancing large muscle skills.

1-3-2 Guidance for the Child

The curriculum concentrates on the function of guidance in the early childhood years. The curriculum encourages a positive environment in order to help children learn and behave appropriately, and to give them opportunities to make decisions and to make discoveries. It also helps children to develop self-esteem. This section of the teacher's manual presents discipline methods for the teacher that work with young children. In addition, it gives examples of the most common problems the teachers might face during their work with children.

1-3-3 Organizing of the Learning Environment

The Self Learning Curriculum explains how to organise the physical environment for children to learn. This environment is referred to as the *educational environment* (EE) and is divided into various centres for the children. It emphasizes several principles:
1- There is a variety of experience, so that children learn better in the EE and they depend on themselves more than on their teacher;
2- The EE allows every child to concentrate in a quiet centre and to learn and discover things there;
3- Children select their own learning;
4- The EE gives opportunities for children to find solutions to their problems by themselves;
5-The EE helps children to communicate with each other;
6- The EE should feel like home for every child.

The learning environment in the NDC is divided into two basic areas: indoors and outdoors, the indoor environment is in turn divided into seven basic centres.

1-3-4 A Typical Daily Routine

This section of the teacher's manual instructs the teacher in how to plan the daily programme. It also explains the goal for each element of the daily routine. It is designed to achieve four major aims: firstly, it encourages self-learning; secondly, it provides an opportunity for children to make choices and decisions in their learning; thirdly, it provides a variety of interaction; and finally, it provides opportunities to work in a variety of environments.

The main elements of the daily routine are: circle time and planning time; outdoor time; breakfast time; work time; and finally circle time. Private pre-schools insert other elements, such as language time, math time, and English time.

<u>A typical daily routine</u>

7:00 – 7:30 am	Children arrive and have free play time.
7:45 – 8:30 am	Circle time (children and teacher gather and discuss different topics, such as news, calendar updates and who is absent).

	The teacher then introduces the day's plan and activities for the children.
8:30 – 9:30 am	Outdoor time (children have free gross-motor/physical-oriented play).
9:30 – 10:00 am	Breakfast time.
10:00 – 11:00 am	Work time (children play and work with materials in different settings at different centres).
11:00-11:30 am	Last circle time (stories, songs and games; children are given opportunities to talk about activities in which they have participated and present their work in front of their peers).

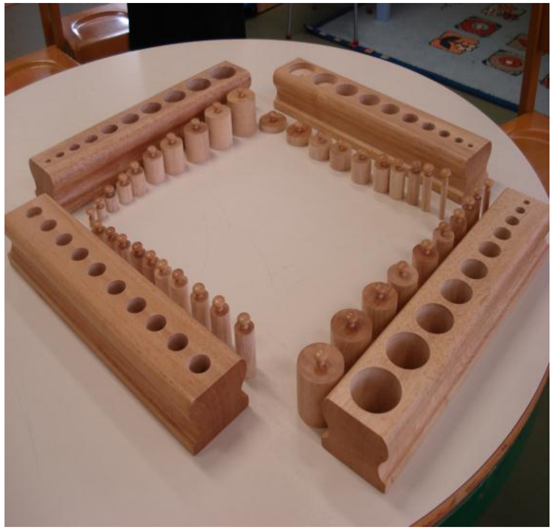
1-3-5 Preparing the Child for Pre-school

The teacher's manual describes how the teacher should plan for and start the new year. This section begins with building a relationship with the children and their families, inviting them to spend time in their classes and answering their questions. This section also describes how teachers can plan in conjunction with other teachers for the new year, especially for the first two weeks.

1-4 The Thematic Unit Books

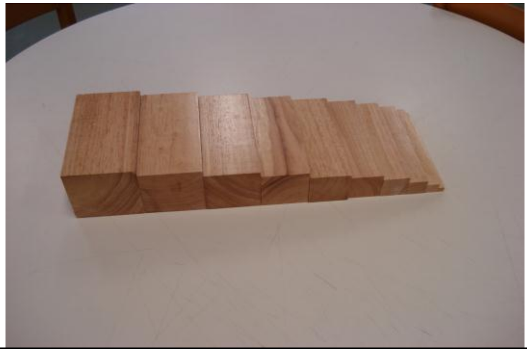
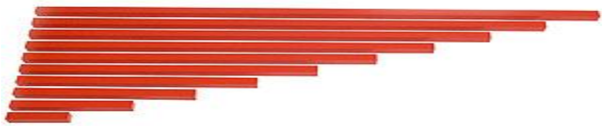
The five textbooks contain five planned units on the subjects of Water, Sand, Food, Home and Hands. For each of them there is a separate book with a full description of the theme, goals and materials that may be needed. The seventh textbook contains a variety of concepts to meet children's needs, developmental levels and interests. It contains five different units on the subjects of *My Health and Safety*, *Friends*, *Clothes*, *Family* and *My Book*. The textbooks give ideas and suggestions to teachers for initiative taking and helps them to adopt these concepts during their work. Also, for the other books, the unit books, there is a description for the teacher of how to introduce the principles of each unit into the daily routine and into learning centre activities.

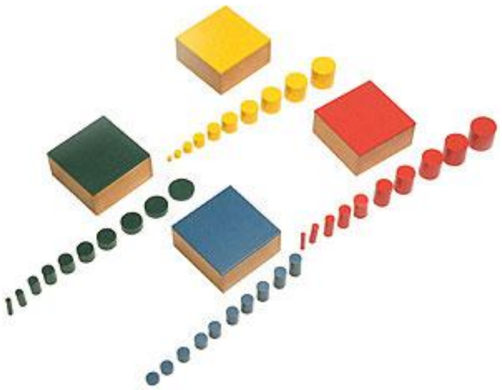
Appendix 1.2
SENSORIAL EDUCATIONAL MATERIALS

<table>
<tr><th colspan="5">Visual education
Discrimination and Dimension</th></tr>
<tr><th rowspan="2">Picture</th><th rowspan="2">Name of material</th><th rowspan="2">Description</th><th colspan="2">Aim</th></tr>
<tr><th>Direct</th><th>Indirect</th></tr>
<tr><td></td><td>Cylinder insets</td><td>4 blocks of 10 cylinders each;
-cylinders decreasing in diameter only;
-cylinders decreasing in diameter and height;
-cylinders decreasing in height only; and
-cylinders decreasing in diameter and increasing in height.</td><td>Visual discrimination of size
-differentiate objects according to thickness; height and size;
- knowledge of dimension;
-coordination of movement
-small muscle control

Language:
Thick, thickness, height, cylinder shape, diameter, large, larger than, largest, increase,</td><td>- exercising the sense of touch
-Preparation for writing</td></tr>
</table>

Visual education Discrimination and Dimension				
Picture	**Name of material**	**Description**	**Aim**	
			Direct	**Indirect**
			and decrease.	
	Pink tower	10 pink cubs graded in length of sides from 1-10 centimetres.	-Visual discrimination of difference in dimension; -order -preparation for the decimal system; and -preparation of cube root. **Language:** small; smaller; smallest, cube	education of voluntary movement; -preparation for mathematical understanding

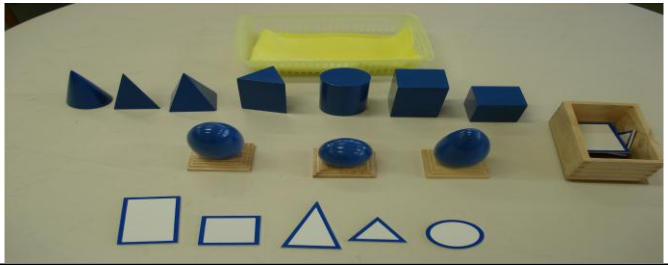
<table>
<tr><th colspan="5">Visual education
Discrimination and Dimension</th></tr>
<tr><th rowspan="2">Picture</th><th rowspan="2">Name of material</th><th rowspan="2">Description</th><th colspan="2">Aim</th></tr>
<tr><th>Direct</th><th>Indirect</th></tr>
<tr><td></td><td>Brown stair</td><td>10 rectangular brown prisms, each 20 cm in length and square section diminishes from ten cm a side to the smallest, one cm a side.</td><td>Visual discrimination of dimensions in thickness;
-order
Language: thick, thicker; thickest; thinnest; thinner; thin</td><td>-muscular education of grip;
-preparation for mathematical understanding</td></tr>
<tr><td></td><td>Red rods</td><td>10 red rods graded in length from 10-100 cm and have same square section of four cm a side</td><td>-Visual discrimination of dimension in length;
-order of length;
-comparnce
Language: tall; taller; tallest</td><td>-preparation for number work;</td></tr>
</table>

<table>
<tr><th colspan="5">Visual education
Discrimination and Dimension</th></tr>
<tr><th rowspan="2">Picture</th><th rowspan="2">Name of material</th><th rowspan="2">Description</th><th colspan="2">Aim</th></tr>
<tr><th>Direct</th><th>Indirect</th></tr>
<tr><td></td><td>Knobless cylinders</td><td>4 boxes of 10 cylinders each, in blue, yellow, red, and green. Cylinders vary as do cylinders insets</td><td>Discrimination and comparison of dimensions

Language:
Thick, thickness, height, cylinder shape, diameter, large, larger than, largest, increase, and decrease.</td><td>Further development of ideas about dimensions and their interplay</td></tr>
</table>

Visual education Discrimination of Colour				
Picture	**Name of material**	**Description**	**Aim**	
			Direct	**Indirect**
 	Colour tablets	3 boxes of paired tablets. -Box I: primary colour has 3 pairs; -Box II: 11 pairs; -Box III: 8 compartments of 8 tablets each	-development of chromatic sense; -match pair; -visual recognizing of identity of colour's pair; -differences of shade in every colour Language: bright, brighter, brightest; dark, darker, darkest	-preparation of art work

Visual education Discrimination of form				
Picture	**Name of material**	**Description**	**Aim**	
			Direct	**Indirect**
 	Geometric cabinets	A wooden cabinet containing 6 drawers of geometric figures; every drawer has display six (rectangles, triangle, circles, polygons, irregular figures) wooden frames in each; all frames have a large geometrical figure inserted in the centre, each coloured blue and provided with a small button for handle.	-Visual and muscular discrimination of form; -recognize identities of form; -names of different geometrical figures; -coordinate hand with eyes; -preparation of hand to trace an enclosed form; **Language**: Square, circle, rectangle, triangle, trapezoid, pentagon, decagon, ellipse, oval, flower	-Preparing for mathematical and geometric understanding; -prepare for drawing; - prepare for writing.

Visual education Discrimination of Form				
Picture	**Name of material**	**Description**	**Aim**	
			Direct	**Indirect**
		-cards form a series presenting the geometric forms, first: full form from blue paper, second: same figure is mounted in thick outline 1 cm in width, third same shape form is outlined by a black line.		
	Geometric solids	8 dark blue geometric solids	-awareness of solid geometric forms	-Preparation for geometry

Visual education Discrimination of Form				
Picture	**Name of material**	**Description**	**Aim**	
			Direct	**Indirect**
	Constructive triangles-rectangular box	14 wooden triangles-equilateral, scalene, and isosceles; some with right angles	-awareness of plane triangular composition	- Preparation for geometry;
	Constructive triangles-triangular box	10 coloured triangles, equilateral and isosceles, some with black-edged borders for matching	-construction of equilateral triangles	- Preparation for geometry;

Appendix 2.1

The Three Period Lesson

The three period lesson breaks down all learning of new material into three steps. For example, the teacher presents to the child a Pink Tower. Only this material is allowed to fill the child's area of perception because then he will not be distracted. The teacher should enunciate slowly and clearly as she presents and identifies the Pink Tower. She asks the child to roll out a mat on the floor and explains to him that the first four cubes can be carried by hand whilst the rest must be carried using two hands. The teacher shows the child that the cubes are always carried individually.

First Period

Pointing to the small cube, she says, "Look at this", and then she says showing him the smallest cube, "This is small. Small". Repeating the term "small" imprints the word on the child's consciousness. Then showing him the biggest cube, states "This is large. Large".

Second Period

This is the recognition step. In order to make sure that the child has understood she says to him, "Give me the small cube", "Give me the large cube", or "Show me" instead of "Give me". The teacher repeats this several times with variations on wording.

Third Period

This is the recall or confirmation of knowledge. The teacher asks the child "What is this?", pointing to the small cube of the Pink Tower and the child answers "Small". The teacher points to the large cube and asks, "What is this?". The child answers "Large".

Appendix 4.1

Flexibility

Balka [1974] defined flexibility the ability to respond to a "number of different categories of problem generated". Hokanson [2007: 4] defined flexibility as "the ability to develop a wide range of answers that differ from each other". Torrance [1965:302] argued that flexibility is "used in the production of a diversity of ideas in a relatively unrestricted situation".

Torrance [1965] adopted Osborn's [1957] work in defining categories of flexibility which were: changing colour, changing shape, and changing other sensory aspects (such as sound, feel, look or smell). Meador [1997] give an example of flexibility which was: "crayons, markers, paints, colour pencils, colour chalk"; all of these objects fall into the category of things to use in art.

In this research, children have come up with a variety of solutions. To identify the flexibility categories, I recorded all the children's solutions and gave them to teacher-1 and teacher-2 and asked them to put them into categories according to their similarity. T1, T2 and I agreed on the solutions for all categories except "fish pond", "fruit", "snow man", "gun" and "cannon". T2 and I put "fish pond" in the fish category, but T1 put it in the view category. We agreed to put it in with fish because the child called it a "fish pond", not "pond" alone. T1 and T2 agreed on putting "fruit" in the food category while I put it in a separate category. I asked three other teachers in the school and two of them agreed with putting "fruit" in the food category. T1 and T2 agreed that children would make a "snow man" in the play garden, but I disagreed with them. I asked the same three teachers and two of them agreed with T1 and T2. For "gun" and "cannon", T1 put them with equipment and T2 and I put them into a "weapon" category; then T1 agreed with us.

The children have come up with twenty-three different categories, as shown in the table below.

Categories	Child's Solutions
Animal	Cat, Dog, Animal web, Frog, Deer, Sea star, Rabbit, Monkey, Mouse, Dinosaur, Chick, Bat
Bird	Owl, Bird, Seagull
Insect	Butterfly, Snail, worm, Spider web
Fish	Fish, Fish pond
Human	Face, Girl, Boy, Friend, Japanese man, Man, Human, Thief, Brothers, Head, Evil, Evil face, Evil teeth, Clown head, Batman
Mathematical Shapes	Square, Rectangle, Line, Arc, Diamond, Triangle, Pyramid, Circle
Plant	Flower, Palm tree, Tree
Transportation	Airplane, Traffic light, Boat, Ship, Car, Train, Bridge

Equipment	Tires, Dough roller, Lamp, Tent, Ladder, Flower pot, Map, Envelope, Umbrella
Home Furniture	Bed, Sofa, Table, Pillow, Candles, Blanket, Chair, Carpet, Basket, Stairs
View	Sea, Slides and Sea, Pond, Fountain,
Play Garden	Garden, Garden and dolls, Back garden, Snow man
Human Accessories	Crown, Bandanna, Hat
Landscape	Mountain, Cave, The world
Weather	Sun, Moon, Cloud, Lightning
Leisure	Animal zoo, Circuses, Animal circuses, Swimming pool, Park, Restaurant, Maze,
Toy	Balloon, Car toy, Robot man, Toy
Accommodation	Room, Bedroom
Food	Cake, Ice cream, Candy, Pizza, Egg, Fruit
Building	Building, Tower, Thief house, Car park, Castle, House, Hotel, Gate, Farm, Bailey, Home, House, School
Learning	Alphabet letters, English letters, Arabic numbers, English numbers
Weapon	Gun, Cannon
Service	Gas station, Mosque

Appendix 5.1

British Abilities Scales II

1- Block Building

The first sub-scale is Block Building which contributes to measuring children's general conceptual ability for the youngest pre-school ages 2:6 to 7:11. Children in this test are required to build a tower using eight blocks, each 4 cm by 4 cm by 2 cm.

For the remaining items, the administrator constructs either a two-dimensional or three-dimensional design with three or four blocks. These items responses are scored according to the accuracy of the orientation and relative position of the blocks. Some of the later items present 'flat' (two-dimensional) designs which are more challenging than the preceding three-dimensional items because they emphasize orientation sequence p47.

Block Building was created to measure spatial problem solving, visual perceptual matching, and eye-hand coordination (see BAS II, p 47). Performance in this scale requires motor skill and visual perceptual encoding and certain idiosyncratic tendencies in young children in constructing according to their own desires rather than constructing what is required by an administrator. However, the researcher also has to be aware of children's egocentricity (i.e: children paying insufficient attention to the administrator's instructions (BAS II, p 47).

Sensorial visual materials aim to help children in exercises such as colour matching and cylinder insets and to put material in sequence to solve problems by using these materials.

2- Picture Similarities

It is a non-verbal scale which contributes to measuring the General Conceptual Ability for children from ages 2:6 to 7:11 years old. It also measures the reasoning ability for pre-school children; non-verbal problem solving; visual perception and analysis; the ability to attach meaning to pictures; and, the ability to develop and test hypotheses and general knowledge (see BAS II, p 48-49).

The child is shown a row of four pictures or designs in a booklet. The child places a fifth card with a single picture or design below the stimulus picture that it matches with best. The nature of the task is demonstrated for the child in the first two items which requires the child to match identical pictures. The increasingly difficult items require the child to recognize a relationship based on a common concept or element. To perform the task the child must perceive various (potentially relevant) features of the drawing and must engage in hypothesis testing to select a feature that the target picture shares with only one of the possible drawings.

The test does not require fine motor coordination because the child need only place or push the response card near the correct stimulus pictures. However, the administrator has to be aware of children's impulsiveness (responding without checking the response) which can result in poor scores.

3- Pattern Construction

Pattern construction is a non-verbal scale which contributes to measure the General Conceptual Ability for children from ages 3:0 to 7:11 years old. The test reflects the child's visuo-spatial analysis (decomposing a design into its component parts); perception of relative orientation; visuo-spatial matching including size, angles and orientation, and spatial problem solving including the use of strategies such as sequential assembly or trial and error and eye-hand coordination (BAS II: 53).

The BAS II requires the child to construct patterns with 'flat' foam squares, approximarely 1 cm thick with each side either solid yellow or solid black. For the first item, the child duplicates a model provided by the administrator. Pictures in the test booklet are then introduced as the target designs. The procedures of modelling, teaching, demonstration, and second trials on the example items aim to ensure that children understand the nature of the task.
Poor scores may indicate poor visuo-spatial ability which may be reflected in a number of ways, such as rotation of the designs, distraction by the side of the blocks or the inability to perceive the connection between the pattern on the block and the pattern in the booklet.

4- Copying

It is a non-verbal scale which contributes to measure the General Conceptual Ability for children from ages 3:6 to 7:11 years old. The test reflects the child's visuo-spatial analysis including perception of shape, angle, relative size and orientation. It also reflects visuo-spatial matching in comparing drawing with stimulus, eye-hand coordination, fine motor skills and pencil control (BAS II, p 56).

The items in the scale are very simple figures, for example a straight line or a circle. Later items can include shapes which commonly cause reversal difficulties for young children. Finally, the child is asked to produce more complex geometrical figures. For each item, the child has a line drawing printed in a booklet. The drawing is always in view as the child attempts to reproduce it.

Copying of designs appears to require the ability to perceive similarities between a standard figure being drawn. Poor performance may be the result of the child's lack of experience or opportunity in copying activities at home or at school or may indicate poor development of matching skills or of motor control.

Appendix 5.2
Aims of Sensorial Materials and Problems using the BAS

Montessori Sensorial materials	BAS II	Problems in using BAS II
Cylinder Insets (CI) The aim of the exercises using this material is to attempt to improve: • Trying to test whether the cylinder fits in a particular hole makes the child like testing hypotheses to solve the problem. • The child's reasoning ability. • The cylinder insets increase in difficulty, and this requires the child to recognize a relationship based on an element or concept, which the materials are designed to develop. • The materials help the child to improve his ability to recognize a pattern of correlations in putting the cylinders in the holes. • The child copies the cylinders with his index finger to find a matching hole, and also traces the hole with his finger.	The sub-scales that might measure what the Cylinder Insets attempt to improve are: **Pattern Construction** The sub-scale measures the child's ability to solve problems, especially sequential assembly or trial and error, which Cylinder Insets might be designed to improve. **Copying** The sub-scale measures the child's ability to match and compare.	1. MSM-CI encourages the child to develop his own thinking using his own egocentric perspective; however, the child has to copy what the presenter tells him to do, moving from egocentric activities to interactional activities. 2. MSM-CI builds a schema for logical ordered thinking according to physical properties, but BAS II uses a schema of imitation for copying. ***Pattern Construction*** a. The problem with using the pattern construction test is that with MSM children have an orderly schema, but for BAS II children have to use a competing schema. b. Children in the control group practise imitation naturally, but the MSM children spend less time doing that.

Montessori Sensorial materials	BAS II	Problems in using BAS II
Pink Tower / Brown Stairs / Red Roads The aim of the exercises using this material is to attempt to improve: • Design different patterns by using these blocks.	The sub-scales that might measure what the large pieces attempt to improve are: **Block Building** This sub-scale measures the child's abilities in spatial problem solving and perception of relative orientation. **Pattern Construction** This helps to measure the child's ability in: • Constructing patterns. • Spatial problem solving including using strategies such as sequential assembly.	

<table>
<tr><th>Montessori Sensorial materials</th><th>BAS II</th><th>Problems in using BAS II</th></tr>
<tr><td>Knobless Cylinders (KC)
The aim of the exercises using this material is to attempt to improve:
• Recognition of difference in dimension.
• The materials develop the child’s identification of differences of height and diameter.
• Use of these cylinders to design a pattern.
• Comparison of one cylinder with another to discover the similarities and differences.</td><td>The sub-scales that might measure what the Knobless Cylinder attempts to improve are:

Pattern Construction
This helps to measure the child’s ability in:
• Constructing patterns.
• Visuo-spatial matching, for example size and orientation.
• Spatial problem solving including using strategies such as sequential assembly.

Block Building
This helps to measure the child’s ability in:
• Copying a design with wooden blocks, in this case cylinders.
• Measuring the child’s ability in sequence and orientation.</td><td>The potential problems with this material are:

1. MSM-KC uses relative relationships but BAS II uses the same shapes.
2. BAS II has a pattern but no sequence.</td></tr>
</table>

Montessori Sensorial materials	**BAS II**	**Problems in using BAS II**
Colour Tablets (CT) The aim of the exercises using this material is to attempt to improve: • Distinguishing very fine colour gradation in tint. • Recognizing the similarity and differences in shades of one colour. • Recognizing the sequence of shades of one colour.		1. The tablets have the same shape but different colours. On the other hand the BAS II has the same shape and the same colour, and that is possibly confusing for the child. 2. MSM-CT encourages relative ordering but in BAS II there is no ordering.

Montessori Sensorial materials	BAS II	Problems in using BAS II
Constructive Triangles (CT) The aim of the exercises using this material is to attempt to improve: • Identify triangle family • Explore and design different patterns using different triangle shapes, such as square and rectangle or other shapes • Congruence of triangles.	The sub-scales that might measure what the constructive triangles attempt to improve are: **Pattern Construction** This helps to measure the child's ability in: • Constructing patterns • Decomposing a design into its parts **Picture Similarities** This helps to measure the child's ability in: • Non-verbal problem-solving inductive reasoning • Matching identical pictures • Recognizing a relationship based on elements • Visual perception and analysis **Copying** This helps to measure the child's ability in: • Tracing and matching	For Picture Similarities, the child has to use his social knowledge in doing BAS II, but he does not have to use it as the MSM-CT does not improve abstract social knowledge.

Montessori Sensorial materials	BAS II	Problems in using BAS II
Geometric Cabinets (GC) The aim of the exercises using this material is to attempt to improve: • Tracing the shape and frame's correspondence with the child's finger. • Matching the shape with series of three cards. • Drawing different shapes. • Designing by drawing different patterns using different shapes.	The sub-scales that might measure what the Geometric Cabinets attempt to improve are: **Pattern Construction** The sub-scale measures the child's ability in: • Perception of relative orientation. • Visuo-spatial ability, as reflected in the rotation of the designs and the inability to perceive the correspondence between two dimensions and three dimensions. **Copying** The sub-scale measures the child's ability in: • Matching and comparing own drawing with stimulus. • Control of pencil. **Picture Similarities** The sub-scale measures the child's ability in: • Matching identical pictures. Recognizing a relationship based on elements.	For Picture Similarities, the child has to use his social knowledge in doing BAS II, but he does not have to use it as the MSM-GC does not improve abstract social knowledge.

Montessori Sensorial materials	BAS II	Problems in using BAS II
Geometric Solids (GS) The aim of the exercises using this material is to attempt to improve: • The child's ability to distinguish a three-dimensional shape from a two-dimensional shape (from concrete to abstract thinking). • Copying one side of the shape in pencil and matching it with the corresponding shape in two dimensions.	The sub-scales that might measure what the geometric solids attempt to improve are: **Pattern Construction** The sub-scale measures the child's ability in: • Visuo-spatial ability, reflected on rotation of the designs and ability to perceive the correspondence between two dimensions and three dimensions. **Copying** The sub-scale measures the child's ability in: • Visuo-spatial matching in comparing own drawing with stimulus. **Picture Similarities** The sub-scale measures the child's ability in: • Recognizing a relationship based on elements.	For Picture Similarities, the child has to use his social knowledge in doing BAS II, but he does not have to use it as the MSM-GS does not improve abstract social knowledge

Appendix 5.3

Dear Parent (1)

This research is conducting into the Saudi pre-school curriculum with permission from the Ministry of Education. ----- has kindly agreed to take part in a study I am currently conducting into children's creative problem solving. I am investigating whether Montessori learning materials can help to improve children's problem-solving skills. Also, the study is being carried out as part of a research project I am undertaking with the School of Education at Southampton University.

I will conduct my research by placing Montessori materials in the room and observing how one group of children interact with them. I will observe the children for sixty minutes in free play period at the centres for a period of one school year. The other group of children will not interact with the materials. I will also administer a short test (the British Ability Scales) to both groups before and after the experiment. The materials consist of various wooden geometric shapes and are manipulated by the children in such a way as to organise the shapes according to shape and size.

Both groups will be video-taped for 30-60 minutes per day for the duration of the experiment, but these video tapes will be treated with the utmost confidentiality. All other data provided by parents or children will also be treated with complete confidentiality. However, as the children move around the pre-school, it is possible that your child will also appear on the recorded materials. I would like to ask your permission to include your child in the data I collect. In addition, I would like to assure you that the materials gathered will be used for research purposes only but as a part of that process it may also be used for conference presentations and/or written publications.

Because of their young age and associated limited experience of what they are agreeing to, consent is taken as something requiring negotiation. I will have to explain what I am planning to do and ask them if they would like to have their play videoed or recorded. If children are uncomfortable, distracted by the equipment or have had enough of wearing the audio equipment, I will immediately stop observing them. I anticipate that the children will be very clear in conveying their wishes. In addition, children will also be given the opportunity to view, to play with and to talk about the videoed material and they will have a copy of their videoed sessions.

All participants has rights to withdraw from or not participate in the research will be fully respected. If you have any concern please do not hesitate to contact me at telephone number given below. In the thesis, all names of establishments, children, parents, teachers will be made anonymous to ensure that participants are protected.

If you will give your consent for your child to participate in this research, please sign below and return it to school. I would also like to ask that you explain the purpose and method of this research to the relevant child. Many thanks for your time and cooperation

Raja Bahatheg

……………………………………………………………………………………………..
Parent

I, the parent of _____, give my consent for my child to participate in this research.

Please print your name………………………………..

Dear Parent (2)

I am investigating whether Montessori learning materials can help to improve children's problem-solving skills. Also, the study is being carried out as part of a research project I am undertaking with the School of Education at Southampton University.

As part of this research, children will take the British Ability Scales II. Please note that this scale will not judge the child's ability because the researcher will use just part of it. It is used to choose the sample of children and compare their progress at the end of the research period with the beginning.

I plan to observe 24 children in pre-school form September 2006 to June 2007. The movement and talk of the children will be audio and video recorded for approximately an hour as they enjoy playing at pre-school's centres. I also plan to interview the staff and parents to get a better understanding of each child.

The study is being carried out as part of a research project I have undertaken with the School of Education at Southampton University. The materials gathered will be used primarily for my PhD thesis but as a part of that process it may also be used for conference presentations and/or written publications

All participants has rights to withdraw from or not participate in the research will be fully respected. If you have any concern please do not hesitate to contact me at telephone number given below. In the thesis, all names of establishments, children, parents, teachers will be made anonymous to ensure that participants are protected.

If you will give your consent for your child to participate in this research, please sign below and return it to the school. I would also like to ask that you explain the purpose and method of this research to the relevant child. Many thanks for your time and cooperation

Raja Bahatheg

……………………………………………………………………………………..
Parent

I, the parent of _____, give my consent for my child to participate in this research.

Please print your name……………………

Dear Parent (3)

This research is conducting into the Saudi pre-school curriculum with permission from the Ministry of Education. ----- has kindly agreed to take part in a study I am currently conducting into children's creative problem solving. I am investigating whether Montessori learning materials can help to improve children's problem-solving skills. Also, the study is being carried out as part of a research project I have undertaken with the School of Education at Southampton University.

I will conduct my research by placing Montessori materials in the room and observing how one group of children interact with them. I will observe the children all day long for a period of one school year. However, as your child moves around the pre-school, it is possible that your child will also appear on the recorded materials. I would like to ask your permission to include your child in the data I collect should they appear on the tape. In addition, I would like to assure you that the materials gathered will be used for research purposes only, but as a part of that process may also be used for conference presentations and/or written publications.

If you will give your consent for your child to participate in this research, please sign below and retain it to school. In the thesis, all names of establishments, children, parents, teachers will be made anonymous to ensure that participants are protected. Many thanks for your time and cooperation

Raja Bahatheg

………………………………………………………………………………………..
Parent

I, the parent of _____, give my consent for my child to participate in this research.

Please print your name………………………………..

Appendix 5.4
Teacher Permission

Dear Teacher

I am investigating whether Montessori learning materials can help to improve children's problem-solving skills. Also, the study is being carried out as part of a research project I have undertaken with the School of Education at Southampton University.

I plan to observe 24 children in pre-school form September 2006 to June 2007. The movement and talk of the children will be audio and video recorded for approximately an hour as they enjoy playing at pre-school's centres. For a short period of time each day, the children will be asked to wear a tiny microphone, which will be pinned onto their clothes, and a small lightweight audio recorder which can be clipped onto a belt or carried in a pocket. The video recording will not be intrusive, so the children will be unaware or soon forget they are being observed. I also plan to interview the staff and parents to get a better understanding of each child.

Because of their young age and associated limited experience of what they are agreeing to, consent is taken as something requiring negotiation. I will have to explain what I am planning to do and ask them if they would like to have their play videoed or recorded. If children are uncomfortable, distracted by the equipment or have had enough of wearing the audio equipment, I will immediately stop observing them. I anticipate that the children will be very clear in conveying their wishes. In addition, children will also be given the opportunity to view, to play with and to talk about the videoed material and they will have a copy of their videoed sessions.

The study is being carried out as part of a research project I have undertaken with the School of Education at Southampton University. The materials gathered will be used primarily for my PhD thesis but as a part of that process it may also be used for conference presentations and/or written publications

All participants has rights to withdraw from or not participate in the research will be fully respected. If you have any concern please do not hesitate to contact me at telephone number given below. In the thesis, all names of establishments, children, parents, teachers will be made anonymous to ensure that participants are protected.

Raja Bahatheg

……………………………………………………………………………………………..
Teacher

I agree to participate in this research.

Please print your name……………………

Signature

Appendix 5.5

Teacher Qualifications and Experiences

Name	Experience in Pre-school	Qualifications
Teacher1	10 years	- Graduate from School of Education and Early Years. - Montessori Diploma
Teacher 2	8 years	Graduate from School of Education and Early Years. - Montessori Diploma
Teacher 3	13 years	Graduate from School of Education and Early Years.
Teacher 4	9 years	Graduate from School of Education and Early Years.

Appendix 5.6

Observational Sheet

Time Observation……W2….. Date			Child's Initials		
Materials					
Time	Activity record	Language Record	Figure	Task	Social

Appendix 5.7

Internal Validity

1- History: The experiment was over an extended period of time, thus enabling further events to occur in addition to those originally intended [Robson, 2002]. Children in the sample are involved in the experiment over the same period of time. Researchers cannot be certain that the control group has not had experience that has differed from the experimental group. As a result, they should be aware of any such influences that may occur during the experiment [Wallen and Fraenkel, 2001]. In the current research, the control and experimental groups had the same head teacher in the same school but different class teachers. All classrooms had the same materials except the experimental group's classroom. The researcher might have reduced the threat by having a control group that was exposed to the same events during the study as the experimental group, apart from the treatment. Collaboration between the researcher, the head teacher and class teachers might also reduce the threat; however, other events might occur in the homes of the children, over which the researcher would have had no control.

2- Maturation: There is a physical development in participants unrelated to the treatment. Children will change differently because of ageing and experience and simply due to the passage of time. In the present study, they would experience physical developmental changes similar to those in the experimental group. Both groups would develop new abilities. Children do show differences in improvement and growth. Maturation is a serious threat in studies that use only pre-test and post-test data, but by combining another methodology, this threat can be controlled [Campbell, and Stanley, 1966; Robson, 2002 and Mertens, 1998]. 'Matching pairs' is part of the control features [Wallen and Fraenkel, 2001].

3- Instrumentation: Certain methods can differ between the pre-test and post-tests. If the pre-test is different from the post-test, it leads to the possibility that one test might be easier than the other, and the effect on the dependent variable may be due to the nature of the instrument, not to the independent variable. Using different methods for pre- and post-tests during the collection of data can be associated with changes in the research instrument (see test threat discussion below). This research eliminated this threat by having all the sample tested and observed using the same instruments, in particular BAS-II.

4- *Testing:* If the pre-test and the post-test are similar, participants may show an improvement because of their experience with the pre-test. There is debate on how to minimize the effect. Campbell and Stanley [1963], Cohen *et al.* [2007] and Robson [2002] argue that a pre-test at the beginning of the experiment can produce effects on experimental treatment because it might affect the true purposes of the experiment and subjects may score higher on the post-test measure. A pre-test will influence performance in a post-test. On the other hand, Ross and Morrison [2004] suggest dealing with this threat by using each version of the test as a pre-test for half the students and a post test for the other half.

However, with this procedure, the present research cannot compare the subjects' performance before and after the experimental treatment to assess the effectiveness of the treatment, which is what this research attempts to discover. Brog and Gall [1983] argue that, if there is a long period of time between pre- and post-tests, it is unlikely for an extraneous variable to operate. The current research had a full academic year between pre-post test. As was discussed, the children in the research sample had the same pre-test and post-test to compare the children's performance and to discover the effectiveness of the sensorial materials.

5- Regression: the participants are selected because they are unusual or atypical (i.e.: children at the high or low end of the normal curve) [Mertens, 1998]. After testing all children potentially participating in the research, I eliminated children who had a significantly higher or lower score from the research sample. Regression was controlled by obtaining an equivalent comparison (matching) group [Wallen and Fraenkel, 2001].

6- Mortality: This term is used to indicate participants who drop out of the research group. When some children are perceived not to be making achievement gains, they might leave the study. This threat can be controlled by having a pre-test that allows the researcher to determine if the children who drop out of the study are systematically different from those who complete it [Mertens, 1998; Cohen and Manion, 1994]. The study used matched pairs to help to identify differences between children in the sample and children who drop out. In the present study, no child dropped out.

7- Selection: There were preliminary differences between the control and experimental groups before involvement in the study. The result indicates group not treatment differences. To deal with this threat, a subject is randomly is assigned to the two groups. However, the present study used matched pairs, one in the control group and the other in the experimental group.

8- Selection by maturation interaction: This threat of validity (maturation) is the differential characteristic that causes the group to differ. Using matched pairs eliminated the effect of this threat. Cook and Campbell [1979] extended the discussion of this threat by adding the following items.

9- Experimental treatment diffusion: The control group may learn about independent variables and might use some of the experimental group's ideas themselves, particularly when the control group is close to the experimental group. Teachers in the control group may discuss issues related to the experiment with the experimental group's teachers and may even borrow some of the study materials, even if instructed not to do so. Thus, the treatment diffuses to the control group. However, observation in the ethnographic approach (use of video in the experimental and control groups) might help to avoid movement and diffusion of the treatment to the control classroom. In addition, with support from the head teacher, all four teachers had different break times and the researcher explicitly told members of each group not to talk with each other about the experiment while it was in progress.

10- Compensatory rivalry by the control group: t*he effect of participants themselves*. Some children in the control group may try extra hard to prove that their way of doing things is the superlative and thus affect the result. Malone and Mastropier [1992] arranged for the treatment to be in a quiet room near the students' classroom, so the students were probably unaware that they were in the control group. All control group children in the present study were in a different classroom from the experimental group.

11- Compensatory equalization of treatment: Participants in the control group would become disgruntled if they thought that the experimental group were receiving extra resources. All classrooms contained the same materials, apart from the experimental classrooms. Thus, the teacher's collaboration with the researcher controlled this threat.

12- Resent and demoralization among the control group: The control group feels demoralized because they are not part of the chosen group. This might affect their performance. However, children did not know in this study that they were part of the control group, due to the procedures described previously.

Appendix 5.8

External Validity

1 - *Explicit description of experimental treatment*: it is important to describe the experimental treatment in coherent detail in order for other researchers to replicate it.

2- *Multiple treatment interference*: when participants receive more than one treatment, it is not possible to say which of the treatments is bringing the desired results. Due to more than one treatment being used, the research cannot safely be generalised in the findings. Researchers ought to choose an experimental paradigm in which only one treatment is given to the subject. This research used only Montessori sensorial materials.

3- The *Hawthorne effect* occurs when participants speculate that the study may result in a change in their performance. When children exhibit attention, this may cause a change in performance that may not generalise to other research findings. Through ethnographic case study and the triangulation method, children did not exhibit special attention and that may eradicate the effect of this threat. Montessori sensorial materials were introduced to children in the same manner that other materials were introduced to them, letting the children know how to play with them and all materials left for them to play with.

4-*Novelty and disruption effect*: A new treatment may produce positive results simply because it is new. If the treatment is 'novel', the results have low generalisability. A new treatment may cause an upset in normal activities that initially may not be effective, but once integrated into the situation, could become highly effective. The treatment in this research is an educational tool like other tools in the environment of the children. The materials were already in the classroom when the children arrived in the environment on the first day of the academic year at pre-school.

5- *Experimenter effect*. The effectiveness of a treatment may depend on the specific individual who administers it. The effect would not be general to another situation because that individual would not be present. To control this threat, the study should have a verification procedure [e.g. direct observation, video], as mentioned by Mertens [1998]. The ethnographic case study may help to get rid of this threat through the triangulation method.

6- *Pre-test sensitization*. The pre-test may act as part of the experimental treatment and affect research results. There is a limitation to the generalisation of the research findings if the experiment is repeated without the pre-test and different research results are found. It might be claimed that the pre-test using the BAS-II affected the participants' performance on the post-test because the children had had this test before. However, the length of time between the tests was one academic year, which might reduce the effect. Also, this threat can be controlled by comparing with a control group [Best and Kahn, 1998].

7- *Post-test sensitization*. It is possible that the results of the experiment are dependent upon giving a pre-test. The participants who pre-tested may bring information to the post-test.

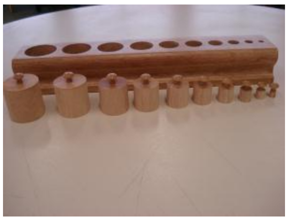
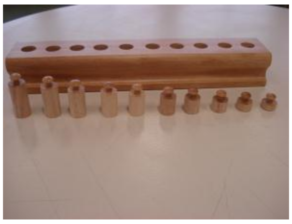
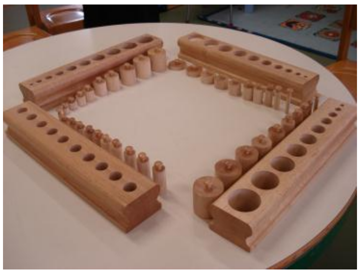
8- *Interaction of history and treatment effects*. An experiment which takes place at a certain time with contextual factors cannot be repeated in another setting. According to Onwuegbuzie [2000], treatment diffusion can threaten external validity by contaminating one of the treatment conditions in a unique way that cannot be replicated. In this research, I considered Montessori sensorial materials as the treatment and presented it to the children to play with during their pre-school academic year. The MSM can be found in different schools where children play with them. It is not a unique situation that cannot be repeated by another researcher in a different setting and time.

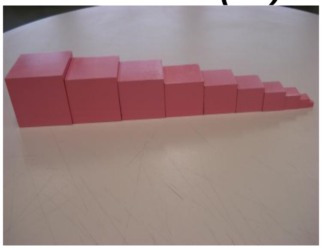
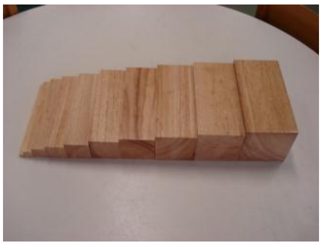
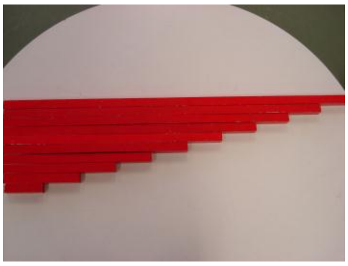
9- *Measurement of the dependent variable*. The effectiveness of the research may depend on the type of measurement used in the study. However, it might be eliminated when comparing experimental results with a control group, as this study did.

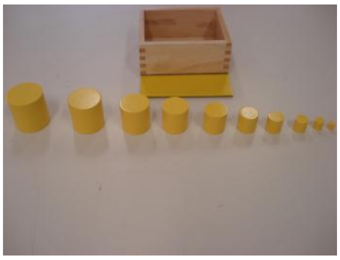
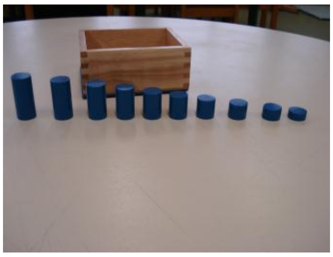
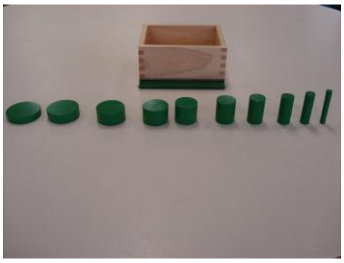
10- *Interaction of measurement time and treatment effects*. The timing of the administration of the post-test might influence the research results. Usually the post-test is administered after participants have completed the experiment. The effectiveness of the treatment is based on the results of this post-test administration. Again, all groups had the pre- and post-BAS-II at the same time and results for the control group and the experimental group were compared. If the time administration had influenced the research results, it would have influenced all the groups, not just one. The triangulation methods may eliminate this threat.

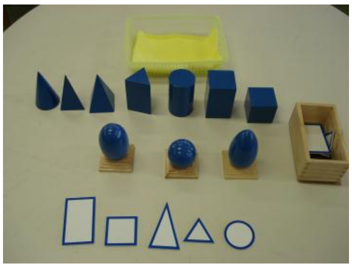
Appendix 5.9

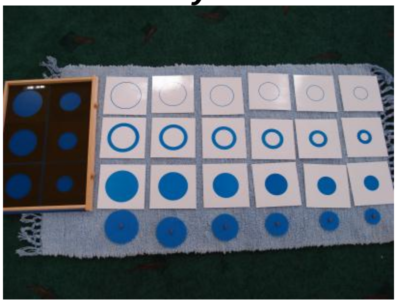
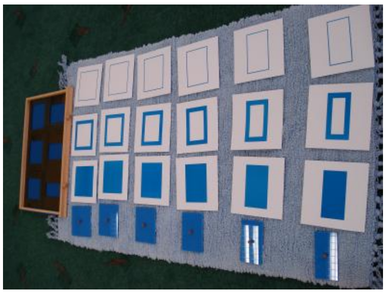
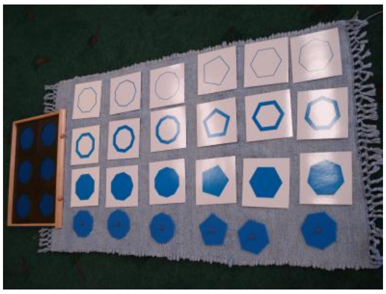
Description of Montessori Sensorial Materials

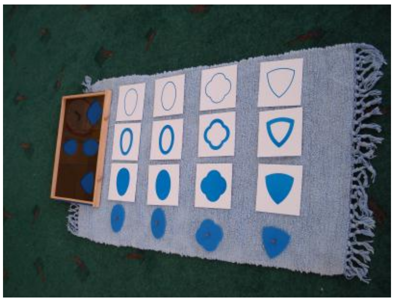
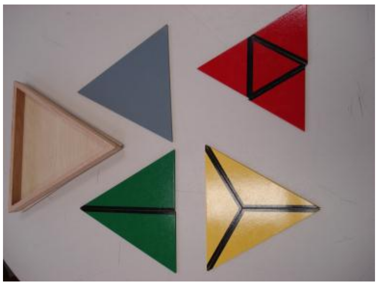
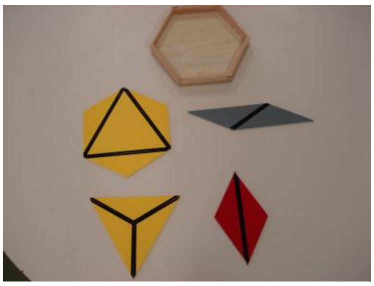
Material	*Description*
Block Cylinders 	**B1**= Cylinders decreasing in Deiameter only. The diameter if the thick cylinders is B1(10)=10cm and the thinnest is B1(1)= 1 cm.
	**B2** = Cylinders Decreasing in Diameter and Height. The B2(10) diameter is 10 and height =10 cm, the diameter of the smallest B2(1)= 1 and the height is 1cm.
	**B3**= Cylinders Decreasing in Height only. The B3(10) diameter is 1.5 cm and the height is 10 cm, the smallest B3(1) height is 1 cm.
	**B4**= Cylinders Decreasing in Diameter and Increasing in Height. The height of the B4(10) is 1 cm and the diameter is 10 cm, the smallest B4(1) diameter is 1cm and the height is 10cm.
	

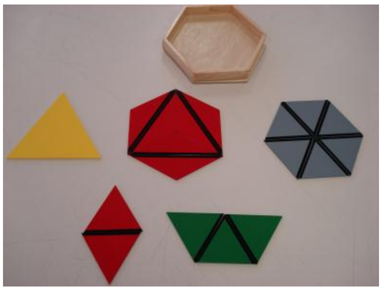
Material	*Description*
Large materials ***Pink Tower (PT)*** 	The Pink cubes are a set of 10 cubes varying sequentially in size by 1 cubic centimeter, ranging from 1 cubic cm to 10 cubic cm. PT10 is cube number 10 which is 10 cubic cm, PT9 is 9 cubic cm,…PT1 is the 1 cubic cm.
Brown Stairs ***BS*** 	There are ten brown wooden prisms. All of the prisms have same length but different in width and height by one centimetre each. The BS(10) is 10 cm in width and 10 cm in height and the smallest prism is BS1 is 1 cm in width and 1 cm in height.
Red Rods 	The Shortest rod is 10 cms. long and each successive rod is 10 cms. longer. The longest rod is ten times the length of the smallest one (100 centimeters). RR10 is 100cm, RR9 is 90 cm long… and the RR1 is 10cm long.

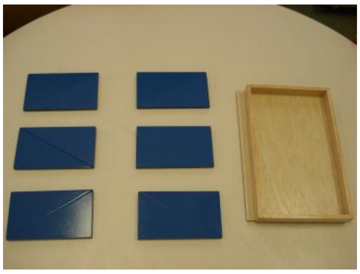
Material	*Description*
Knobless Cylinders ***Red Cylinders*** ***RC***    	Four boxes, each box containing ten cylinders. Red cylinders are equal in height but decrease in diameter. The yellow cylinders decrease in height and diameter. The blue cylinders are equal of diameter but decrease in height. The green cylinders decrease in diameter but increase in height.

Material	***Description***
Colour Tablets (Box2) ***COL2*** 	The box contain 11 pairs of colour tablets as following: Primary colours: red, yellow and blue. Secondary colours: Purple, Green and Orange. Tertiary Colours: Brown, Gray and pink. Also, a set of block and white colour tablets.
Colour Tablets (Box3) ***COL3*** 	COL3 has nine separate compartments representing each of the colour in Box2, with the exception of black and white. The tablets range from darkest to lightest for each colour.
Geometric Solids ***GS*** 	A set of geometric form: Sphere, cone, Ovoid, ellipsoid, triangular prism, triangular based pyramid, square based pyramid, cylinder, cube, and rectangular prism. In addition, a set of wooden tablets.

Material	***Description***
Geometry Cabinet    	***First Drawer***: six circles varying in diameter from 5 cm to 10 cm***.*** ***Second Drawer:*** six variations of rectangles, establish with a squreand each shape is I cm narrow than the preceding rectangle. ***Third Drawer:*** six different types of triangles-equilateral, right angle isosceles, obtuse-angle isosceles, actue-angle isosceles, right angle scalene and obtuse-angled scalene. ***Fourth Drawer:*** six regular polygons-pentagon, hexagon, heptagon, actagon, nonagon, and decagon. ***Fifth Drawer:*** four quadrilaterals and one triangle- rhombus, parallelogram. Isosceles trapezoid, right-angle trapezoid and an obtuse-angled scalene triangle. ***Sixth Drawer:*** four curvilinear shapes-oval, ellipse, curvilinear triangle and quatrefoil. Each figure has three corresponding set of cards : one set of cards is completely shaded in, the second set has a thick outlin and the third card has a thin outline.

Material	***Description***
 	
Contructive Triangles TB1 	***Triangle Box 1(TB1)*** The TB1 consists of: one big gray equilateral triangle having no black lines(QT); two green scaled right angled triangles (RAT) which have black lines on the longer of the two sides which inscribe the right angle; three yellow isosceles obtuse triangles (IOT) having black lines on equal sides which inscribe the obtuse angle; and four red equilateral triangles, one of which has black lines on all three sides and three which have black lines on one side. When these black lines are mapped, the four triangles form an equilateral triangle equal to the gray triangle and this is the Montessori idea of controlling the error.
Triangle Box 2 	***Triangle Box 2 (TB2)*** The box contains one big yellow equilateral triangle with black lines on all sides (QT), three yellow small isosceles obtuse triangles (IOT) with black lines at the side opposite to the obtuse angle, equal of three triangles mentioned before and having black lines on the two equal sides, two red (IOT) equal to both sets of yellow and having a black line on the side opposite to the obtuse angle, and two gray IOT having black lines on one side.

Material	*Description*
Triangle Box 3 	***Triangle Box 3 (TB3)*** The small hexagonal box contains: six gray equilateral triangles with black lines on two sides. Three green equilateral triangles, one of which has black lines on two sides and two with black lines on one side. When these black lines are mapped, the triangles form a trapezoid. Six red isosceles obtuse triangles which have black line on the side opposite to the obtuse angle. In addition, one yellow equilateral triangle which represents half the size of the red hexagon and two red equilateral triangle with a black line on one side.
Rectangular Box TB4	The Box contains two yellow equilateral triangles, black lines on one side. When the two lines are mapped a rhombus is formed. Two green right-angle isosceles triangles with a black line on the hypotenuse of each triangles. When the two black lines are mapped, a square is formed. Also, two yellow right angle isosceles triangles with black lines painted on one side and when lines mapped a parallelogram is formed. Two yellow right angle scalene triangles with black lines drawn on one side and when these two line are mapped, an oblique parallelogram is formed. Two green right angle scalene triangles equal to the yellow scalene right angle triangles; black lines drawn on one side. When the black lines are mapped, a parallelogram is formed. In addition, tow gray right angle scalene triangles, the same size as the yellow and green with black lines painted on the hypotenuse. When the black lines mapped, a rectangle is formed. One red right angle scalene triangle with black line on one side. Last triangle is red obtuse-angle isosceles triangle with black line on one side. When the black line of red triangles are mapped, a trapezoid is formed.

Material	*Description*
Rectangle Box 2 (TB5) ***Blue Triangle*** 	The Box contains 12 blue right angle scalene triangles with 5mm thickn.

Appendix 5-10

Digital Equipments

Video Recording

The Canon camera has a 22x optical /440x combined zoom, which helped the researcher to be close to the action and to give her a clear picture. In addition, a tripod gave the camera stability. The tripod had different height settings and was therefore easy to control. The researcher used a Sony VCT-R 640 standard tripod. The Sony standard technology was as follows: a lightweight frame, whereby the legs could be lengthened to 3 times longer than when folded up, and the height could be further altered by a winder which could also be used to raise the camera higher. A pan handle with an easy and expandable pan head could be used to rotate the camera in 3 ways.

A second camera, a Sony DCR-HC26E, was used, with a second Sony tripod. The specifications of the Sony camera were: 20x optical zoom with a Super Steady Shot picture stabilization scheme, and a 2.5 inch high-resolution touch panel swivel LCD screen which rotates up to 270 degrees because of multiple viewing angles of 1/6 inch CCD images. The Sony camera has a side opening monitor and is lightweight.

Audio Recording

I used two types of MP3 player: two MuVo S200 1 GB (one pink for girls and one blue for boys), and two Logic-ORBIT 1 GB (one pink for girls and one black for boys). The MP3 players were lightweight, compact, battery operated digital recording devices capable of highly receptive recordings of up to 1 GB on memory stick, downloadable onto a computer and possible to play back using on-screen editing software. The battery provided up to 17 hours of playback.

The Sony ICD-P320 digital voice recorder has a 64 MB built-in flash memory and is linked to Digital Voice Editing software, supplying up to 1,930 minutes of recording capacity. It also has four separate folders for easy reference. I used the A folder for children, the B folder for teacher interviews, and the C folder for me to record comments during observation.

Digital Camera

The DDSC-W50 has 6.0 Mega pixels, which produces clear and highly sensitive pictures, and it also has 3X optical zoom and 32mb internal memory.

Appendix 5.11

Interview Questions

- Did children play with Montessori materials using her method or play with it differentially? Can you explain more?
- Is it appropriate to leave the children free to play with MSM or to teach them Montessori solutions? Is there any difference? How?
- Which materials did children keep playing with in the Montessori Method and did they not discover new ways to solve problems? Why?
- Which material/s did children play with and discover new solutions? How? Explain more.
- Is the schedule for introducing the Montessori materials for children suitable? Explain?
- Are all the materials suitable for children’s age? Explain please?
- Did the material help to improve children’s skills in the table toy area? Who?
- Did child/ren solve problems in different way? Which material/s?
- Is there a benefit allowing the children to play with MSM in bigger place? Explain please?
- Are there any differences in children’s skills insolving Montessori problems?
-

Appendix 7

Appendix 7.1
The Story of Saud

DATA	*ANALYSIS*
Week 6-Episode-22 1- I sit next to Saud, who begins putting the tablets in order, from darkest to lightest, and I ask him: 2- R: How about if you put the tablets on top of each other? 	Saud **construct this opportunity** by choosing to play with the Col3 (line 1). Saud begins to solve the Col3 following the Montessori solution. I try to help him to discover a new method of play with the colour tablets (line 2).
3- Saud gathers the tablets and puts two tablets parallel vertically but it falls down. 	Saud **frames** the problem by using the tablet differently to **generate an idea** by putting the tablets vertically (lines 3).
4 - Saud puts two tablets horizontally next to each other. 5- R: Is there another way to add the tablet?. 6 -Saud stands the third tablet vertically on top of the first two tablets, then directly adds a fourth tablet horizontally and tells me:	Saud selects the two tablets and **develops** his solution with me and combines two dimensions in his solution (line 4-6), **accepts** an airplane building by telling me (line 7).

 7 - Saud: I made an airplane. 8 - R: You made an airplane 9 - Saud adds one more tablet on top of the fourth, but vertically: 10 - Saud: I want to make another airplane on top of the first one.  11 - Saud adds two more tablets on top of each other on top of the fifth tablet, but then he mixes them up. 12 - Saud puts two tablets next to each other horizontally, then makes a space between them and puts them vertically.  13 - Saud puts one tablet horizontally on top of the last tablets:	Saud wants to **develop** his previous solution and makes it into two airplanes, but he give up (lines 9-10-11) He is mixing the tablets and returning to put tablets next each other, but

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14 - R: What is this?
15 - Saud: I made pillow.
16- R: A pillow, ok, can you do something else?
17 - Saud makes a third pillow in the same way:
18 - Saud puts two tablets to one side and makes a ^ shape.

19 - He tries to stabilise it, but it keeps falling down.
20 - Saud mixes his shape up, puts two tablets on top of each other, vertically and wants to add more
</td>
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when he adds one vertical tablet he frames the problem and starts to generate an idea which is in different positions from Montessori (line 13).

He accepts a pillow building by telling me (line 15) and develops his solution by making two more pillows next to each others (line 17)

Saud wants to explores another position of the tablets by holding them up, but he could not manage (line 18).

He is framing the problem by changing the tablet position vertically to generate an idea (line 20).
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</table>

tablet also vertically: 21- R: how about if you try to put it horizontally? 22- Saud adds a third one horizontally next to it and adds a fourth tablet on the opposite side. 	He combines horizontal and vertical positions in one solution to **develop** it (line 22).
23 - Saud takes two tablets and puts them perpendicular on top of the fourth horizontal tablet. 	Saud begins with a vertical position and then **develops** the solution with perpendicular position (line 23).
24 - Saud adds another two tablets perpendicular on top of the third horizontal tablet, adds another horizontal tablet on top of the first perpendicular tablet and then he adds two more vertical tablets on top of the first tablet.	He **develops** his solution more by adding two perpendicular tablets for each horizontal tablet (lines 24-25).

 25 - Saud adds another horizontal tablet on top of last four vertical tablets. 26 - Saud: Teacher, these are mountains. 27 - T1: These are mountains! 28 - Saud adds two horizontal tablets in the same movement on top of each one.  29 - Saud adds two perpendicular tablets and wants to add horizontal tablet on top of it, but it falls down. 30 - Saud leaves the material for him and leaves the area.	Saud **accepts** a mountain building by telling me (line 26). Saud **develops** his solution more by the same placement of perpendicular and horizontal tablets (line 28-29).

Appendix 7.2

DATA	*ANALYSIS*
Week 11-Episode-42 1-Saud begins play with TB3, making two rhombus shapes using four QTs. 2- He makes a hexagonal shape by QTs shape but he does not put the last small QT to complete it. 3-He instead adds two red isosceles obtuse triangles (IOT) to make a diamond, then he adds two further IOTs horizontally at the top of his shape.  	 Saud is **constructing this opportunity** by choosing the TB3 to play with at this episode (line 1). Saud begins with QT by putting them next each other to make a hexagon shape- In What Way Might Saud puts these triangles different from Montessori's position (line 1). However, Saud does not complete the hexagon shape and **frames** the problem by adding two IOTs to make diamonds shape and **generates** an idea (line 3). He **develops** the solution by adding more triangles horizontally (line 3).
4- He adds two more IOT triangles but then he removes all the four IOTs from the diamond shapes and wants to put just one IOT at the bottom of his shape.	Saud tries to **develop** his solution more by adjusting the triangles' positions by gathering the triangles by angles (line 4), but then he removes the horizontal IOT and adding just

 5- Saud: Teacher, Raja come and see what I have done. 6- R: what did you do Saud? 7- Saud: Kite. 8 -I sit next to him and he tells me that he wants to make a boy. 9- Saud wants to make a boy but he does not know how. 10- I make a suggestion to add triangles in different places. 11- Saud begins to add two IOTs horizontally to his shape and making rhombus shape by another two IOTs and adds to the bottom of his shape. 12- R: This is the body [points to the kite shape] and… 13- Saud: … and this is his legs. 14- Saud adds two grey QTs to the shape: 15- Saud: This is a boy. 16- R: Yes, this is Saud's boy. 17- Saud: And I can make it a girl. 18 - R: You can transfer these triangles and make it a girl. Can you show me? 	one IOT at the bottom (line 4). Saud **accepts** his building by telling me and names it a kite solution (line 7). Saud is **generating** a new idea which is boy idea (line 8). When I suggest to him to move the QTs, I want him to **frame** the problem to generate the boy idea (line 10). Saud **develops** the solution by changing the triangle position by putting the first two red IOTs by side with the angle of the diamond shape (line 11) and by adding rhombus shape and grey QT at the bottom of the shape to reach a boy solution (line 11). He **accepts** the boy building (line 15).

19-Saud adds two QTs to the head of his shape and tells me that it is a girl. 20- Saud: No, this is a cat, see …..a cat. 	Saud **generates another idea** for himself which was a girl idea and wants to apply it by action to reach that solution. However, when he adds two grey QTs, he **develops** his solution and discovers a cat solution (line 19). He **accepts** the cat building by telling me (line 20).
21- Saud moves the two grey triangles to reach a girl solution. 22- R: How about if you move these last triangles … you add to a different place around here to make a girl shape. 23- Saud: How? 24- I move the grey QTs to other places and tell him that we will make another cat. 	By switching the two grey QT's places which is **generating** a new idea and **developing** the previous one (line 21). We **accept** a cat building just by changing the same last two grey QTs (line 24).

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25- Saud: I would like to keep this shape, taking out the grey triangles.
26- R: Now, what you can do to reach another solution?
27- Saud returns to his first solution and looks at it.

28-Saud takes out four QTs from his shape and puts them back in different places, seeming to make a desk lamp shape.
29- R: Saud: Look at your shape, you've found another shape.
30- Saud: Yes, I made a lamp.
31- R: A lamp, what else can you make?. How about if you put the four grey triangles back, but in different places. Can you try?
</td>
<td>
By keeping the basic shape he had then by adding two grey QTs in different places, he frames the problem, to generate another idea (line 28).
Saud accepts his building by telling me (line 30).
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</table>

	
32-Saud begins to move the four grey QTs to different places then he returns the two QTs to the same places in the lamp solution and adds two QTs in the top corner of his shape. 33- Then he says it is a spaceship. 34- R: Saud, what is this? 35- Saud: Spaceship… T1, look what I did. 36- Saud points at his shape: Spaceship. 37- T1: Spaceship! It is a spaceship. Can you make another shape?	By taking out the two QTs, returning them to the original position, the child then places the two QT at the corner of his pattern to **frame** the problem and to **generate** an idea (line 32) and **develops** his solution by adding two more QTs at the other corners and **accepts** spaceship building (line 35).
	
38-Saud moves the bottom four IOT's, then puts them back again. 39- Saud takes one IOT and one QT and begins to create another solution near the previous shape. 40- I left to help a girl. 41-Saud places the QT at the hypotenuse of the IOT and adds one	Saud **develops the solution** by taking two IOTs and one QT (line 39). Saud starting to **frame** another problem and to **generate another**

red IOT at a 45 degree angle. 42- He picks up the two red IOTs and makes a rhombus shape and adding it vertically to the shape.  43-Saud looks at his shape and grasps a grey QT, but seems hesitant to add it (he moves the triangles back and forth twice). 44- Saud adds another grey QT, which is next to the first one which these two grey QTs touch one side of each red IOT.  45-Saud then moves the two grey QTs and removes them from the shape whilst observing it. 46- R: What is this, Saud? 47- Saud bows in Japanese style. 48- R: Ahh, you might mean a Japanese man. 49- T1 comes over and asks him about his solution and Saud tell her: it is Japanese man. 50- Saud adds one more grey triangle	**idea** by gathering the QT to the red IOT which is different from Montessori (line 41). He **develops** the solution by making the rhombus shape (line 42) and gathering one side of the rhombus shape to the angle of the grey QT (lines 43-44). Saud **develops** his solution by adding and taking them out of his solution (line 45). Saud adds two more grey QTs and **develops** his solution further to **accept** the Japanese man building by telling T1 (line 49) Saud **develops** his solution by

<table>
<tr><td>next to first QT.
</td><td>deciding to take the last two greys, and keep the previous shape and called it the Japanese man (line 50).</td></tr>
<tr><td>51-Saud adds two grey QT, but then he removes all the last three grey QT and puts back just two.
52- R: What is this Saud?
53- Saud: A lamp.
54- R: Another lamp shape, what else you can do by these triangles?.
</td><td>Saud adds the last two grey QTs to the japans man and develops another solution but he adds it in different positions and accepts the lamp building (line 51-52).</td></tr>
<tr><td>55- He takes out two grey QTs and returns to the Japanese man solution.
56- Saud takes the two red IOT triangles from the Japanese solution and the two triangles touching by the angle then he adds one grey QT between the two IOTs.
57- He removes the rest of the triangles to make space.</td><td>Saud frames the problem and generates a new idea by gathering the IOT by one corner which is a new position (line 56). He adds one QT between them to develop a new solution (lines 56-57).</td></tr>
</table>

 58-Saud adds a red IOT horizontally between the two previous red IOTs. 59- He adds one more red IOT and makes a rhombus shape with the third IOT. 60- Saud adds two grey QTs to one side of the first two IOTs.  61-Saud then adds two more grey QTs to the fourth IOT but then he picks up the last three grey QTs. 	Saud adds the rhombus shape to **develop** it more, adds two more grey QTs, and adds more triangles in different positions to **develop** his solution (lines 59-61).

 62- Saud takes the rhombus shape from the spaceship solution and adds and moves the rest of the unused triangles from his shape.	Saud adds more red IOTs in a rhombus shape, but then decides to take one red IOT out of the rhombus shape. He is still **developing** his solution (line 62).
  63-Saud takes out the last red IOT but then puts it back. 64-Saud adds one more red IOT to his shape.	Saud **explores** another position for the red IOT by gathering the triangles by tips (line 63). He **develops** the solution by adding more IOT to his solution (line 64) and **accepts** spaceship building (line 66).

 65- R: Saud, what did you do? 66- Saud: A spaceship. 67- Saud returns the triangles to the box and leave.	

Appendix 7-3

DATA	*ANALYSIS*
W15-Episode- 59 1-Saud takes out a number of green cylinders (GC). 2- He puts GC5 on top of GC7, then puts GC2-3 horizontally. In both sides of the previous GC. 	Saud **constructs** this opportunity by choosing the GC to play with (line1). He begins to **frame the problem** by adding GC2-3 horizontally which different from Montessori to **generate** an idea (line2).
3- Saud adds another GC horizontally at 90 degrees to GC2-3 and adds GC10 on top of GC8 next to his shape, but then he takes it out. 	Saud adds more cylinders to his solution to **develop** it more but he does not accept his last move of adding GC 10-8 (line 3).

	
4- Saud return GC8 vertically and its rolls and full down but Saud hold it with GC6 and he calls T1: 	Saud **explores data** which is a way to stop the cylinder from rolling and keeps **developing** his solution further by adding another GC (line 4).
5- T1: What is this Saud? 6- Saud: Boy watching TV.	Saud calls his solution a boy. It is composed of two cylinders on top of each other and three other cylinders as hand and feet. The rolling cylinder and the one holding are the TV (lines 4-6). He **accepts** his building by telling T1 and me (line 6).
7- Saud directly puts one GC and RC parallel on top on opposite sides of the cylinder's box. 8- Saud also puts two GCs parallel on the box front side like eyes, but then he puts them on top. 9- Saud tries to steady the GC's from rolling off but he exchanges the GC for smaller BC 2-1 and puts them on the side of the box.	Saud **frames** the problem to **generate** another idea by putting cylinders in parallel on top of the box and uses it as a part of his solution (line 7). He **develops** the solution by putting two GCs on top of the box (line 8). Saud is switching cylinders from large diameter GC to small BC and **explores** the idea that small cylinders

 	can be prevented from rolling more easily comparing with large diameter of the GC (line 9)
10- Saud: Teacher Raja I made a cat. Come and see it, and my toys inside it. 11- R: You made a cat and put your toys inside. 12- Saud takes down the RC from the tower and puts it next to the cat and he matches the diameter of the two GCs with two RCs and puts GC on top of RC. 	By telling an adult about his solution, Saud **accepts** a cat building (line 10). By taking down the cylinders, and restructures the RC with GC by matching the cylinders diameter and putting them on top of each other, Saud **farms** the problem and **generates** another idea which is different from Montessori (line 12).

13- Saud puts two RC on top of each other then puts one BC on top of them He adds one more RC, then returns the BC to the top. 	He **develops** his solution by adding the RC and BC on top of each other (line 13).
14- Saud looks at his solution, putting the BCs in the box then he stop and adds more GC to his previous pattern. 15- Saud covers the box with the blue cover and tells me: 16- Saud: this is the Sea (the box) and all these are houses and this is the playground and toy (the tower) and this is the tree (GC on top of the RC). 	Saud **develops** the solution by putting the blue cylinders in the box and covers it with blue cover (line 14-15).
17- Saud: inside the sea you can find fish.	Saud **accepts** the sea solution by telling T1 and me about it (line 17-18).

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18- Saud calls T1 and tells her about his solution.
19- Saud adds RC and GC on top of the toy shape and put them slightly to one side of the cylinders.</td><td>He develops his solution by adding the RC and GC on top of each other and puts them slightly to one side (line 19).</td></tr>
<tr><td>
20- Saud tells his friend who set next to him: We are making a building.</td><td>By saying “we are making a building”, Saud generates another idea (line 20).</td></tr>
<tr><td>
21- Saud takes BC4, holds it vertically and puts next to it on both sides BC1-2 (vertically) and adds RC2-GC2 next to the pattern.</td><td>By adding the BC and RC in different positions, Saud develops the solution (line 21)</td></tr>
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22- Saud rolls BC like a car and calls the shape a gas station:
23- Saud: Teacher Raja, look at the car driving through here and the man filling the car with petrol.

24- Saud asks me to go to art area then he leaves the area.
</td>
<td>Saud develops the solution by rolling BC like a car and accepts a gas station building (line 22-23).</td>
</tr>
</table>

Appendix 7-4

DATA	***ANALYSIS***
W19 –Episode-78 **TB4-RC-GC** 1-Saud brings the TB4, RC and GC to the Morning Circle. 2-He takes out the two QTs and puts them on top of each other. 	Saud is **constructing** opportunity by choosing the material he wants to play with (line1). He **frames** the problem by taking out two QT and putting them on top of each others to **generate** a new idea (lines 2).
3 - Saud takes out two yellow RATs from the box and adds them along the long side of one of the two QTs and adds the second RAT to the short side at an angle. 4 - Saud adds two GCs on top of each other to the second RAT and two GCs next to his shape. 	Saud **developing** the solution by touching one angle of the QT to the right angle side and by adding one more triangle (line 3). He **develops** his solution by adding the GC to it (line4).
5 - Saud rolls the GC10 onto the triangles and asks me to look to it. 6- Saud takes the two grey RATs and places them together along the long side of the right angle and tells his	Saud **accepts** this building without naming it (line 5). I call it a cylinder slide. Saud begins to **frame** another

friends that he is making an airplane. 	problem by gathering the grey triangles (line 6) to **generates** an airplane idea.
7 - Saud adds one yellow Scalene right-angled triangle (SRAT) to the left of his shape and adds a yellow RAT to the right side of his shape, telling his friends: Saud: It is an airplane. 8 - Alyahiya adds one yellow QT to the shape to give it more effect as an airplane solution. 	He is retrieving the grey triangles and **developing** the solution by adding the angle of the SRAT to one side of the grey triangle (line 7). Saud **accepts** his building and names it an airplane by telling his friend (line7). Saud's friend **develops** his solution more by adding the jet plume to it (line 8).
9- Saud adds a green SRAT to the top of his shape, a yellow SRAT alongside, and a green RAT next to the green SRAT.	Saud **develops** his solution by adding more triangles to gives their solution a shape of airplane (line 9).

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10 - Saud takes a SRAT, a yellow QT and a green SRAT and begins another (refusing his friend interrupting) pattern by putting the tip of the yellow QT in the middle of the green SRAT’s hypotenuse but then he left the traingles.

11- Saud takes the green SRAT and puts the tip of it against the tip of the red IST opposite its hypotenuse.

12 - Saud adds the yellow RAT</td>
<td>Saud starts to frame by putting the tip of the yellow QT into the hypotenuse of the SRAT to generate an idea (line 10).
Saud frames the problem again by taking two triangles to generate the same previous idea by potion them by head (line 11).
He develops his solution by adding more triangles (lines 11-12) and gathers them all in one tip with different positions.</td></tr>
</table>

between the red IST and the green SRAT, with its hypotenuse adjacent to the side of the red IST.  13 - Saud adds a green RAT in the same way to the opposite side of the yellow RAT. 14- Saud to his friend: Look, this is another airplane.  15 - Saud takes a green SRAT and the red IST and puts them by side. 16 - Saud adds another green RST to the shape, but then stops looking at it. 	He **develops** his solution and **accepts** the airplane building (line 14). He **develops** the solution by putting the triangles by sides and (lines 16).

<table>
<tr><td>17 - Saud adds a yellow RAT to the opposite side of the green RAT .
</td><td>Saud develops his solution by adding the RAT (line 17).</td></tr>
<tr><td>18 - Saud takes the two green SRATs and joins them by their hypotenuse to form a square.

19 - Saud rotates the green square 45 degrees, then rotates it back again.
</td><td>Saud develops his solution further by making a square shape and then a rectangle by reusing the same movement and adding smaller triangles (line 18). Saud manipulates the shape by moving it 45 degrees then returns it to how it was before to show his understanding of the triangles’ position (line 18-19).</td></tr>
<tr><td>20 - Saud takes the square shape a way from other triangles and adds a green RAT to one side of the square shape.</td><td>Saud did not complete his idea but he framing the problem to generate another idea by taking the square shape and develops the solution by adding green RAT (line 20).</td></tr>
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<tr><td>
21 - Saud removes the RAT from the square shape but then returns it and adds the second green RAT to make a rectangle shape with the two green RAT’s.</td><td>Saud identifies the desired solution by rotating the triangles and developing his solution further (line 21).</td></tr>
<tr><td>
22 - Saud places the narrow point of one yellow RAT on one side of the square shape and adds a red IST similarly to the opposite side.</td><td>Saud develops the solution, and, looking at it, accepts it and turns to developing it more by adding more triangles (line 22).</td></tr>
<tr><td>
23- Saud adds a grey and a second yellow RAT by their thin points to the free side of the square shape and looks at it.</td><td></td></tr>
</table>

 24 -Saud: This is a fat boy walking like this. 25 - Saud: This is his legs (points to the grey and yellow RATs). 26 - Saud adds BC4 to the head of the boy solution as an eye.	He **accepts** a fat boy idea and **develops** the boy solution by adding more details like a leg, using the triangles (lines 23-24). He **develops** it further by using the cylinders as eyes and mouth (lines 25-26).
 27 – Saud keeps the square and rectangle shape in his solution.	By removing the leg and hand triangles, Saud is **developing** his solution by keeping the square and rectangle shapes (line 27).
 28 - Saud adds the third BC as a mouth to his solution.	He **develops** his solution by adding the BC and returning the yellow and grey triangles (lines 28-29).

 29- Saud returns the yellow and grey RAT and red IST to his shape.	
 30- Saud takes a second blue RAT and adds it to his solution as the second leg in the fat boy solution.	Saud **develops** his solution further by adding two triangles and returns to his previous solution (line 30).
 31 - Saud moves the red IST and the blue RAT, which was the leg of the boy solution, at an angle and calls it a spaceship then he adds more GC and BC to his shape.	Saud **develops the solution** by moving the blue RAT and red IST at an angle and in the same time **h**e **accepts** a spaceship solution by telling his friend about it (line 31). He **develops** it more by adding more BCs and GCs to his shape.

 32 - I come and ask Saud about his shape. 33 - Saud: This is a spaceship…(laugh) this is nothing. 34 - R: What? 35 – Saud: This is nothing. 36 - Saud plays with his nothing shape, then he begins to pile groups of three green cylinders on top of each other, but the top one is the widest.	When Saud **develops** his solutions by adding a number of cylinders, he change his solution to a nothing solution and **accepts** it (line 33-35). Saud **develops** his solution by putting the wide diameter green cylinder on top of the blue cylinder (line 36)
 37- Saud begins to put the blue and red triangles from the short side to touch the square shape and tells his friend this is now a spaceship. 38- Saud adds YC10 at the corner of each blue RAT and says: Spaceship.	By moving the red and blue triangle to the corner, Saud **develops** his solution and names it by spaceship and **accepts** it (line 37). He **develops** his solution more by adding the YC (line 38).

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39 - Saud mixes his shape and grasps two blue RATs and joins them by their short side.

40 - Saud adds two GCs to his shape and calls it loudly: A balancing game.
41 - Saud then adds two more GCs to his shape.

42 - Saud adds a yellow SRAT to his shape and looks at it.
43 - Saud adds a green SRAT on the opposite side to the yellow SRAT.

44 - Saud adds a green SRAT to the shape and a grey RAT, and calls it a rocket:
45 - Saud: T1 come and see what I
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<td>
When Saud mixes the, he frames the problem and generates another idea by structures the two blue RATs (line 39) and developing the solution by adding GCs to accepts a balanced game idea (see-saw) (line 40).

Saud develops the solution by adding yellow SRAT touching the two GC (line 42) and by adding SRAT triangles to give his solution more detail (lines 43-44).
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</table>

have done? 46- T1: What did you do? 47 - Saud: A rocket. 48 - Saud adds a red IST to his shape to represent the fiery plume at the tail of the rocket. 	He **accepts** a rocket building by telling his T1 about it (line 47). Saud **develops** the rocket solution by adding yellow triangles as a jet plume (line 48).
49 - Saud mixes up his shape and takes the two blue RATs. 50 - Saud takes the cylinder box and holds the blue RATs by their short side to the nearest side of the box.  51- Saud hold the second blue to the second side of the box and the third blue RAT to the third side of the box but its keeps falling off because of unevenness in the carpet.	By mixing the shapes and structuring the two blue RATs, Saud begins to **frame** the problem to **generate** a new idea (line 49) by finding another way to play with the blue RATs adjacent to the box (lines 50-51).
52- Saud holds four blue RATs to the four sides of the cylinder box.	Saud **develops** his solution more by putting four blue RATs n every side of the box (line 52).

 53 - Saud says: I want to make a farm, no ….a maid's house. 54 - Saud puts a yellow SRAT on top of one side of the box. 55- Saud picks up pairs of blue RATs and stands them upright on all four sides of the box. 56- Some of the blue triangles keep falling down, in spite of Saud's attempts to balance them by supporting them with the box.  57 - Saud begins to add one GC to the inside of the box and a girl doll. 58 - Saud: Teacher T1 and Raja, this is the maid's house. 59 - R: The Maid's house! 60- Saud adds the yellow SRAT at the first corner of the box between the two big blue QTs. 61 - Saud adds one more yellow SRAT and two green RATs at each of the three corners of the box. Then he looks at it and all his friends are watching.	He **develops** his solution by adding the yellow triangle in top of the box (line 54) Saud Takes out the yellow triangle and **develops** his solution more by making an equilateral triangle using two blue RATs at every side of the box (line 55). Saud **exploring the data** of holding the blue triangles and supports them by the four sides of the box (line 56). He **develops** his solution by adding the GC inside the box with the girl doll (line 57). He **accepts** a maid's house by telling T1, me and his friends about it (line 58). Saud **develops** his solution by adding the yellow SRAT at the corner between the two sides of the box. (line 60)

 	

The Story of Soluman

Appendix 7-5

DATA	*ANALYSIS*
W5-Episode-19 1- Soluman play with the Col2, takes two tablets and puts them next to each other. 	Soluman is **constructing the opportunities** by choosing to play with the Col2 material (line 1).
2- Soluman puts another two tablets next to the first two tablets in a line. 3- Soluman adds a fifth tablet next to the first tablet in the line, but an angle and adds one more by angle. 	Soluman **framings** the problem by adding two tablets at angles next to the first one which is different from Montessori and **generating** a new idea. In the same time, he **explores** the angle position (line 3).
4- Soluman adds one tablet vertically above the line and next to an angle tablet. 5- Soluman adds another tablet at an angle next to the first angled tablets, seeming to make a sunshine shape, with tablets at angles.	Soluman **develops** the solution putting the tablet vertically at the one side of the angle (line 4). Soluman **develops** the solution by placing the tablets in a sunshine shape (lines 5-6) coping his previous moves.

 6- Soluman adds another tablet in line and adds a third tablet at an angle to his shape.  7- Soluman reorganises his shape to make a sunshine shape by moving the inside tablets to form a circle shape. 	He is restructures his solution by giving the tablets a sunshine shape (line7) which mean that he **develops** the solution.

8- Oufee asks Soluman what he has made and Soluman answers him: 9- Soluman: Sunshine 10- Soluman begins to collect the tablets to put them back in the box.	Soluman **accepts** the sunshine building by telling his friend (line 10)

Appendix 7-6

DATA	***ANALYSIS***
Week11-Episode- 43 1-Soluman takes all the triangles out of the box except the big grey QT. 2- He connects two red QT at one angle then he adds the third red QT at the hypotenuse and makes a trapezium shape.	Soluman **constructing the** opportunity by choosing the TB1 to play with instead of other materials (line 1) Soluman **framing** the problem by selecting two Qt and connect them head to head to **generate** an idea and **develops** the solution by making trapezium shape (line 2).
 	
3-Soluman moves the trapezium shape 45 degrees and adds the fourth red QT on the top side of the trapezium shape.	He restructures the triangles shape which helps him to **develop his solution** (line 3).

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4-Soluman moves the green RAT 45 degrees twice, then he adds it to the middle red QT on its base side.
5- Soluman moves the RAT from the middle QT to the side QT.</td>
<td>He explores the new position of the RAT by testing it twice and decides to add it in the places he thinks is more appropriates for it (line 4).</td>
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6-Soluman adds the second green RAT on the opposite side from the</td>
<td>Soluman copies the same movement of the RAT on the opposite side and develops his solution (line 6).</td>
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first green RAT by putting the base side on to the red QT. 7- He looks at his shape and moves it 45 degrees. 8- The triangles are disturbed on the surface of the blue rubber mat, but Soluman reorganises them.   9-The child adds the first yellow IOT's hypotenuse to the base side of the trapezium shape. 10-Soluman adds the second yellow IOT to the green RAT and connects them by black lines, but then he takes it out and puts it beside the first yellow IOT. 11-He adds the third yellow IOT next to the other yellow IOT's. 12-Soluman looks at his shape and I observe him during his attempt: 13- R: What is this Soluman?. 14- Soluman: Bird. 15-R: A bird.	He **develops** his solution by moving it 45 degrees (line7) Soluman **develops** the solution by adding the yellow IOT (line 9) Soluman **develops** his solution by adding the yellow triangle next to the first one (line 10). When **accepts** it by looking at it and telling me what it was (line 14).

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16- Soluman puts the yellow IOT's on top of each other.
17-He stops to look at his shape, then he takes the two greens RAT from his previous solution.
18-Soluman: A castle, look at it (he says to Oufee).</td>
<td>Soluman frames the problem again to generate new idea by moving the yellow triangles' positions (line 16) and develops it more by removing the green triangles (line 17). Soluman accepts a castle building by telling his friend about it (line 18).</td>
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19-Soluman takes out all the four red QTs from his shape. 20- He takes two red QTs and tries to balance them, but he cannot and needs to steady them with his hands. 	Soluman **frames the problem** by taking out the QT from his solution (line 19) and hold it by hands. Soluman attempts a balancing method and tries several times unsuccessfully to generate an idea (line 20).
21-Oufee takes one red QT and puts it between two yellow IOT's, but Soluman stops him: 22- Soluman: Don't move it, stop!. 23-Soluman takes the red QT and puts it back in the place where Oufee had put it and adds the second red QT to his shape. 24-Soluman looks around, then	The third solution starts with an idea by Oufee (line 21). Soluman copies Oufee's idea and restructures **the** triangle shape to **develop** his solution. He **develops** his solution by adding the second red QT (line 23)

begins to return the triangles to the box and leave the area.  	

Appendix 7-7

DATA	*ANALYSIS*
Week-14- Episode-58 1- Soluman chooses to play with the red, green and blue cylinders (RC- GC- BC) and begins by taking the green tower down which his friend left it. 2- He starts to compare the diameters of GC10 and GC9, putting one on top of other, but then putting them side by side. 	Soluman is **constructing** the opportunity by choosing the cylinders problem (line 1). Soluman is **developing solution** by taking the green tower down to establish his own pattern (line 1) and by comparing the diameters of the cylinders (line 2).
3- After comparing the diameter of four cylinders; then he completes the tower by putting the cylinders on top of each other. 4- Soluman puts the final cylinder on top of the green tower which is Red Cylinder1 instead of the GC1. 	Soluman **develops** his solution by putting the cylinders on top of each other (line 3). Soluman **frames** the problem and **generates** an idea by switching the RC on top of the green cylinders and GC1 on top of the red cylinders (line 4).

<table>
<tr><td>5- Soluman discovers that he is missing the GC2, but then he takes out the RC and puts in the GC2.
</td><td>He develops his solution by putting back the GC2 in order to other cylinders (line 5).</td></tr>
<tr><td>6- Soluman puts the GC1 on top of the green tower.
</td><td>Soluman performs a building sequence, putting the cylinders in order from biggest to smallest according to their diameter like Montessori solution (line 6).</td></tr>
<tr><td>7- Soluman begins with the Red cylinders after dismantling his friend's tower.
</td><td>He develops his solution during his play with the red cylinders (line 7).</td></tr>
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<td>8- Soluman arranges the RCs to build a tower, going from biggest to smallest.

9- Soluman tries to complete the tower with the RC1 on top but RC1 keeps full down.

10- Soluman puts the blue cylinders BC1-2-3 on top of each other.

11- When Soluman tries to add the BC6, the tower falls down.</td>
<td>He develops the RC to build a tower (line 8-9).

Soluman develops the problem by putting the BCs on top of each others (line 10).

Soluman tries to develop his solution by beginning with the shortest BC instead of putting the taller cylinders first (line 11).</td>
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</table>

 12- Soluman starts again using smallest cylinders and again the tower falls down. 13- Soluman returns to put the BC1-2-3-4 on top of each other. 	Soluman persists with the same mistake of putting the shortest cylinders at the bottom of the tower. He is still restructures his method to **develop** the solution to build a stable building (line12). Soluman **develops** the solution by putting the cylinders on top of each others (line 13).
14- Soluman compares between two blue cylinders and he takes the shorter once and puts it on top of his building. 	Soluman is still restructures the problems and copying the Montessori solution. However, he begins with the shortest cylinders instead what T2 presented by (beginning with the tallest cylinders to make the tower stable) (line14).

 **15-** Soluman adds the last BC10, but the tower is lopsided then he uses his hand to stop it from collapsing.	Soluman is still **exploring** his way to understand how to stabile the cylinders but could not discover the right way until now (line 15).
 **16-**The tower of BCs collapses when Soluman adds the BC10 and left his hand. **17-** Soluman returns the BC to the box then the RC and the GC.	Soluman did not build the blue tower because he did not **explore** that he has to put the largest cylinders at the bottom.

Appendix 7-8

DATA	***ANALYSIS***
Week21-Episode-85 1- Soluman brings the TB2 to the MC and takes them out. 2- Soluman places two yellow IOTs along their hypotenuse to make a rhombus. 3- He brings a grey IOT close to the lines of the hypotenuse. 4**-** But he leaves that shape and begins with another two yellow IOTs, putting them side by side.	Soluman is **constructing** the opportunity by choosing to play with the TB2 (line1). He **develops** his solution by adding the grey triangle (line 3).
5- Soluman adds the third yellow IOT and makes a large yellow triangle. 6- Soluman adds a red IOT, putting it on top of the third yellow IOT, but then he removes it. 	Soluman **develops** his solution by looking at his shape and adding another red triangle (line 6).
7- Soluman puts the hypotenuse of the fourth yellow IOT between one side of the red IOT and the large yellow triangle. 8- Soluman looks at his shape, then takes the red IOT out and adds the fifth yellow IOT on the opposite side to the fourth one.	Soluman **frames** the problem by adding the yellow IOT to his shape which is different position from Montessori to **generate** an idea. He **develops** his solution by taking out the red IOT and looks again then adds the yellow IOT to his shape (lines 7-8).

	
9- Soluman looks again at the pattern and returns the red IOT to its place.	Soluman **develops** his idea by returning the red IOT to its place (line 9).
10- Soluman takes away the red IOT again and adds a grey IOT instead.	Soluman **develops** his solution by adding the grey IOT (line10).
	
11- Soluman adds the second grey IOT next to the first one and makes a rhombus with the two grey triangles then he looks at his task from a different position.	Soluman **develops** his solution further by making a grey rhombus (line11)
	

12- Soluman tells his friend about his shape: 13- Soluman: I make a rocket. 14- Soluman returns to the shape and takes a second grey IOT from his it, and he removes it and replaces it before leaving it out completely. 	Soluman **accepts** his building by telling his friend (line 13). His hesitancy of adding or taking a way the second grey triangle leads him to takes a decision to **develop** his solution and **accepts** it (line 14).
15- Soluman returns the red IOT in the same place of the second grey IOT. 	He **develops** his solution by returns the red IOT instead of the grey triangle (line 15).
16- Soluman adds the grey IOT to his shape along side the red IOT . 17- He adds the yellow IOT on the side of the red IOT.	Soluman **develops** the solution by adding the grey and yellow IOTs side by side with the red IOT (line 16-17).

 18- Soluman looks at his shape and smiles, holding the large yellow triangles while his hand. 19- Soluman puts down the yellow triangles and holds a red IOT in the middle of one of them. 20- Soluman directly takes two yellow IOT from his previous solution and puts them side by side. 21- Soluman takes away one yellow IOT and puts the grey there instead then adds a red IOT and makes a large equilateral triangle.	Soluman seems to establishe another solution by holding large yellow triangle (line 18), by holding the red IOT (line 19) and then by gathering the two yellow IOT side by side (line20). Soluman **develops** his solution by choosing three different colours to make a large triangle (line 21).
 22- Soluman holds the second grey IOT between the yellow and grey triangles.	He **frames** the problem by repositioning the triangle and by holding the grey IOT up between the two triangles to **generate** an idea (line 22).

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23- He takes out the red IOT and makes a space between the two yellow and grey IOTs to hold the red IOT between them.

</td><td>He develops his solution further by taking out the red IOT and making a space between the two IOT to hold the second grey IOT between them (line23). Soluman explores the holding position(line23).</td></tr>
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24- Soluman takes another yellow IOT and aligns it with the red IOT and holding it up.

</td><td>He develops his solution by joining the yellow and red IOT and putting between the grey and yellow IOT (line 24).</td></tr>
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25- Soluman succeeds in holding up the red and yellow IOT between the grey and yellow IOT.
26- T2 asks Soluman about his shape:
27- T2: what is this Soluman?
28- Soluman: Airplane.
29- T2: It is an air plane, can you make something else with these triangles?
30- Soluman puts five yellow IOTs on top of each other.
31- Soluman makes a rhombus using two grey IOTs and adds it vertically to his shape.

32- Soluman makes a small space between the two grey IOTs and moves them like a scissors.
33- Soluman smiles :Scorpion, woooo</td>
<td>Soluman accepts an air plane building by telling his teacher about it (line 28).

T2 asks Soluman to make something else which is framing the problem for the child. He takes three yellow IOTs from his previous solution and frames the problem by putting them on top of each others to generate an idea (line 30).

Soluman develops his solution by putting five yellow IOT on top of each others and looking at it (line 30).

Soluman develops his solution by adding the rhombus shape (lines 31-32).

He accepts the scorpion building and by telling himself about it (line 33).</td>
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34- Soluman takes out the grey rhombuses and the two yellow IOTs from his shape.
35- He looks at his shape then adds the red IOT with its hypotenuse on one side of one yellow IOT.


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<td>
Soluman is **generating another idea** by taking out the grey IOTs from his shape and also taking out the yellow IOTs (line 34).

He **develops his solution** by adding the red IOTs hypotenuse to one side to the yellow IOT (line 35).
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36- Soluman copies the same action of adding a red IOT on the opposite side using grey IOT and copies it also with another red and another yellow IOT.


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<td>
Soluman **develops** his solution by copying the same move of adding the red IOT to the opposite side (line 36).
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<table>
<tr><td>37- Soluman adds two yellow IOTs next to the first yellow IOT and makes a large triangle.
38- He directly goes to his friend telling him that he has made a spaceship.
</td><td>He develops his solution by adding the two yellow IOTs to his pattern (line 37).

He accepts a spaceship building by telling his friend (line 38).</td></tr>
<tr><td>39- Soluman takes two yellow IOT from his previous task.
40- He gathers two red IOTs beside the yellow triangles and he arranges them shapes by their corners.
</td><td>Soluman is taking two IOTs and gathers them by sides (line 39). He is framing the problem with these triangles by touching two corners of the two yellow IOTs with the two corners of the two red IOTs to generate an idea (line 40).</td></tr>
<tr><td>41- Soluman makes a rhombus shape using two yellow IOTs and adds a piece to cover the gap in his shape.
42- Soluman adds the side of the grey IOT to the hypotenuse of one red IOT.</td><td>Soluman develops his solution by placing the rhombus shape between the four IOTs (line 41).
Soluman develops his solution by adding the grey IOT to his pattern (lines 42-43).</td></tr>
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43- Soluman adds the second grey IOT on the opposite side of the first grey triangle.

44- Soluman takes one of the grey IOTs from the left hand side of his pattern.
45- He looks at his pattern, returns the grey IOT from the hypotenuse to red IOT hypotenuse and brings the yellow IOT closer to his shape, and adding it horizontally.

46- Soluman changes the second
</td><td>
Soluman develops his solution by placing the grey IOT in a different position (line 44).
He develops his solution further by adding the yellow IOT horizontally side by side with the grey triangle (line 45).
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grey IOT on his right hand side and puts the grey by the yellow on its hypotenuse.  47 - He adds the fourth yellow IOT horizontally to the second grey triangle.	Soluman **develops** his solution by copying his moves with the grey and yellow triangles from left to right hand side (line 46- 47).
48- Soluman looks at his shape and switches the yellow IOT from the left hand side to the second side of the grey triangles.  49- He looks at his shape then changes the second yellow IOT and makes the same move.	Soluman **develops** his solution by reorganizing the triangles places (lines 48-49)

 50- Soluman looks at his pattern and asks T2 to look at his solution: 51- Soluman: I've made a spaceship. 52- T2: Spaceship! I think you are our future spaceman. 53- Soluman returns the triangles to the box.	Soluman **accepts** his building by telling T2 about it (line 51)

The story of Sara

Appendix 7-9

<table>
<tr><td>DATA</td><td>ANALYSIS</td></tr>
<tr><td>Week-4-Tues-Episode-16
1- Sara brings the Brown Stairs (BS) to the Morning Circle (MC).
2- She starts with the thickest prism BS10, keeps placing the prisms on top of each other and carefully centres them at one side of the BS10.

3- Sara finishes building the brown stairs and left the area.

4- Sara’s friends take the tower down, put the pink cubes next to the BS.
5- Sara comes back and Meshoo puts the thickest prisms BS9-10 next to each other.
6- Sara puts the largest PTs (10-9-8) on top of the BS, and her friend Hala</td><td>Sara constructs this opportunities by choosing to play with the BS (line 1).

She is copying the Montessori solution by putting the prism on top of each other, making a vertical tower (line 2). She is still framing the problem “In What Ways Might She puts these prisms different from Montessori solutions”.

Meshoo starts to put the BS next to each others.</td></tr>
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<table>
<tr><td>puts the PT7 next to the PT8.
</td><td>Sara is framing the problem by mixing the PT and BS together to generate an idea (line 6).</td></tr>
<tr><td>7- Meshoo puts the BS6 vertically on top of the pink cubes and Sara adds BS7 vertically parallel with the BS6.
8- Sara adds the PT4 on top of BS6 then Meshoo adds another PT on top of the BS and Hala copies them.
9- Sara adds BS4 on top of the PT, then and Meshoo did the same.
10- Meshoo takes out the pink cubes that Sara has added and puts the BS6 on top of the BS7 at one corner of the building, while Sara watches her.
11- Sara adds BS8 vertically at one corner of the building and puts the PTs (4-3-2) back on top of the BS4.
</td><td>Sara develops the solution by putting the BS vertically which is different position from previous with the PT at the same solution (line 7).

Sara and her friends develop the solution by adding one prism to the top of the cubes (lines 8-9).
Meshoo develops the solution by moving the two prisms on top of each other at one corner of the building (line 10).

Sara develops the solution by adding the BS8 vertically and PT at the building (lines 11).</td></tr>
<tr><td>12- Sara takes out the small cubes and puts the BS4 on top of the BS6, then returns the cubes.

13- The girls go to T1 and Sara tells</td><td>Sara develops the solution further by adding the BS4 vertically to their building (line 12).

Sara with her friends accept their</td></tr>
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her: we made a cake.  14- Sara takes out PT5 and Hala takes out the PT4-3-2. 15- Sara moves the BS4 closer to BS7 then adds BS3 to the top of BS4.  16- Sara puts PT5 back on top of BS3 and Hala puts back PTs (4-3-2); then Sara goes to her T1. 17- Sara tells her T1: Look another Cake. 18-T1: Cake, what is the cake song? 19- Meshoo starts to change the positions of BSs (4-5) but Sara takes them and tells Hala to put the BS3 at the corner of the building.	solution 'a cake' by telling their teacher about it (line 13). Sara **develops** her solution by taking out the cube from the top of BS5 (line 14). Sara also **develops** the solution by adding BS3 to the top of BS4 and brings them closer to BS7-6 (line 15). Sara **develops** her solution by putting PTs (5-4-3-2-1) with Hala back on top of BS3, not on top of BS5 (line 16). Sara **accepts** her developing solution of the 'Cake' building by telling T1 about it (line 17). Sara **frames** the problem by taking two prisms out and returning BS3 in different place to **generate** a new idea (line 19).

	
20- Hala also switches the BS places, but Sara switches them back again. 21- Sara transforms the BSs into a vertically column.	Hala and Sara try to **develop** the solution by switching the prisms places, but Sara returns them back (line 20). Sara develops the solution by putting BSs (6-7-5-4) in a vertical column (line 21).
	
22- Sara puts BS (5-6) on top of each other in one corner parallel to BS7 and puts BS3 on top of BS7, adding BS 4 parallel with them. 23- Sara also puts PTs (5-4-3-2-1) back on top of each other and put them on top of BS3. 24- Sara and Hala call T1 and tell here: 25- Sara: Look at our castle. 26- T1: Castle, you changed your design from a cake to a castle.	Sara **develops** their solution by re-positioning the BSs (lines 22-23). Sara and Hala **accept** the Castle building by telling T1 about it (line 25).

	
27- Hala removes two BSs from their places and puts them on top of each others. 28- Sara also moves PTs (5-4-3-2-1) to a different place and looks at the building. 29- Hala starts to put the PTs in order, from largest cube to smallest, on top of each other. 30- Sara also puts the BS on top of each other, starting with BS10.	Hala and Sara **develop** their solution by removing the Bs and PT from their places (lines 27-28). Hala and Sara go back to make the Montessori vertical solution with PTs and BSs (lines 29-30).
	
31- Sara takes down both towers, her friend leaves the area and she asks me to play with her. 32- I take the PT10 and put it in the middle then I take the BS10 placing the edge of it to one side of the PT10, while Sara watches me.	I **frame** the problem with Sara by selecting to start with Pt10 and I **generate** an idea by putting BS10 to one side of the PT10 (line 32). Sara **explore**s the laying position of the prisms.
33- Meshoo returns to play with us, while Sara laying BS9 next to the BS10. 34- Sara copies my move and lays	Sara and I **develop** the solution by

BS8 on the BS9. 	copying the first BS move (lines 36-34).
35- Sara lays PT9 on top of BS10 and I lay PT8 on top of BS8. 36- Sara finishes laying the BS and teaches Meshoo and Hall how to put the PTs on top of the BSs. 	Sara **develops** the solution by adding the PT to our building (line 35). Sara and her friends **develop** the solution by copying the same move (line 36).
37- I ask the children what we have been doing? 38- Sara says: bridge. 39- Meshoo: No, animal zoo. 40- Meshoo brings the animal box and with Sara put animals on top of the PT. 	Meshoo and Sara **develop** their solution by adding a plastic animal and **accept** their building (line 40).

41-T1 turns off the light and the children put the materials back on the shelves.	

Appendix 7-10

<table>
<tr><th>DATA</th><th>ANALYSIS</th></tr>
<tr><td>Week12-Sun-Episode-46
1-Sara takes out the two grey isosceles obtuse triangles (IOT) from TB3 and connects them by one corner.
</td><td>Sara constructs this opportunity by choosing to play with the TB3 and frames the problem by connecting two IOTs corner to generate an idea (line 1).</td></tr>
<tr><td>2- She takes one red IOT and puts it between the two grey IOTs.

3-She adds one more red IOT to make a rhombus, but then dismantles it.
</td><td>She develops her solution by adding a red IOT between the two grey IOTs (line 2).</td></tr>
<tr><td>4- Sara makes a rhombus with the red and grey IOTs, but then she moves them and puts them on top of each other.</td><td>Sara develops her solution by making a rhombus with red and grey triangles (line 4).</td></tr>
</table>

	
5- Sara mixes the triangles. 6- Sara arranges the IOT triangles by colour (grey, red and yellow) one under anther. 	Sara is not satisfied with this idea and mixing them to start over (line 5). She **frames** the problem again by putting them one under the other to **generate** another idea (line 6).
7- Sara adds three more IOT and puts them in the same order. 8-Sara wants to add a big yellow QT underneath the triangles, but there is no room. 	Sara **develops** the solution by adding more triangles in the same order of colour (line 7). She pushes the IOTs triangles to make space for the yellow QT and **develop** the solution (line 8).
9- She pushes the triangles and puts one side of the yellow IOT piece against the hypotenuse of the red triangle, which gave her an idea.	During her pushing of the triangles, she is indicates that she **generating** an idea (line 9) by putting six IOTs together at one angle (line 10) which is new position that Sara **explored** by

 10- Sara places the IOTs in such a way that she creates a half circle.  11- Sara adds three more yellow IOTs to the right hand side, then she calls me.	chance. Sara **develops** the solution more by adding three yellow IOTs (line11).
12-Sara adds the big yellow QT to her shape. 	She **develops** the solution further by adding the QT (line12)
13- R: What is this? 14- Sara: First, it was a sun but now it is a flower. 15- R: It is a colourful flower by triangle.	Sara **accepts** the sun and her flower buildings by telling me (line 14).
16-Sara takes a big grey QT from TB1 and puts it on top of her shape at the centre.	She **develops** her solution by adding the grey QT (line 16).

<table>
<tr>
<td>
17- She asks Lulu to give her a cylinder.
18- Sara positions the green cylinders as eyes and puts the red cylinder horizontally as a mouth:
19- Sara: This is her eyes and this is the mouth
(talking to Lulu)

20- Sara looks at her solution for a few minutes, and then she returns the triangles to the box.</td>
<td>Sara develops her solution by adding cylinders to her pattern and giving it more detail (line 18).
Sara accepts the face solution by telling Lulu (line 19).</td>
</tr>
</table>

Appendix 7-11

DATA	*ANALYSIS*
Week-16-Mon-Episode-65 1- Sara chooses to play with the TB3. 2- She puts the red, yellow and grey QTs next to each other. 3- Lulu brings the TB4 and sits next to Sara and they add more QTs to their shape. 	Sara **constructs** this opportunity by playing with the TB3 (line 1). She is starting by copying the Montessori solution by making hexagon by QTs (line 2). They **develop** the solution by adding more QTs (line 3).
4- They search for more QT at TB2-3-4 to finish a second level. 	Sara and Lulu **develop** the solution by adding more QTs and makes a second level with them (line 4).
5- Lulu brings the TB1 and takes out the red QT and Sara adds the red QT to their shape with Lulu.	They **develop** their solution by adding the red QT (line 5).

 6- Sara whispers to Lulu: I don't like this. 7- Lulu takes out the last three red QTS. 8- Sara returns one red QT.	Lulu **develops** their solution by taking out the red QT (line7) and Sara **develops** it more by returning one red QT (line 8).
 9- Sara takes out three grey QTs and one green QT.	Sara **develop the solution** by taking out four QTs (line 9).
 10- Sara takes out and puts back same QTs. 11- Sara organises the colours of the	Sara is still **developing** the solution by taking out and adding QTs (line 10).

QTs, by making two hexagons and explains how she did it to Lulu. 12- Lulu puts one of the red cylinders (RC) at the edge of one QT and Sara adds one YC. 	Sara **frames the problem** by organizing the red, green and grey QTs in a pattern to **generate** an idea (line 11). Lulu and Sara **generate an idea** by adding RC-YC around the triangles (line 12).
13- Lulu adds the Green cylinder (GC) and Blue cylinder (BC) next to the first yellow cylinder: 14- Lulu to Sara: see like this. 15- Sara surrounds the shape in order starting with small cylinders from the YC- BC-GC then RC 16- Sara to Lulu: how about this? (both smiling). 	Sara **develops the solution** by surrounding their pattern with cylinders in order (line 14) and in the same time, the girls **develop** their solution. Sara **develops** the solution by surrounding the pattern with three cylinder colours (line 15). Sara **develops** the solution by adding RC1 and GC1 to the middle of the shape (line 16).
17- Sara does not add any more YCs and calls for the cylinder colour and Lulu gives her the cylinders to surround the shape. 18- Sara finishes from surrounding the shape and puts the GC1 and RC1 in the middle.	Sara **develops** the solution by re-positioning the cylinders in the middle (line 17). Sara **develops** the solution by adding the YCs in the middle (line 18).

 19- Sara puts the GC10 in the middle then BC1 on top of it then the RC1 on top of them.	Sara **develops** the solution by adding colour cubes (line 19).
 20- Sara adds two YCs in the middle of the shape.	Sara and Lulu **develop** their solution by adding more colour cubes on top of the colour cylinders (line 20).
 21- Sara asks Lulu to bring the colour cubes from the shelves to add to their shape, and she did.	

 22- Sara adds more colour cubes to the middle, then on top of the surrounding cylinders, and Lulu hands the cube to her. 23- Sara adds more cubes and tells T1 about it:  24- Sara: This is Lulu's birthday cake. 25- T1: Lulu's Birthday cake. 26- The girls return the materials to their boxes because the free-time period is finished.	Sara **accepts** a birthday cake by telling T1 about it (line 22).

Appendix 7-12

Data	Analysis
Week-20-Mon-Episode-80 1-Sara brings the TB3 to the MC and Lulu sits next to her. 2-Sara establishes her solution a hexagon shape with six small QTs. 	Sara is **constructing** this opportunity to play with the TB3 (line 1). She copies the Montessori solution with QT by making a hexagonal shape (line 2).
3- She adds a small space ship to her shape. 4- Lulu brings a TB2 and mixes it with TB3. 5-Sara takes the spaceman and wants to stand him on the ground but it keeps falling over, so Lulu gives her the lid of triangle box2 to stand him on. 6- The girls then put some spaceship accessories on to the lid, then Lulu leaves.	Sara **develop** the solution by using the spaceman (line 5)
7- Sara returns the ship to its box and looks at the IOT and the spaceship. 8- R: You have a spaceship and these triangles, what do you want to do? 9- Sara: A spaceship. 10- R: A spaceship, how can we make it with these triangles? Which one of these triangles can we start with?	Sara returns the triangles, which means that she not satisfied with the pattern (line 7)
11- Sara: I don't know. 12- R: How about this one (I point to the big yellow triangle). 13- Sara: I want to make a big rocket. 14- R: We can make a big rocket too. 15-I take two red IOTs and re-position	Sara **generates** tow ideas by saying a spaceship and rocket ideas (lines 9-13). Sara decides to generate a rocket idea and apply it by action using the

them but Sara puts them underneath the yellow IOT. 	TB. I **develop** the rocket solution by two IOTs but Sara puts them underneath each other (line 15).
16- Sara puts a grey QT between the red and yellow IOT. 17- Sara mixes the triangles. 18- Sara puts two red IOTs one under the other, then she adds more yellow IOTs to her shape. 	Sara **develops** the solution by adding grey QT (line 16). She **develops** her solution by adding more yellow IOTs (line 18).
19-Aziz asks Sara to play with her and he puts the big yellow one on top. 20- Sara adds more IOTs to the shape then she removes the big yellow QT and I suggest to leave it to develop their solution: R: how about if we leave it for now, and we will see what happen next . 21- Aziz returns the yellow QT to be the head of their rocket.	Aziz plays collaboratively with Sara and **develops** the solution by adding the yellow QTs at the top (line 19). Sara also **develops** the solution by adding more IOTs and removing the QT (line 20) but then Aziz returns it (line 21).

 22- R: Now we have a head (points to the big yellow) and body (points to the IOTs). 23- Sara puts another big yellow triangle at the end: 24- Sara: This is the tail. 25- R: You can use more red IOTs to improve your rocket tail. 26- Sara: Like a fire. 27- Aziz: Yes, like a fire. 28- R: Like a flame.	Sara **develops** the solution by adding the second yellow QT and two red IOTs (line 23).
29-Sara and Aziz search for more red Its. 30- Sara stands up to look at her rocket and so does Aziz.	Sara and Aziz **develop** their solution by adding more IOTs (line 29). Sara **accepts** the building by looking at it and does not change anything (line 30).
 31- Aziz adds grey IOTs to the head of their rocket and Sara tells her friends to look at her rocket.	Aziz **develops** their solution by adding grey IOT (line 31).

<table>
<tr>
<td>
32-Sara adds small plastic (spaceship) accessories on top of the IOTs.

33- Sara starts playing with her rocket and soon T1 asks her to clean up.
</td>
<td>Sara develops her solution by adding spaceship accessories (line 32).</td>
</tr>
</table>

The Story of Soso

Appendix 7-13

DATA	*ANALYSIS*
Week-5-Mon-Episode-19 1- Soso chooses to play with Col3. 2- Soso takes out the seven yellow colour tablets at once. 3- Soso begins by standing two tablets horizontally next to each other. 4- Soso stands a third and a fourth yellow tablet horizontally next to the second tablet.  5- Soso takes another two yellow tablets and puts them next to each other. 6- Soso looks at the tablets, then takes the last two tablets and puts one perpendicular and places it with the horizontal tablet. 	Soso **constructs** this opportunity to play with the Col3 (line 1). She starts with the yellow tablets and puts them next to each other (line 2). Soso **frames** the problem by standing two more yellow tablets next to the second tablet which is different from the Montessori to **generate an idea** (line 4). She also **explores** anew position for the Col. Soso **develops** her solution by putting two tablets next to each other (line 5). She indicates that she **develops** her solution by changing the tablets position which is the first times does that by adding one perpendicular tablet next to the horizontal one (line 6).

<table>
<tr><td>7- Soso adds the third yellow tablet perpendicular and parallel with the previous one.</td><td>Soso develops her solution by adding the third tablet perpendicular (line 7).</td></tr>
<tr><td>8- Soso tries to add the fourth yellow tablet horizontally on top of the two perpendicular tablets but she cannot.
</td><td>Soso wants to develop the solution further by adding the fourth yellow tablets horizontally between the last two perpendicular tablets, but she cannot, because the space between these wider than the yellow tablet (line 8).</td></tr>
<tr><td>9- Soso holds the three yellow tablets in her hands and looks at them.
</td><td>By holding the tablets by her hand, Soso wants to start over again (line 9).</td></tr>
<tr><td>10- Soso places one tablet vertically and adds another one horizontally next to it.</td><td>Soso regenerates the same idea by putting two tablets next to each other, one vertically and the second one horizontally (line 10).</td></tr>
</table>

 11- Soso adds another perpendicular tablet and holds the three yellow tablets again in her hand. 12- Soso starts again by holding two yellow perpendicular tablets and putting them close together.	Soso wants to **develop** the solution by putting two perpendicular tablets close to each other (line 12).
 13- In this way, Soso adds the third yellow tablet on top of the two perpendicular yellow tablets.	Soso **explores** the method of holding one horizontal tablet on top of two perpendicular tablets (line13).
 14- Soso says to her friend: look, a table.	Soso **accepts** the table building by telling her friend (line14).

 15- Soso mixes the tablets and directly puts one horizontal tablet with one vertical tablet next to his previous solution and looks at them.	Soso starts again by mixing the tablets and **frames** the problem by taking two tablets with two different dimensions different from matching the colour tablets to **generate** another idea (line 15).
 16- Soso claps to herself and says: pillow.	She **accepts** the pillow building by talking to herself (line 16).
 17- Soso takes out all the green tablets from the box. 18- Soso stands one green tablet vertically and stands another one horizontally.	Soso **frames** the problem by taking out the green tablets from by putting one of them vertically to **generate** an idea (line 17-18) She **develops** the solution by standing another green tablets in horizontal positions (line 18).

 19- Soso takes these two tablets down and stands them horizontally next to each other and lays one more on the table.	Soso **develops** the solution by taking down the two tablets and standing them horizontally next to each other (lines 19-20).
 20- Soso adds two green tablets in front on them.	
 21- T2: What did you do, Soso? 22- Soso: A table and a sofa. 23- T2: A table and a couch by these tablet, show me what else you can	Soso **develops** her solution by adding two green tablets (line 20).

do? 24- Soso stands two horizontal green tablets facing each other.  25- Soso stands two more green tablets horizontally and makes a square with them.  28- Soso claps to her self :Square then returns the tablets to the box.	Soso **accepts** a table and sofa building with the last four green tablets by answering T2 (line 22). Soso **develop**s the solution by putting two tablets parallel horizontally (line 24). Soso **develops** the solution by adding two more tablets and makes a square shape (line 25). She accepts the squire shape which is basic mathematic shape.

Appendix 7-14

<table>
<tr><th>DATA</th><th>ANALYSIS</th></tr>
<tr><td>Week-Sat-12-Episode-45
1-Soso brings the TB2 to the table.
2-Soso takes out the triangles and makes a rhombus shape using one yellow and one grey IOT.
3- Soso adds one more grey IOT to her shape then asks Lelee to give her one small red QT to finish.

4-Soso adds the red QT and makes an envelope shape.


5- T2: Soso, what is this?
6- Soso: It is for mail
7- T2: an envelop
8- Soso: yep.

9- Soso develops her previous shape by adding yellow right angle triangle (RAT).</td><td>Soso constructing this opportunity by playing with the TB2 (line 1).
Soso copies the Montessori solution using two IOT (line 2) by siding them with hypotenuse.

Soso frames the problem by asking her friend to give her QT to add it to the pattern which is different from Montessori to generate an idea (line 3).

She develops the solution by adding QT (line 4)

Soso accepts her building by telling T2 (line 6).

Soso develops the solution by adding RAT to her shape (line 9).</td></tr>
</table>

<table>
<tr><td>
10- Soso reposition the QT by taking out the red QT from her left side and put it to right side and adds grey QT to left side.</td><td>She frames the problem by reposition the QTs to generate an idea (lines 10).</td></tr>
<tr><td>
11- She adds three small QTs to make a diamond shape.</td><td>She develops her solution by adding three QTs (line 11).</td></tr>
<tr><td>
11- Soso positions a green QT vertically and wants to include it in her shape, then adds another green QT and stand it up like the previous triangles, but it keeps falling down, then she swatches it with big yellow QT.</td><td>Soso explores the holding position and tries to develop the solution (line 11).</td></tr>
</table>

 12-Soso takes out the green QT and yellow QT then she returns two Qt to her shape.	Soso **develops** her solution by taking out the two QTs (line 12).
 13- Soso takes the two QTs out off her shape then she calls her teacher.  14- Soso: Teacher2 come and see what I have done. 15- T2: What did you do? 16- Soso: A spider web 17- T2: A spider web. What else you can do with these triangles?.	Soso **develops** her solution by taking out the two QT (line 13) and **accepts** a spider web by telling her T2 (line 16).

18- Soso mixes the triangles and gathers two QT head to head.  19- Soso adds the third QT in between the two QT. 20- Soso gathers two IOTs at their hypotenuse and makes a rhombus shape.  21- She shouts that she has finished 22- R: What did you do? 23- Soso: A flower. 24- Soso mixes the triangles, establishes a structure with the big yellow triangle and puts the long side of one red IOT with the big yellow Qt and connect short side of the second IOT with another side of the QT. 25- She adds green QT to her shape.	By mixing the triangles, Soso **framing** the problem by gathering two QT by head which is different position from Montessori to **generate** an idea (line 18). Soso **develops** her solution by adding one more QT (line 19). Soso **develops** her solution by making rhombus shape and adds to her pattern (line 20). She **accepts** her building by telling me 'flower' (line 23). Soso establishing with big yellow QT in new solution (line 24). She **develops** her solution by adding the first red IOT at one side. She **framed** the problem by adding the second IOT in different position she indicates that she **generates** an idea (lines 24-25).

 26- Then she adds one more big yellow QT and one green QT puts it in the opposite side from the first QT.	She **develops** her solution by adding big yellow QT and green QT (line 26).
 27- Soso adds two more IOT for the two side of the second yellow QT.	Soso **develops** her solution by adding two IOT (line 27) and **accepts** the blanket building by telling me (line 30).
 28- Soso: Teacher Raja, I finished. 29- R: what did you do? 30- Soso: A blanket. 31- Soso mixes the shape and takes two IOTs puts them head to head. 32- Teacher Raja: see this is a bandanna. 33- R: A bandanna by two triangles, what else you can make?.	She **frames** the problem by mixing the shape and **generates** another idea by gather two IOT by head (line 31) and **accepts** it by telling me (line 32)

 34- Soso picks up the triangles and returns them to the box.	

Appendix 7-15

DATA	***ANALYSIS***
Week-15-Sat-Episode- 59 1- Soso brings the red cylinder (RC) box and the yellow cylinder box (YC) to the table-toy area. 	Soso **constructs the opportunity** by choosing the RC and YC to play with (line 1).
2- Soso starts by taking out RC10-9 and puts them on top of each other. 3- Soso takes out the YC10 and takes out the RC8. 4- Soso puts the red cylinders on top of each other until she reaches RC3 and compares it with RC2, then adds it to the tower. 	Soso **copies** the Montessori solution by putting the cylinders on top of each other (line 2). Soso **develops** the solution by building a red tower (line 4). She **explores** which of RC2 or RC3 has a larger diameter by comparing them (line 4).
5- Soso finishes the red tower by placing RC1 and looks at it. 6- Soso takes down the red tower and puts RC10 on top of YC10.	Soso **accepts** her building by looking at it (line 5) then takes it down. Soso starts solution by putting the RC on top of the YC to one of the Montessori solution (line 6).

 7- Soso takes out the YC and Compares it with the RC to decide which one has the largest diameter in order to put one on top of the other in a more stable way.	Soso **develops** the solution by comparing the YCs with the RC to decide which one she wants to choose to put them on top of each others (line 7).
 8- Soso adds the YC9 and RC9 on top of the previous cylinders and keeps adding YCs-RCs to the building.	Soso **develops** the solution by adding YCs-RCs in the same order to the previous cylinders. (line 8).
 9- Soso knocks the building down accidentally with her shoulder.	

<table>
<tr><td>10- Soso puts the RC and YC next to each other.
</td><td>Soso frames the problem by putting the cylinders next to each other to generate an idea (line 10).</td></tr>
<tr><td>11- Soso adds the rest of the RC and YCs but not in order, and makes a circle with them.
</td><td>Soso develops the solution by adding two RCs then one YC next to each other and making a circle with them (line 11).</td></tr>
<tr><td>12- Soso adds one RC to the middle and tells me:
13- Soso: Look, a cake.
14- R: A cake made with red and yellow cylinders.
15- Soso: And this is the candle (points to the middle RC).
</td><td>Soso develops the solution by adding one more RC to the middle, accepts it by telling me (line 13).</td></tr>
<tr><td>16- Soso tries to add the YC1 on top of the RC, but then she mixes up the</td><td>Soso frames the problem by putting the RCs next to each other and mixes</td></tr>
</table>

pieces and puts the big red cylinders next to each other with the YC.  17- Soso adds more cylinders and makes a vertical line.  18- Soso makes another line and adds one YC1 and one RC1 in the middle.  19- Soso changes the places of the RC1-YC1 and adds YC2-3 in the middle and puts the RC1 horizontally also in the middle.	it with YC to generate an idea (line 16). Soso **develops the solution** when she adds more cylinders vertically with the previous cylinders (line 17). Soso **develops** the solution by adding more cylinders and gives detail to her solution by adding RC1-YC1 in the middle (lines 18-19).

 20- Soso brings the BC and adds cylinders to close the shape.  21- Soso asks T2 to come and see her pattern: 22- Soso: Look what I have done? 23- T2: What is this? 24- Soso: A face. This these are the eyes and nose and the mouth. 25- T2: You made a face with the cylinders, ok, what else can you do? 26- Soso plays with the face dramatically and then returns the cylinders to the boxes. 	Soso **develops** her solution by adding a BC to her pattern (line 20). Soso **accepts** a face idea by telling her teacher (line 24).

Appendix 7-16

Data	**Analysis**
W19- Tuesday- Epsidoe-78-TB2-TB3 1- Soso brings the TB3, takes out two green, red and grey QTs, putting them next to each other. 2- She adds more QTs, to make a hexagonal shape.	Soso is **constructing** this opportunity by choosing to play with TB2 (line 1). She copies the Montessori solution by putting two QTs next to each other and making hexagonal shape (line 2).
 3- Soso adds two more QT triangles and makes a diamond shape.	She **frames** the problem an idea by adding two QTs which is different from Montessori to **generate** an idea (line 3).
	
4- Soso says loudly: Candy. 5-Soso adds two yellow circular blocks as eyes to her shape. 6- Soso takes the RR1 and puts it horizontally on top of the hexagon shape and takes out the last two QTs. 7- Soso is talking to Deema: This is my face. 8- Soso makes a rhombus shape with	She **accepts** the candy building by saying it out lout(line 4). Soso **develops** her solution by adding the eyes and mouth and taking out the last QTs (lines 5-6). Soso **accepts** the face building by telling her friend (line 7).

two IOTs and adds it vertically to the shape. 9- Deema adds one more but Soso reorganises Deema's triangle Soso: not like this…like this, then Deema gives Soso one more yellow IOT.	Soso **frames** the problem by adding two IOTs vertically to her shape which indicates that she is **generating** an idea (line 8). Soso **develops** the solution by adding two more IOT horizontally to her shape (line 9).
10- Soso quickly takes two small red QT and put them down in the shape.	Soso **develops** the solution by adding two QTs (line 10).
	
11- Soso: Duck, quack …quack 12- They go to teacher2 and tell her that they have made a duck. 13- Deema gathers the yellow IOT and they establish another solution next to the duck shape. 14- Soso joins the triangles along their hypotenuse and makes a rhombus and Deema makes a second rhombus. 15- Soso adds one more IOT on top of each rhombus.	Soso **accepts** the duck building by saying it out loudly and tells T2 about it (lines 11-12). Soso and Deema **copies the Montessori solution** by gathering the IOTs (line 13). Soso **framed the problem** by adding an IOT to **generate** an idea (line 15).
	
16- Soso: A mountain. 17- Deema: Two mountains	Soso **accepts** the building by saying Mountain (line 16).