PRE-SCHOOL CHILDREN’S PERFORMANCE IN PREDICTION AND HYPOTHESIZING: A STUDY OF ISINYA AND NGONG DIVISIONS OF KAJIADO DISTRICT, KENYA.

By
Githinji, Alice W.

A THESIS SUBMITTED FOR THE AWARD OF THE DEGREE OF MASTER OF EDUCATION (EARLY CHILDHOOD STUDIES), KENYATTA UNIVERSITY

2007
DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

GITHINJI, ALICE W. Date

We confirm that the work reported within this thesis was carried out by the candidate under our supervision as university supervisors

DR. BARBARA G. KOECH Date
Senior Lecturer
Department of Early Childhood Studies

DR. JOHN N. MAUNDU Date
Senior Lecturer
Department of Educational Communication and Technology
DEDICATION

This thesis is dedicated to my dear mother Ruth.
ACKNOWLEDGEMENTS

First is to thank the Almighty God for His gift of life and health and for making it possible for me to pursue my studies to completion. All honour and glory be to Him.

I owe very special thanks to my two supervisors, Dr Barbara Koech and Dr John Maundu, for their extraordinary patience and understanding that helped produce this thesis. They painstakingly encouraged me when I felt defeated. They sacrificed their valuable time and resources to see me through this thesis. It is my prayer that our Almighty God blesses each one of them abundantly.

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genuine concern over my success kept me going especially when things felt difficult.

May our Almighty God bless each one of them abundantly.

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I may not manage to thank all those who contributed either directly or indirectly to the success of this work. It is my prayer that God rewards each one of them in a special way.
ABSTRACT

The performance in science subjects at all levels of education in Kenya has been consistently poor over the years. Kenya National Examination Council (KNEC) reports of 2002/2004 indicated that performance was better placed on questions testing for recall of knowledge and relatively poor on questions testing process skills. These reports suggested that learners were not well prepared in science process skills. Studies carried out in Kenya in the area of science process skills had focused on higher levels of education. Little was known, therefore, about the competence of young children in science process skills yet the poor performance in science in national examinations could have been due to lack of a firm foundation in science at the pre-school level. This study was designed to investigate the competence of five-year old Kenyan pre-school children in science process skills. Since five-year-olds are in transition into primary school, the education they get should provide a firm foundation for later learning. For purposes of this study, the skills of prediction and hypothesizing were purposively selected to represent other process skills. The two are important skills that promote reasoning. More specifically, the research sought to determine whether the geographical location of a pre-school child is related to his/her performance in the skills of prediction and hypothesizing and whether the gender of a pre-school child is related to his/her performance in the skills of prediction and hypothesizing. The study also sought to determine if any relationship existed between the performances of pre-school children in the skill of prediction and that of hypothesizing. The theoretical framework underpinning the study was based on Piaget’s theory of cognitive development. The study used a quasi-experimental design in a naturalistic setting. The independent variable was the geographical location of the pre-school while the dependent variable was the scores obtained by the child in the process tests. Ngong and Isinya divisions of Kajiado District were purposively selected on basis of accessibility. Isinya division was categorised as a rural region while Ngong division was categorised as peri-urban region. From each of these divisions, five pre-schools were selected on basis of accessibility. Two boys and two girls, all five year-olds, were randomly selected from each of these pre-schools. As a result, a total of 20 girls and 20 boys were assessed on their performance in prediction and hypothesizing skills using the Piagetian sinking and floating experiment. Responses were recorded on a questionnaire. The data obtained was descriptively and inferentially analysed using the Statistical Package for Social Scientists (SPSS). Eleven hypotheses were tested at a significant alpha (a) level of 0.05. Eight of these were tested using the t-test for independent samples while three were tested using Pearson’s Product Moment Correlation. The findings of this study suggest that five-year old pre-school children had basic prediction and hypothesizing skills. However, pre-school children were more advanced in the skill of prediction than in
the skill of hypothesizing. The study findings also indicated significant gender and geographical differences in performances in prediction with pre-school girls outperforming pre-school boys and with rural pre-school boys outperforming the peri-urban pre-school boys in the skill respectively. No significant gender or geographical differences were observed in performance in hypothesizing. This study had recommendations for policy makers, curriculum developers and teacher trainers. The study also recommended that both parents and pre-school teachers involve boys and girls in similar experiences, expose them to different regions and also introduce them to English language as early in life as possible. Recommendations for further research focused on the need to consider other geographical regions, other levels of education, other science process skills and other variables that may influence performance in science at pre-school level.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>APU</td>
<td>Assessment of Performance Unit</td>
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<tr>
<td>ASAL</td>
<td>Arid and Semi-Arid Lands</td>
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<td>ECD</td>
<td>Early Childhood Development</td>
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<td>ECE</td>
<td>Early Childhood Education</td>
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<tr>
<td>GOK</td>
<td>Government of Kenya</td>
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<td>KAPC</td>
<td>Kenya Association of Professional Counsellors</td>
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<tr>
<td>KCPE</td>
<td>Kenya Certificate of Primary Education</td>
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<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
</tr>
<tr>
<td>KIE</td>
<td>Kenya Institute of Education</td>
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<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
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<tr>
<td>MOE</td>
<td>Ministry of Education</td>
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<tr>
<td>NACECE</td>
<td>National Centre for Early Childhood Education</td>
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<tr>
<td>PTAs</td>
<td>Parents/Teachers Association(s)</td>
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<tr>
<td>PU</td>
<td>Peri-urban</td>
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<tr>
<td>R</td>
<td>Rural</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for Social Scientists</td>
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DEFINITION OF TERMS

Prediction: Guessing in advance whether an object would float or sink when placed in water.

Justification: Giving a reason to support the prediction made on whether an object would float or sink when placed in water.

Hypothesizing: Giving an explanation as to why an object floated or sank in water.

Pre-school child: A child aged 5 years and who was receiving formal education in an ECD institution.

Rural pre-school child: A pre-school child who was attending an ECD institution in Isinya Division of Kajiado District.

Peri-urban Pre-school Child: A pre-school child who was attending an ECD institution in Ngong Division of Kajiado District.

Performance: Scores for correct and partially correct answers obtained in the
prediction and/or hypothesizing tests.
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CHAPTER ONE
INTRODUCTION

1.0 Introduction

Chapter 1 discusses the background to this study leading to the statement of the problem on performance in science process skills in science at pre-school level - the setting for this research. The purpose, objectives, research hypotheses, conceptual framework, significance, assumptions, scope and delimitations of the study are then discussed. The chapter ends with the definition of terms that were used in the study.

1.1 Background to the Study

Over the years, it has become increasingly clear that a science and technology-driven economy is the way forward to national development. It is also generally accepted that the developed nations of the world are readily distinguished from the developing or underdeveloped nations by their higher level of scientific and technological development (Odhiambo and Isoun 1989). Indeed, in this time of rapid scientific and technological change, virtually every dimension of our lives; the environment, waste management, consumer products, health, employment and so on is affected by science and technology (Czerniak, 1996). It is, thus, imperative that developing countries forge ahead in the use of science and technology in order to modernise their economies and compete successfully with developed countries.
As a developing country, Kenya fully recognises the vital role of science and technology in national development. In this regard, the Government of Kenya has shown its commitment to the establishment of science and technology as a basis for national development. Consequently, the Government has rapidly expanded the nation’s capacity for higher education at universities, and, re-focused pre-university education system to give more emphasis to technological self-reliance (Ndoto, 1989). The Government has also considered it important to include science education at all levels of its education system, ECE level included. This importance was emphasized by the Koech Report (1999) which observed science to be a vital requirement for industrialisation, and, thus recommended that “children be exposed to science concepts from an early age” amongst other recommendations. Further, the broad and practical oriented 8-4-4 curriculum had implications on the sciences to be taught in schools (Mackay Report, 1981). The curriculum emphasized, inter alia, active learners’ participation as they interact with their immediate environment.

Despite these efforts, the performance in science subjects at all levels of education in Kenya remained consistently poor over the years (KNEC, 2000/2001; 2002; 2003; 2004) an issue that threatened the attainment of the national goal of being industrialised by the year 2020. The Kenya National Examination Council (KNEC) reports of 2000/2001 indicated that performance
was better placed on questions testing recall of knowledge and relatively poor on questions testing science process skills. These reports suggested that learners were not well prepared in science process skills. There was need to verify this empirically.

While technology “applies knowledge and skills to create processes and products that meet human needs” (Jarvis, 1993: p 9), science helps learners “develop attitudes, skills and knowledge that will help them to be comfortable and successful in the science and technology society” (Czerniak, 1996: p 96). Thus, science is a pre-requisite for science and technology literacy, and, science education is undoubtedly the *sine qua non* means for materializing this perspective. Citizens must then acquire science education in order to become literate in the scientific and technological world. Such literacy will not only make them capable of understanding scientific and technological issues, but it will also empower them to make informed and responsible decisions, as well as enable them to act on these decisions (Pedretti, 1996). Indeed, if citizens are to function effectively in science and if they are to become contributing members of the society, they must become competent in both content and process skills that are complementary to each other in science. Recognising the vital role of science education in its totality, this study intended to find, albeit in a small way, how well children in ECE were able to perform scientifically through prediction and hypothesizing, both of which are important science
Competence in science requires a firm base and this base needs to be formed as early in life as possible. According to Piaget (1964), learning is developmental with knowledge being accumulated in an orderly, sequential and hierarchical manner. This developmental process requires the formation of lower-order schemata on which more advanced work can be built in later years. In Kenya, consistent poor performance in science at higher levels of education could have been as a result of a poor foundation in science during the Early Childhood Education (ECE) years. However, this had not been empirically established. There was a need, therefore, to focus research to the area of ECE.

The experiences of a child in transition into primary school level – ages five through eight – are critical if what is to be learned is to be sustained and if the child is to do well in school in later life (Evans, Myers and Ilfield, 2000). If a child leaves this pre-school stage without proper development, he/she cannot really understand much of schoolwork and will resort to memorising and parrot-like learning (Sharp, 1970). It is important, therefore, that children in this age group acquire basic scientific literacy if they are to perform well in higher academic levels. Whether or not this was happening with Kenyan children was not clear. The situation needed to be established.

Processes of science are the skills by which observations are acquired, and
meaning is constructed by the learner (Martin, Sexton, Wagner and Gerlovich, 1997). They are the basis on which knowledge is constructed. Examples of such processes are: observing, classifying, asking questions, hypothesizing, controlling variables, constructing, data recording and interpreting, making inferences, communicating, predicting, estimating and measuring, among others (Maundu, 1995). Science process skills are vital for learning and everyday living. Many of these processes are the same that young children use when they act on the physical world, discovering attributes, organising schema and representing the world. In recognition of this, the official curriculum for ECE - the Guidelines for Early Childhood Development in Kenya - had emphasised the need for children to develop science process skills. One of the objectives in the Guidelines stipulated that, “science should enable children to observe, hypothesize and develop problem solving skills” (NACECE/KIE, 1997; p 36). It was expected, therefore, that children at ECE level in Kenya would have acquired the stipulated science process skills, among others, before they progressed to the primary school level. This study sought to establish whether this was happening by focusing on the skills of prediction and hypothesizing. The two skills are some of the important skills that promote reasoning.

Studies conducted in older children had shown weak performances in process skills (Thiel and George, 1976; APU, 1983; 1985; 1986; Otieno-Alego, 1987).
They had also shown gender and regional influences in performance in science process skills. Performance in science process skills, as well as the gender and regional influences, if any, in pre-school children in the Kenyan context was not documented. Lack of documentation suggested lack of research in the area of science process skills at ECE level; yet the solutions to the problems of science education could well have been lying at this level. There was need for research at ECE level with the aim of determining the competence of pre-school children in science process skills.

1.2 Statement of the Problem

Poor performance in science subjects at the national examinations level indicated that science education in Kenya was not achieving the intended aim. According to KNEC reports (2000/2001; 2003) performance in science subjects was especially poor in questions that tested process skills. This suggested that learners were not well prepared in the science process skills yet these are important in helping learners construct knowledge as well as solve problems of learning and life.

Research in child development had demonstrated that experiences gained in the early childhood stage influenced performance in cognitive and social skills at higher levels of education (Evans, Myers and Ilfield, 2000). Other studies had also indicated that elementary school children, if taught process skills abilities,
not only learnt to use those processes, but also retained them for future use
(Wideen, 1975; McCathery, 1970; Quinn and George 1975; Wright, 1981).
This meant that poor performance in process skills in science at higher levels
of education could have been as a result of poor development of science
process skills at ECE level. According to the guidelines given for early
childhood development in Kenya (NACECE/KIE, 1997), pre-school children
ought to have learned process skills in science, including prediction and
hypothesizing both of which are necessary for better decision-making and
problem solving. It would have been expected, therefore, that, pre-school
children would have developed these skills if proper learning had taken place.

By the time of this study, many researches with young children had been
carried out all over the world (Almy, Chittenden & Miller, 1966; Sime 1973;
Njubi; 1993). Several of these studies were carried out using the Piagetian
tasks (Almy, Chittenden & Miller, 1966; Sime 1973; Kiminyo, 1973; Thiel and
George, 1976; Njubi; 1993). Majority of these studies had largely focussed on
primary and secondary school children and only a few of them had focused on
science process skills (Thiel and George, 1976; APU, 1981; Otieno-Alego,
1987). The author was not aware of any study that had focused directly on
development of science process skills in pre-school children in Kenya.
The studies focusing on science process skills had shown a weak performance in the skills. The studies had also indicated gender and regional differences in performance in these skills. An important concern was whether or not pre-school children in Kenya were developing science process skills and whether or not there existed regional or gender differences in the children’s performance in these skills. This study was undertaken to deal with this concern and to fill the existing knowledge gap.

1.3 Purpose of the Study

The purposes of this study were to assess the competence of Kenyan pre-school children in two science process skills - prediction and hypothesizing - and to determine if gender and geographical location are related to performance in the process skills. The study would also find out whether there was any relationship between performances in the two science process skills investigated.

1.4 Objectives of the Study

The study sought to achieve the following objectives:

1. To assess the performance of five-year old pre-school children in the prediction and hypothesizing skills in science.
2. To find out whether there were any gender differences in performance in the skills.

3. To find out whether there were any differences in performances between rural and peri-urban pre-school children.

4. To determine whether there was any relationship between pre-school children’s performances in prediction and hypothesizing skills.

1.5 Research Hypotheses

The research hypotheses for the study were as follows:

1. Gender differences result in significant differences in performance in pre-school children’s prediction and hypothesizing skills.

2. Differences in geographical locations result in significant differences in performance in pre-school children’s prediction and hypothesizing skills.

3. Performances of pre-school children in the skill of prediction are not significantly related to their performances in the skill of hypothesizing.
Cognitive development is a cumulative process whose hierarchical nature requires the formation of lower-order schemata on which more advanced work can be built in later years. In relation to this, pre-operational stage (2-7 years) is considered to be the most important in laying a foundation for later learning (Evans, Myers & Ilfield; 2000). The experiences of a child in this stage are critical if what is to be learned is to be sustained and if the child is to do well in school in later life. This study proposed that consistent poor performance in science at primary and secondary levels could have been as a result of a poor foundation during the early years of learning and in particular during the pre-operational stage.

Piaget outlined four interrelated factors that influence the course of cognitive development from one stage to another. These factors are: maturation, experience, equilibration and social interaction (Piaget & Inhelder, 1941). Piaget views each of the above factors and their interactions as necessary conditions for cognitive development but, none of them, by themselves, is seen as sufficient to ensure cognitive development. In relation to this study, the development of the skills of prediction and hypothesizing would, as in any other cognitive development, depend on the four factors.

Studies seeking to identify the determinants of achievement in science had
come up with different factors. Schiefelbin and Simmons (1981), Eshiwani (1982) and Twoli (1985), for example, identified three policy-related factors that may affect general academic performance at all educational levels. These factors are related to: school resources and processes, the teacher characteristics and students’ traits or characteristics such as age and sex. Other studies had considered gender as playing an important role in determining students’ interest and performance (Comber and Keeves, 1973; Erickson and Erickson 1984; Jones, Mullis, Raizen, Weiss and Weston, 1992; Ogonda, 1991; Twoli, 1986) while others had identified geographical location as another important factor in determining achievement (Harlen, 1995; Kahle, 1990; Kodero, 1985; Ogonda, 1991). Prior experience had also been identified as an important factor in learning and consequent achievement (Yager, 1991; Harlen, 1992; Peterson & Knapp, 1993). This study focused on the child’s gender, geographical location of the pre-school and the child’s prior experience as among important factors affecting performance in science at ECE level. They were, therefore, adopted for this study.

A synthesis of the above literature generates the following interrelationship. The course of a child’s development of science process skills is influenced by maturation, experience, equilibration and social interaction. These factors are in turn influenced by the school, teacher and parent’s characteristics. An interaction of all these factors should determine whether a pre-school child
would develop science process skills or not. Proper development of these skills should then act as a strong foundation that could be built on in subsequent levels, and, as a result, improve children’s performance in science in national examinations. In view of this relationship, the following conceptual framework was developed for this study.
Figure 1.1: Children's performance in Selected Science Process Skills in Relation to Age, Gender and Geographical Location

Children's performance in science at primary and secondary level
- Scientific knowledge
- Science process skills: Prediction and Hypothesizing

Science knowledge and skills accumulated by children during early stages of cognitive development:
- Sensorimotor stage (0-2yrs)
- Preoperational stage (2-7yrs)
- Concrete operational stage (7-11yrs)
- Formal operation stage (11-14yrs)

Maturation:
- Brain/Nervous system

Experience:
- Physical/Logico-mathematical
- Hands on exposure
- Age
- Gender

Equilibration

Social transmission
- Parents
- Teachers
- Peers
- Other persons

Parent's characteristics
- Age
- Gender
- Level of education

Teacher characteristics
- Certification
- Experience
- Competence in handling science subjects

School characteristics
- Geographical location-rural/peri-urban
- Administration
- Resources and facilities
- Class size

Key:
- Factors considered for the study
- Factors not studied
1.7 Significance of the Study

This study is significant in the field of education and especially at the ECD level. Educational policy makers could take into consideration the findings and recommendations of this study when formulating policies on science for pre-school children.

Results of this study could also enlighten curriculum developers on whether pre-school children were developing science process skills. The curriculum developers could then take into consideration the recommendations of the study when determining the content as well as developing materials and writing books for pre-school science education.

Results of the study could also inform pre-school teacher trainers on whether pre-school teachers were well prepared to effectively teach science process skills at pre-school level. The trainers could then adjust their training accordingly with a view to appropriately preparing pre-school teachers.

Pre-school teachers could replicate the methodology used in the study to find out whether the children in their classes were developing science process skills. They could also use the findings of this study to improve on the curriculum delivery.
Findings of this study could also advise parents of pre-school children of what they may do to enhance their children’s development of science process skills.

Lastly, the research findings could contribute to the literature on performance in science process skills at ECE level. It could also serve as an impetus for further research on science process skills at ECE level.

1.8 Assumptions

This study was based on the assumption that all pre-schools selected were following the guidelines designed for ECE in Kenya in planning for teaching (NACECE/KIE, 1997). As a result, it was assumed that the pre-school children had been exposed to various science activities that were outlined in the guidelines and in particular to the floating and sinking activities that were used in this study. It was also assumed that all pre-school children selected had some ability in prediction and hypothesizing.

1.9 Scope and Delimitations of the Study

The study had the following de-limitations:

1. Only two divisions of Kajiado District were considered for the study. These were purposively selected based on accessibility. Though other divisions were equally important, it was not possible to cover all of them due to poor
communication infrastructure as well as financial and time constraints. Future studies could focus on these divisions.

2. Pre-schools for the study were purposively selected based on accessibility and representation. Random selection of pre-schools may have been a preferred design. This was not possible in this study due to a poor communication infrastructure in Kajiado District and also due to lack of means of transport.

3. The study considered only two independent variables: gender and geographical location. Other variables that could influence science performance were not considered for this study, but could be considered in other studies in the future.

4. Only two process skills of prediction and hypothesizing were considered for this study. Other process skills are important but the researcher focused, with modification, on the skills that Piaget used in his studies with pre-school children. The rest of the process skills could form the subject for investigation in other studies.

1.10 Summary

Chapter one gives an introduction to the study. It starts with the background to
the study and summarizes the importance of science education and the efforts
the Kenyan government has made to ensure that its citizens acquire science
literacy. The chapter continues to highlight the poor performance in science
education in national examinations in Kenya, and, in particular in the area of
science process skills. This is despite the efforts made. The chapter then
presents the conceptual framework that was used for this study. The chapter
also summarizes the importance of science process skills and the studies
carried out related to science process skills.

The chapter further discusses the statement of the problem proposing that the
poor performance in science in national examinations was as a result of a faulty
foundation at ECE level. The chapter then presents the purposes of the study
and identifies them as to assess the competence of Kenyan pre-school children
in the skills of prediction and hypothesizing, and, to determine if gender and
geographical region are related to performance in these process skills. The
objectives of the study, the research hypotheses and conceptual framework are
then discussed. Other sections relevant to the chapter are finally discussed.
Chapter two presents a detailed review of the literature relevant to this study.
CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

This chapter discusses the literature reviewed for this study. It starts by giving an overview of the theoretical framework on which the study was based. Piaget's theory of cognitive development and the related literature are then presented. The chapter then discusses the sinking and floating experiment as used by Piaget and also presents studies carried out based on Piaget's theory. Factors affecting performance in science are later discussed. The chapter then discusses the importance of science process skills, and, in particular, prediction and hypothesizing. The chapter ends by discussing some studies carried out on science process skills.

2.1 Theoretical Framework: An Overview

This study adapted Jean Piaget's theory of intellectual development (Piaget, 1964). The theory deals exclusively with cognitive development beginning with the primitive reflexes and motor coordination of infancy and extending to the thinking and problem solving abilities of adolescents and adults. The theory also stresses scientific and mathematical abilities including abstract and logical reasoning, generation of hypotheses, and organizing mental activities into more complex structures.
In Piaget's theory, knowledge accumulates in an orderly, sequential and hierarchical manner (Mussen, Conger, Kagan and Huston, 1984; Driver, 1983). Thus, consistent with this theory, children should form and master lower order science process skills before being introduced to higher order ones. This study proposed, therefore, that the poor performance in science recorded in higher levels of education was due to a faulty or insecure foundation at the pre-school level.

2.2 Piaget's Theory of Cognitive Development

Cognitive development is defined as that aspect of development that deals with thinking, problem solving, intelligence and language (Black and Pucket, 1996). Piaget conceptualized a stage theory of cognitive development and specifically on how children develop knowledge. According to Piaget, children develop intellectually in a sequence of stages by age from infancy to post-adolescence. This cognitive development will follow predictable and qualitatively distinct levels or stages that will occur during specific periods of a child's life. These stages are said to emerge in an invariant and universal sequence. All children pass through each in the same order with each stage of learning being necessary for the development of the stages that follow. No stage or sub-stage can be skipped, and each must be negotiated in turn, because each stage not only utilizes and integrates the preceding stage but also paves the way for the one that follows (Mussen, Conger, Kagan and Huston, 1984). Children proceed
through these stages at their own rate and the age at which each stage or sub-stage is negotiated varies from child to child (Kaplan, 1991).

Though the sequence in these stages of development are invariant and universal, Piaget cautions against literal identification of stage with age asserting that his own findings give rough estimates of the mean ages at which various stages are achieved in the cultural milieu from which subjects are drawn. He also notes that intellectually impaired children may develop at a slower rate or may fail to reach the higher stages (Dworetzky, 1996).

The stage progression portion of Piaget’s theory as discussed above had important implications for this study. First, the children selected for the study were presumed to have successfully negotiated the preceding stages as proposed by Piaget. Second, the study proposed that children differed in their ability to predict or hypothesize science activities, probably due to variations in regional as well as gender-related experiences.

2.3 Piaget’s Structures and Stages in Cognitive Development

Piaget found four basic stages of development in children’s mental structures: the sensorimotor, pre-operational, concrete operational and formal operational periods (Fogel and Melson, 1988). The first stage, the *sensorimotor stage*, lasts from birth to until about two years of age. At this stage, sensory impressions...
form the basis for answers. Children act and react on things that are present in the environment. They cannot think of objects they cannot see at the moment. To them it is literally out of sight out of mind. The second stage, the *pre-operational stage*, lasts from age two years to seven years. By "operations" is meant the complex mental acts that children in this stage are not yet capable of accomplishing -hence the 'pre' (Sharp, 1970). The stage marks the beginning of certain types of logical thoughts in children that are needed for the next developmental stage. The third stage, the *concrete operational stage*, lasts on average from seven years to eleven or twelve years of age. At this stage, children are conservers of quantity and number. They understand the relationship between the whole and its parts. They reason in a way that seems rational to us but always about the real world around them. They may not know how to cope with abstract thinking. That comes in the final stage-the period of the *formal operations* that lasts from about eleven to fourteen or fifteen years, and leads to an adult level of thinking. In the formal stage, the adolescent can think not only about the reality he sees but also about the potential. He can look at a situation, ponder all the possibilities, and select the one that fits the case at hand.

Of special concern in this study was the pre-operational stage, which is a child's 'preparatory' stage before entry into the formal school. If a child leaves this stage without proper development - for instance, if a child joins primary
school while he is still a non-conserver- he cannot really understand much of the schoolwork and will resort to memorizing and parrot like learning (Sharp, 1970). This stage is discussed in more details in Section 2.4 that follows.

2.4 Pre-operational Stage (2-7 years)

This stage of cognitive development extends from two years of age to approximately seven years of age. As the pre-operational period sets in, the child demonstrates greater and greater use of symbolic functions. Language development increases dramatically, and imaginative play becomes more apparent as children spend much of their time in make-believe. They can imitate another’s behaviour after sometime has passed, implying that they have a way of symbolically remembering behaviour originally observed in a model (Dworetzky, 1996). During pre-operational period, the child’s ability to think has some limitations. Children often focus on one aspect of a problem that is the most salient, and seem to forget other information that is equally important (Fogel and Melson, 1988). The child is also characteristically egocentric and has difficulty imagining how things look from another person’s perspective. Pre-operational children also lack the ability to understand cause - and - effect in a logical way. They may believe that objects in nature act in a certain way because they choose to (Kroch, 1994).

The pre-operational stage is characterized by two stages: pre-conceptual stage
and intuitive stage. These stages have been outlined by Dworetzky (1996) as follows:

**Pre-conceptual stage (2-4 years):** As children begin to symbolize their environments and develop the ability to internalize objects and events, they first develop premature concepts which Piaget called **pre-concepts**. For instance, a pre-conceptual 3 year-old child may have a general idea that all cars found on the streets are his father's and then call each car 'Daddy's car'. During the pre-conceptual stage, a child's reasoning processes are limited to two kinds: **syncretic** and **transductive**. **Syncretic reasoning** refers to the method by which pre-schoolers tend to use limited and changing criteria to sort and classify objects. It may not be clear to a pre-conceptual child whether the snail he saw in the garden is the same one he sees later a kilometre away. **Syncretic reasoning** may occur partly because the child's conceptual understandings are not fully developed. **Transductive reasoning** involves incorrect identification of cause-and-effect relationships that link two specific events that occur close together (Fogel and Melson, 1988). For example, suppose it rains on the first day of school; a pre-school child might think school started because it rained. Transductive reasoning can also lead to **animistic thinking**, which is the belief that inanimate objects are alive. An example is when a child thinks that the sun is alive because it is “moving” referring to its relative positions during the day.
**Intuitive stage (4-7 years):** This latter stage of the pre-operational period is called the intuitive stage because children’s beliefs are generally based on what they *sense* to be true rather than what logic or rational thought would dictate. It is the period during which many of the basic concepts are being formed, and, if a child’s education is badly handled at this time, the concepts can be prevented from forming healthily or a distorted alternative substitute can form (Sime, 1973). Most children in pre-school fall into this pre-operational stage although some will still be in the sensorimotor stage while others will have progressed to the concrete operational stage. In relation to this study, if science process skills are not properly learned at this stage, the performance of the children at higher educational levels may be affected. It is children in this intuitive stage that this study was concerned about. Specifically, the study focused on pre-school children aged five years.

### 2.5 Mental Processes in Development of Thinking

Piaget believed that all mental processes are rooted in and are a continuation of the earliest reflexive and motor activities. From birth on, through interactions with the environment, the infant begins to form mental structures, which Piaget termed *schemata*. These schemata help the infant organize and interpret experiences. Each additional experience brings new schemata or perhaps a modification of the old one (Black and Pucket, 1996).
According to Piaget, schemes or schemata develop through the interaction between the individual and the environment. This interaction that is known as adaptation is guided by two complementary processes: assimilation and accommodation. Assimilation is the attempt to fit the environment into one’s existing level of ability. In this process, new information is incorporated into a new scheme; that is, it is simply added to the cognitive organization already in place. On the other hand, accommodation is the alteration of existing abilities to better fit the requirements of the task or environment. It occurs each time a new experience is encountered and assimilation does not result in an effective adaptation to the experience. As a result, current ideas or schemes are shifted or enlarged in order to encompass new information. An example is when an infant feeds from the teat of a feeding bottle by comparing it with the mother’s nipple and then has to change how he suckles because the process required is different. In reality most actions involve both assimilation and accommodation and it is often difficult to tell the two apart.

Piaget believed that there is an innate force that drives children from within to actively pursue cognitive adaptation. This force causes equilibrium (balance) or disequilibrium. Equilibrium is achieved when a person’s mental concepts – or in Piaget’s term’s schemata - accord well with his or her current experiences. Disequilibrium is experienced when one’s existing schemata do not seem to ‘fit’ new experiences. Thus, a child in higher levels of learning
may experience equilibrium or disequilibria in learning science process skills depending on whether the skills learned at the pre-school level accord well with new experiences or not. Whether these science process skills were developing in pre-school children was an issue to be investigated through a systematic study. This was the essence of this study.

2.6 Factors Influencing Cognitive Development

From birth through adulthood, the structures of intelligence or the schemata are constantly developing as the child spontaneously acts on the environment and assimilates and accommodates to an increasing array of stimuli in his environment. Piaget (1961) suggests four broad but interrelated factors that act to influence the course transition from one level of cognitive development to another. These factors are: maturation, experience, social interaction and a general progression of equilibration. The factors are discussed below.

Maturation is defined as the ripening of neural structures with age (Athey, 1970). For Piaget (1969), the main contribution to cognitive development is in neurological growth – the growth of brain and nervous system tissue - and the development of the endocrine system.

Experience refers to the role of manipulation of objects and of acquired experiences with objects in the physical world. The growth of cognitive
structures, or schemata, via assimilation and accommodation requires that a child interact with the environment so as to come to an understanding of the world through his own efforts (Athey, 1970). By so doing, the child gets two types of experiences: physical and logico-mathematical, both of which play a crucial role in the development of cognition. Physical experience consists of acting upon objects in order to abstract their properties. Logico-mathematical experience on the other hand requires thinking and consists of acting on objects with a view to learning the results of the co-ordination of actions.

Social interaction refers to the linguistic and educational interaction (Athey, 1970). It involves encounters with other human beings, and more specifically, education. Social interaction is particularly important in the development of social-arbitrary knowledge which is the knowledge developed by human beings through such media as language and values that evolve within cultures. Instructions or explanations given by parents and teachers as well as information learnt through discussions with peers or imitations of a model enhance social-arbitrary knowledge (Williams and Stith, 1974). Piaget parallels the contribution to the logical thinking that is made by a child's physical activity with the contribution that is made by social exchanges the child has with his peers. According to Piaget (1964), the social exchanges that a child has with his peers tend to correct the tendency to take an egocentric view of the world.
Equilibration means attaining equilibrium (Piaget, 1961). This is an internal self-regulating system that operates to reconcile the roles of maturation, experience and social interaction (Wadsworth, 1979). For Piaget, this is the fundamental factor for cognitive development. It is the backbone of mental growth (Ginsburg and Opper, 1969).

Piaget views each of the above factors and their interactions as necessary conditions for cognitive development but none of them, by themselves, is seen as sufficient to ensure cognitive development. Movements within and between stages of development are a function of these factors and their actions. In this regard, as in any other aspect of cognitive development, the development of the skills of prediction and hypothesizing would equally depend on the said factors.

2.7 Piaget’s Floating and Sinking Experiment

Experiments on floating and sinking are a first step in developing the very difficult concept of density. Children in pre-school and lower primary are not ready for the term density. The work on floating and sinking provides a valuable stepping stone towards the development of the concept in later years. Gradually, as the child grows through primary and secondary school days, experimentation will lead him still further into forming the concepts of volume, weight, density and specific gravity (M.O.E., 1990). The science of floating
and sinking also leads the child into developing the skills of classification and of elimination of contradictions.

Piaget used the sinking and floating experiments to study the stages of contradiction that a child passes through in the process of learning and also to determine the responses of children to classifying and ordering of objects on the basis of various attributes (Inhelder & Piaget, 1958). Piaget carried out the studies with children in kindergarten as well as children in first and second grade. In his investigation, subjects were presented with a collection of disparate objects (stones, wooden blocks, nails, etcetera) and were asked to classify them according to whether they float or sink. A large bowl or two of water was also presented. He asked each child to predict whether objects shown would sink or float and then encouraged them to experiment with the objects. He then asked the children to explain why the objects had behaved as they did. Piaget found out that five- and six-year old children could predict but the explanations they gave were merely naming the objects or the water or just giving the properties of the objects or water. His findings also indicated that the children could sort out objects according to predicted action in water. However, their classifications were incoherent and their explanations contradictory. Thus, some objects were said to float because they were little (or light) and others to float because they were big (or heavy). In some cases, a single type of explanation was offered for contrasting predictions; thus a wooden block floats "because it is heavy" and a rock sinks
"because it is heavy too". Concerning this stage, Piaget concludes "...bodies float or sink equally well if they are large, small, heavy (or even by association, because they are round, long, etcetera)" (Inhelder & Piaget, 1958: p.28). The findings further indicated that though seven-to nine-year-old children were unable to formulate a concept of density or gravity, they tried to reconcile some of the contradictions inherent in explanations based on absolute weight and volume.

The results of Piaget's study indicated that the floating and sinking experiment was a good one for children in pre-school. It is an experiment with which children are familiar and they respond to it readily with predictions and explanations. The study also indicated that the floating and sinking experiment is of assured interest to the children and it dealt with problems that bear close resemblance to those that a child encounters in those aspects of the curriculum where he is encouraged to share his ideas with the other children, in a somewhat informal discussion. In view of this, the researcher in this study chose to use this experiment particularly because it had been tested and was thus reliable.

2.8 Studies Focusing on Piaget's Theory

Several studies have been carried out all over the world focusing on Piaget's theory. A few of these have been reviewed for this study.

In one case, Almy, Chittenden, and Miller, (1966) carried out two studies - one
longitudinal and one cross-sectional - concerned with testing Piaget’s theory and findings with American children. In the studies, the researchers used four different Piagetian experiments - conservation of number, conservation of an amount of liquid, construction of stairs using ten blocks and floating and sinking of objects - to study children’s thinking in an educational setting. In the longitudinal study, children were studied successively in the kindergarten, first and second grades. In the cross-sectional study, the researchers used young children from two metropolitan elementary schools located in different socio-economic areas. In the floatation experiment, the findings indicated no significant differences in the prediction scores in the two schools in the cross-sectional study. The findings also indicated a negative relationship between the prediction and explanation scores. Both studies indicated that weight explanations were more commonly used by poorer predictors and material explanations by the better predictors. In general, the findings indicated that the accuracy of a child’s prediction of the behaviour of a given object when placed in water appeared to be related to the extent to which his generalizations from his experiences with objects of varying size and weight were relevant. “Accordingly, children who were conserving, and consequently approaching in a systematic way the task of sorting objects into floating and sinking classes, were likely to make less accurate predictions than children who were not conserving and were presumably responding more randomly or on the basis of memory” (Almy, Chittenden & Miller, 1966: pg 121).
In a similar study, Sime (1973) carried out studies, with young children, on the development of an ability to recognize one’s own contradictory statements, in solving a problem, and to correct them. The studies indicated that children in the early infant school life will attempt to classify floaters and sinkers but will generally fail to do so. Children in this stage are satisfied with multiple explanations as to why their results are not what they anticipated, and they are quite unaware that they are contradicting themselves.

In a study with Kenyan children, Kiminyo (1973) carried out a cross-cultural study of the development of conservation of mass, weight and volume. In this study, Kiminyo used the traditional Piagetian tasks to investigate the effects of schooling, urbanization, and sex on the discovery of conservation of mass, weight and volume. His sample consisted of a total of 120 school children aged 7-12 years and with a range of 0-6 years of schooling. 60 of the children were from a rural setting while 60 were from an urban setting. Both rural and urban children were matched in age, sex and number of years spent in school. The findings of the study indicated no significant differences between urban and rural children by years of schooling. The study further indicated no significant differences between male and female in total scores on conservation tasks. Conversely, the study showed existence of significant differences between age groups, and between types of conservation tasks.
In another study, Kohn and Landau (1987) conducted two experiments to assess the nature and extent of children's knowledge about the density of objects. In the first experiment, 18 children 3- to 5-years-old were shown objects which were to be placed in water one at a time. The children were then asked to judge whether the objects would sink or float when placed in water. Findings indicated that subjects were sensitive to substance, with high accuracy of judgments for objects made of metal: errors were not connected to size or absolute weight. However, a large number of errors occurred, particularly in regard to the heaviest wooden object, which suggested that subjects' judgments were linked to the weight of an object relative to its substance. Experiment 2, while controlling for volume, explored whether children were likely to judge floatability by substance, absolute weight or relative weight. Participants were 10 college students, five 6-years-olds, and five 4-year-olds. All showed that neither absolute weight nor substance was the basis for their floatability judgments.

In yet another study carried out with Kenyan children, Njubi (1993) investigated children's performance on Piagetian tasks of conservation of mass, weight and volume. In this study, Njubi used 40 Kikuyu-English speaking children from a rural area in Central Kenya. The children were in primary standard V and ranged from eleven to twelve years in age. She used the children to study the effects of presenting tasks in Kikuyu and/or English
language. The findings of the study indicated that conservation of mass was acquired earlier than conservation in weight, which was in turn conserved earlier than conservation of volume. The findings also indicated that children’s performance in conservation of mass and weight in Kikuyu language was significantly higher than their performance in English language. The findings further indicated that language of presentation of tasks did not affect children’s performance on Piagetian tasks of conservation before the area of conservation in question was acquired. However, language in which tasks were presented had an influence on children’s performance when the conservation area under investigation was acquired. The language of presentation of tasks also had an influence on the mode of reasoning employed by children on the acquired areas of conservation.

An analysis of the studies reviewed in this section reveals that pre-school children from other backgrounds as well as school children from older age groups could perform in the Piagetian tasks and were, therefore, developing within Piaget’s framework. The analysis also indicates that pre-school children could respond to the problem of floating and sinking. There was need to find out whether pre-school children in Kenya were developing within Piaget’s framework. In particular, there was need to find out how the pre-school children would deal with the floating and sinking problem in relation to prediction and hypothesizing.
2.9 Factors Affecting Performance in Science

Within all subject areas, researchers have consistently sought to identify the determinants of achievement and have come up with different factors that determine achievement. Schiefelbin and Simmons (1981) and Eshiwani (1982), for example, identified three policy-related factors that may affect general academic performance at all educational levels. The first factor relates to school resources and processes such as class size, textbooks, school administration and management including PTAs, play materials, libraries etcetera. The second factor relates to the teacher characteristics including level of education, experience, professional commitment and teacher to pupil ratio, while the third factor relates to the students’ traits or characteristics such as age, sex and socio-economic background. The first and second factors are supported by Twoli’s study (1985) which revealed that school and teacher variables had the greatest influence on achievement in science amongst Form 2 and 3 secondary school students.

Teaching practices are also often considered as one of the reasons why learners do not demonstrate top achievement in science and mathematics (Wenner & Stevens; 1996). Both theory and common sense suggest that teachers’ knowledge of subject matter necessarily influence their classroom practices with the teachers gravitating towards performing those tasks in which they feel confident and competent (Cunningham & Blankenship, 1979; Hone, 1976;
Gender is also considered as playing an important role in determining students' interest and performance. Many studies have reported gender differences in academic achievement (Comber and Keeves, 1973; Erickson and Erickson 1984; Ogonda, 1991; Jones, Mullis, Raizen, Weiss and Weston, 1992; Twoli, 1986). Overall, boys outperformed girls in all branches of science. The studies conclude that sex may be an important factor both as a main effect and in interaction with other variables in determining academic achievement. In an attempt to explain these gender differences, Twoli (1986) suggests that boys were heavily favoured in extra curricular science activities and in opportunities to use scientific instruments. Other literature suggested that gender differences in science related experiences occurred from general socialization patterns in gender-role formation (Bem, 1981; Eccles, 1985; Hollinger, 1991) and parental interaction (Bem, 1981; Archer & Lloyd, 1982; Block, 1983) to specific socialisation activities such as risk taking explorative behaviours (Kahle and Lakes, 1983; Taylor, 1996). Twoli (1985) had suggested that if both genders are given equal levels of motivation and learning resources, girls may perform just as well as the boys.

Prior experience has also been identified as an important factor in learning and consequent achievement. Researchers and theorists suggest that learning is
constructed by a synergistic interaction of prior knowledge and newer experiences (Yager, 1991; Harlen, 1992; Peterson & Knapp, 1993). According to these, children construct their own knowledge by comparing new sensory experience with previous concepts and using this information to arrive at a new level of understanding.

Geographical location is another important factor in determining achievement. The geographical location of a school determines the physical environment in which learning takes place as well as the experiences the child is exposed to. Studies had suggested that experiential differences affect future learning outcomes in science (Harlen, 1995; Kahle, 1990). In Kenya, studies carried out with older children by Kodero (1985) and Ogonda (1991) had found out that pupils in rural and urban environments differed on overall performance in academic achievement, with urban pupils doing better than their rural counterparts.

Other studies have concluded that a positive relationship exists between students’ attitude and achievement (Bloom, 1976; Majoribanks, 1976; Mailu, 1982; Cannon & Simpson, 1985; Simpson et al, 1994; Thyaka, 1997). The studies indicate that how a student feels about home, self and school has a bearing on his/her achievement in education.
Parental influence has also been identified as an important factor affecting student’s achievement (Miller, 1980; Bem, 1981; Archer and Lloyd, 1982; Block, 1983; Dryfoss, 1990).

The above review identifies school factors, teacher characteristics, learners’ characteristics, gender, geographical region, parental influence and prior experience to be among important determinants of a child’s performance in education at higher levels. It is expected that the same factors determine performance at pre-school level. This study focused on the child’s gender, geographical location of the pre-school and the child’s prior experience as among important factors affecting performance in science at ECE level. The main concern was whether there would be any significant gender or regional differences in pre-school children’s performances in science process skills.

2.10 Science Process Skills

When learners interact with the world in a scientific way, they find themselves observing, questioning, hypothesizing, predicting, investigating, interpreting and communicating. These are often called the “process skills” of science. Also known as processes of science, science process skills are the skills by which observations are acquired, and meaning is constructed by the learner (Martin, Sexton, Wagner and Gerlovich, 1997). They are the mental and physical skills that are used in ‘processing’ information about objects, events and materials.
that children encounter (Mayor and Livermore, 1969). They are the basis on which knowledge is constructed. According to Maundu (1995), these processes enable the interested investigator to ‘force’ the universe to reveal her secrets. When properly taught, process skills play a critical role in helping children develop scientific ideas.

A variety of interpretations of science process skills, including the types, their number, order, and relative importance exist as evidenced from different authors (Aikenhead, 1998; Berger and Thompson, 1995; Jarvis, 1991; Martin, Sexton, Wagner and Gerlovich, 1997; Maundu, 1995; Mayor and Livermore, 1969; Okere, 1996; Orwa and Underwood, 1986; Watts, 1991; Harlen and Jelly, 1997). Maundu (1995), for example, identifies the following examples: observing, classifying, asking questions, hypothesizing, controlling variables, constructing, recording of data, interpreting, making inferences, communicating, predicting, estimating and measuring among others. Okere (1996), on the other hand, identifies a total of 15 science process skills. These are: discussing, planning, recording, presenting, applying, classifying, evaluating, experimenting, hypothesizing, inferring, interpreting, investigating, observing, predicting and questioning. Watts (1991) talks of processes and describes them as a sum-total of skills and represents them as a cycle which goes through the following general processes: hypothesizing, experimenting, designing, evaluating, recording, interpreting, and communicating. An analysis
of the types of skills presented by different authors indicates that most authors include prediction and hypothesizing as key science process skills.

Process skills are universal to all scientific areas of study. However, it is important to note that they are not the special preserve or property of science alone (Wellington, 1989) since many of them are applicable to other subjects of study such as Geography, Art and Craft and Music. In this regard, pre-school children should be exposed to all science process skills. This would make them competent and enable them employ the skills as different subject areas and situations demand.

Process skills are not operationally separate, isolated skills. Many of them depend on each other. Some overlap considerably and could even become identical to each other in certain contexts. For example, inferring and observing can at times be very similar processes, so similar as to be indistinguishable (Aikenhead, 1998).

The development of process skills is a crucial ingredient of doing science, and should be taught first in content-free investigations, where more attention can be paid to the spontaneous discovery, elicitation, generalisation and sharing of principles captured by authentic problem solving (S&C Editors, 2005).

According to Kathleen and Lucia (2002), young children, like all scientists,
need to practice the skills of predicting, observing, classifying, hypothesizing, experimenting, and communicating. In this connection, pre-school in Kenya should also learn and practice these skills in order to enable them perform well in science subjects.

Science process skills have tremendous carry-over value in and out of school, as literacy-building tools. Many of these processes are the same ones that young children use when they act on the physical world, discovering attributes, organising schema and representing the world. They are also vital to adult living. They are the mechanisms by which problems are identified, explored and solved and they have the potential to help children to become better decision makers, consumers, citizens and problem solvers. In the words of Martin et al (1997; p 117),

“Whether the adult mission is to improve or improvise on a recipe; determine the cause of a blown fuse (or tripped circuit breaker); trouble-shoot the cause of a car’s failure to start; plan the best route to run a new line for an extension telephone, identify evidence and separate it from opinion while listening to a political candidate; or determine how to thread a sewing machine, the processes of science contribute to solving the problem”.
Consequently, science process skills should be taught to all learners, pre-school children included.

Studies focusing on the teaching and acquisition of basic process skills have concluded that basic skills could be taught, and, that when learned, could readily be transferred to new situations (Allen, 1973; Tomera, 1974; Thiel and George, 1976; Padilla, Cronin, and Twiest, 1985; Okere, 1996). Other studies have indicated that elementary school students, if taught process skills abilities, not only learnt to use them, but also retained them for future use (Wideen, 1975; McCathery, 1970; Quinn and George 1975; Wright, 1981). Studies have further shown that pupils who acquire science process skills and problem-solving abilities do achieve higher in science and in other areas (Padilla, Okey and Garrand, 1984; Twoli, 1985; Ogonda, 1988). It is also argued that process skills based approach in teaching enhanced pupils’ attitudes towards learning science (Okere, 1997). It is important, then, that children develop these processes as early as possible in life in order to perform well in science and other subjects in subsequent levels of education. This study sought to establish whether Kenyan pre-school children were acquiring the said skills by focusing on the skills of prediction and hypothesizing. The two skills are some of the important skills that promote reasoning.
2.11 The Skill of Prediction

Predictions refer to types of thinking that require our best guesses based on the information available to us (Martin et al., 1997). They are not pure guesses, however, but are based on experience or an inference (Aikenhead, 1998). According to Harlen and Jelly (1997), predicting refers to suggesting an event in the future, based on observations. The prediction is based on evidence from past knowledge and/or experience, and upon immediate evidence gained through observation. Meteorologists, for example, predict the weather. Their predictions are made in advance of the weather's actual occurrences and are based on accumulated observations, analysis of information, and prior experience. Some predictions, such as those involving floating and sinking, can be easily proved correct or wrong through carrying out experiments. Other predictions, such as predicting weather, may not be easy to prove immediately; whether it rains or not is only time that can tell. The importance of prediction to scientific inquiry is that science places greater emphasis on the ability to predict -in its process of knowing- than on the ability to describe or explain (Orwa and Underwood, 1986). One explanation could be the transferability of learning. According to Jarvis (1991), opportunities for children to guess or predict will occur in both Mathematics and Science as well as in other aspects of life. Predictions are also important in that they are central to the process of testing whether or not a hypothesis is on the right track.
In this study, pre-school children were expected to predict whether given objects would sink or float once placed in water. Their predictions were based on prior experience gained either at home or at school.

2.12 The Skill of Hypothesizing

A hypothesis is an idea or suggestion that is based on known facts and is used as a basis for reasoning or further investigation (Martin, Sexton, Wagner and Gerlovich, 1997). Hypothesizing, therefore, means giving an explanation for an occurrence (Aikenhead, 1998), or, according to Harlen and Jelly (1997), suggesting a tentative explanation consistent with available observations, questions, and evidence. At an advanced level, hypothesizing also means deriving a general pattern from a set of observations.

Hypothesizing employs scientific concepts and has the purpose of seeking to provide general explanations about how the world behaves (Wellington, 1989). It involves making “educated guesses” based on evidence that can be tested through experimentation (AAAS, 2004). The word “educated”, however, implies that the learners generate better hypotheses as they have more science experiences and move to more advanced developmental stages (Untitled Document, 2004). Hypothesizing arrives after we have an opportunity to observe, comment, raise questions, and explore with materials. When a learner makes a hypothesis, he links information from past experiences that may
explain both how and why events occur (Ash, 2000). Any learner can generate a guess if they do not feel threatened by being wrong. In ECE, hypothesizing should be very simple explanations that can be tested.

Scientific hypothesizing is important in all aspects of life and is used in our daily routines. For instance, the act of crossing a road, which we all routinely accomplish, involves making hypotheses about the future positions of cars and other road users, based on observations and generalisations from past experiences. Making a wrong hypothesis could lead to one being knocked down by a vehicle. Trying to explain how or why things happen is also an important part of science (Allan, 1986). It inspires people to observe systematically, either in a field study or experiment, so they can see how well their hypothesis works.

In this study, the researcher used the term “hypothesizing” instead of the term “explanation” which Piaget used to describe the children’s ability to tell why objects floated or sank in water. This was in an attempt to bridge Piaget’s theory on child development and the science process skills approach. Science process skills are the prevailing focus in science education circles by the time of the study (Harste, 1993; Okere, 1996; Bredekamp and Copple, 1997; Harlen and Jelly, 1997; Martin, Sexton, Wagner and Gerlovich, 1997; Aikenhead, 1998; AAAS, 1999; Ash, 2000; NAEYC, 2002). The use of the term
‘hypothesizing’ was consistent with the use by neo-Piagetians such as Ajkenhead (1998) and Harlen and Jelly (1997) and did not, therefore, alter in any way the meaning of the term ‘explanation’ used by Piaget.

2.13 Studies Carried Out on Science Process Skills

Studies carried out directly concerned with science process skills were relatively few. The researcher found only three such studies relevant for review. In one study, Thiel and George (1976, cited in Otieno-Alego, 1987) undertook an investigation on some factors affecting the use of prediction by elementary school children. Their sample consisted of a total of 180 pupils of grades 3, 4 and 5. They used the Piagetian task in class seriation. Their conclusion was that children had difficulties making predictions that involved multiple co-ordinations of classification and seriation rules. The study indicated that the dimensions of variables available in the task affected prediction. Where a subject was to consider many variables simultaneously in order to make a prediction, then the prediction became more difficult than when there was only one or two variables to consider.

The Assessment of Performance Unit (APU, 1983) carried out a survey in England, Wales and Northern Ireland designed to assess children’s performance in science at age 10-11 years. The study was carried out in 1980 and 1981, and, the results were reported in 1983. The results suggested that
girls were slightly ahead in using graphs, tables and charts and in making observations of differences and similarities. They were also better at planning investigations and in recording descriptions of events during investigations. Boys, on the other hand, were ahead in using measuring instruments, in applying physical science concepts to problems and in recording quantitative results in investigations. On hypothesizing, the survey results indicated that both groups of children were able to hypothesize. However, their responses suggested that many children do not try to explain events, which may be observed in daily life in terms of scientific concepts. A similar survey conducted by the same unit for children of age 15 years suggested that a large majority of pupils at this age possessed science skills at a basic level though these skills may not always be adequate to meet frequently occurring demands in the science curriculum. The results also showed no significant difference in performance in science activities between boys and girls.

In a related study carried out in Kenya by Otieno-Alego (1987), 519 junior secondary school students were tested in four processes of science: Observation, prediction, generalization and controlling variables. The results revealed very low competence by both boys and girls in the performance of science process skills, particularly in observation and prediction. It also revealed that in some process skills such as prediction and controlling variables, the dimension of sex contributed to differential in performance.
Overall, boys proportionally did significantly better than girls in all skills tested except those of generalizations.

The studies reviewed in this section were conducted either at primary or at secondary school level. The researcher was not aware of any such studies carried out locally in the area of ECE. There was need to find out how pre-school children in Kenya could perform in the area of science process skills.

2.14 Summary

This chapter discussed the literature reviewed for this study starting with the theoretical framework and ending with science process skills. The theoretical framework adapted for this study was based on Piaget's theory of cognitive development. According to the theory, children develop intellectually in a sequence of stages by age from infancy to post adolescence. These stages are said to emerge in a universal sequence with each stage of learning being necessary for the development of stages that follow. Consistent with this theory, children must develop science process skills at pre-school level if they are to perform well in science at higher levels of education. The chapter then reviewed some studies based on the Piagetian tasks. The chapter further discussed the process skills in science and in particular, the skills of prediction and hypothesizing both of which were the focus of this study. The chapter also reviewed some studies relevant to the area of science process skills. Chapter
five presents the research design and methodology that were used to find out whether children in Kenyan pre-schools were developing science process skills.

3.0 Introduction

This chapter presents the research design and methodology that were employed in carrying out the study. The chapter will give an overview of the population and the procedure used in the study. The results of the procedures used in data gathering will also be presented. The research design and the data analysis to be used for the study will also be discussed.

3.1 Research Design

The researcher used a quasi-experimental design in the study.

According to Kirkpatrick and Shadish (2007), this research design can take the general form of a pretest-posttest design, a variant of the randomized experimental design, or the randomized design of research to find more conclusive evidence than that of true experimental designs. As a result of this, non-experimental designs are not established and findings from such research designs may come to some problems when it comes to testing or generalization. Piaget himself used the same approach.
CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter discusses the research design and methodology that was followed in carrying out the study. It starts by giving the research design, site and target population as well as the variables used for the research. The sample and the procedure used for sampling are also discussed. The research instruments, data gathering procedures and hypotheses to be tested for the study are finally discussed.

3.1 Research Design

The researcher used a quasi-experimental design in a naturalistic setting.

According to Rosenberg and Daly (1993), quasi-experiments are studies that take the general form of an experiment, but do not have the elements of control or the random assignment of subjects to treatment conditions that characterise true experiments. In such studies, the researcher takes natural settings already established and functioning and adds a data-collection dimension so that he can come to some conclusion about relative effectiveness (Fox, 1969). In this study, the children under study were in existing pre-schools. Piaget himself used the same design.
3.2 Sites and Target Population

The study targeted children from pre-schools in Kajiado District of the Rift Valley Province of Kenya. Kajiado District is part of the Arid and Semi-arid lands (ASALs) and was by then occupied by the pastoralist Maasai community. The District is situated between the longitudes 36°5' and 37°5' East; and, between latitudes 1° 0' and 3° 0' South. It covered an area of 21,903 km². The district was sparsely populated with the total population being 258,659 persons in 1989 and 406,054 persons in 1999 (GOK, 1994; GOK, 2001). The District’s population density for 1999 was approximately 19 persons per square Kilometre (GOK, 2001). Schools were far apart from each other. The district had a very poor communication infrastructure. It was difficult to, therefore, access all pre-schools and especially those that were in the interior. Consequently, only accessible pre-schools were sampled for this study.

There were seven divisions in Kajiado District. Isinya and Ngong divisions were purposively selected due to their accessibility. Isinya division was selected to represent a typical rural Arid and Semi-Arid Lands (ASAL) region while Ngong was selected to represent a peri-urban region within the district. Pre-school children from these two divisions were studied.

Statistical data returns available at Isinya Divisional Education Office
indicated that there were 10 pre-schools in the division with a total enrolment of 113 pre-school children while similar returns at the Ngong Divisional Education Office indicated that the division had 19 pre-schools with a total enrolment of 282. This gave a total population of 29 pre-schools and a total enrolment of 395 pre-school children. Ten pre-schools within the two divisions were selected while a total of 40 five-year old children were sampled from the pre-schools.

3.3 Variables

The following were the variables that were studied:

3.3.1 Independent Variable: The geographical region was the independent variable in this study. The schools were categorised as either being located in a rural or peri-urban region.

3.3.2 Dependent Variable: Children’s performance in the prediction and hypothesizing tests was the dependent variable in this study. Scores obtained were used to measure the children’s performance in the two process skills.

3.3.3 Subject Variable: The gender of the child was the subject variable. The number of boys assessed was equal to that of the girls.
3.4 Sample and Sampling Procedures

40 five-year-old pre-school children were sampled for the study. Twenty of these were boys while twenty were girls. The sampling procedure was done as follows:

Purposive and stratified, clustered random samplings were used to select the pre-schools and children respectively. Two divisions, Isinya and Ngong, were purposively selected on basis of accessibility. Five pre-schools were purposively selected from each of the two divisions. These were selected based on accessibility. The selection gave a total of ten pre-schools. In each of the pre-schools selected, all children aged approximately five years were sorted out. These were categorised into two strata according to gender. Children in each of the groups were assigned numbers. The numbers were written on pieces of paper that were then rolled and put in a tin. After thorough shuffling, two pieces of paper were selected at random and without replacement. This procedure was carried out for both boys and girls. The process generated two boys and two girls from each pre-school, giving a total of 20 children from each of the divisions. A total of 40 children - 20 boys and 20 girls - were thus sampled for the study.

3.5 Distribution of the Sample

The sample consisted of 40 children from two regions -urban and peri-urban-
distributed as shown in table 3.1 below.

Table 3.1: Distribution of Children per Region by Gender

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Isinya (Rural)</td>
<td>10</td>
</tr>
<tr>
<td>Ngong (Peri-urban)</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
</tr>
</tbody>
</table>

Ten female and ten male children were sampled from each of the regions. This gave a total of 20 children from each region.

3.6 Research Instruments

Data were collected using an interview schedule for children designed by the researcher based on Piaget’s floating and sinking experiment. Each interview schedule contained questions on floating and sinking activities based on sixteen different objects. In each case the researcher would ask questions from the interview schedule and then record the responses the children gave on the prediction and hypothesizing tests. The interview schedule contained three questions with tables on which to record responses to each question. The first question dealt with putting twelve objects in water while each of the other two questions dealt with putting two objects in water. The nature of the experiments is explained in section 3.8.3 while the testing procedure is shown
3.7 **Piloting of the Research Instruments**

The pilot study was conducted in two sampled pre-schools in Kajiado District. One school was selected from Ngong division while the other was selected from Isinya division. Four children aged five years - two boys and two girls - were sampled from each pre-school and assessed using Piaget’s sinking and floating activities and the research instrument designed. The data was analysed and the results used to make appropriate adjustments on the instrument and the research process. More specifically, the piloting phase was used to ensure that the experiment worked, the language used was simple and clear as well as to establish the time needed for each child. The piloting process indicated that the pre-school children were familiar with the sinking and floating problem. The piloting also indicated that the experiment worked, was interesting and the objects and the materials used were relevant. The piloting process further indicated that the children were comfortable with the English language as the language of communication; they understood the questions and instructions clearly and responded to those they were sure of with ease. The total contact time needed for each child was also established. The time was found to be twenty two minutes on the average. The piloting finally gave the researcher experience in research work. The pre-schools selected for the pilot study were excluded from the main study.
3.8 Validity and Reliability

This section discusses how the study ensured content validity as well as reliability.

3.8.1 Validity

To ensure content validity, the study adapted Piaget's floating and sinking experiments which he had used to study pre-school children. The changes made involved use of locally available and familiar materials and apparatus similar to those used by Piaget. The process of testing was also similar to that used by Piaget except that the researcher used the term 'hypothesizing' in place of the term 'justification' that Piaget had used to denote the children's ability to explain why the objects either sank or floated. The basis on which the term 'hypothesizing' was used is explained in Section 2.12.

3.8.2 Reliability

The study used Piaget's sinking and floating experiment. This experiment had been tested by several researchers and had been found reliable. The researcher also carried out the research personally using the same objects and materials throughout and asking each child the same questions and in the same order. A reliability analysis was also done on the results obtained during the pilot study.
The equal-length Spearman-Brown split-half analysis technique was done using the SPSS program for windows. The results of the analysis confirmed that both the prediction and hypothesizing tests were of acceptable reliability \( r = 0.6285 \) and \( r = 0.7273 \) for the former and latter tests respectively).

### 3.9 Ethical Issues

Permission was sought from the Ministry of Education, the District Education Office – Kajiado, the Divisional Education Officers and Zonal Inspectors of Schools in charge of the areas where the selected schools were located. The researcher then visited each of the schools selected with an aim of seeking permission from the school managers as well as familiarizing herself with teachers and children. During these visits the assessment dates were fixed. Teachers would also be asked to prepare a quiet and private place where the assessment could be done. On the agreed day, the researcher would visit the school and assess all the children selected. The researcher would carry the materials and apparatus required for the experiment. To ensure uniformity in materials and apparatus used for the study, the researcher used the same material and apparatus except for water and basin which the schools provided. The researcher would be in school as early as possible in order to prepare well in advance and also to ensure that the four children from each school were all assessed on the same day. This ensured that there was no leakage and no prior information was, therefore, passed on to any of the children in that school.
3.10 Data Gathering Procedures

This section discusses the general data gathering procedures as well as the actual experiments that were used for the study.

3.10.1 Specific Testing Procedures

Each child selected was assessed individually in an empty, quiet room within the school premises. The first two minutes were spent establishing rapport after which the child would be given simple tasks on prediction and hypothesizing and then asked some questions orally. The tasks given and the questions asked are shown in Appendix H. The researcher recorded the child’s responses on the designed questionnaire. The actual testing time for each child was twenty minutes. This gave a total of twenty-two minutes of contact with each child. The total time spent while testing the four children selected from each school was, therefore, one and a half hours. The time excluded the change over time from one child to another. This change over time varied from pre-school to pre-school depending on the distance from the classes to the room where the assessment was taking place.

3.10.2 Objects Used for the Experiment

The following objects were used for the floating/sinking experiments.
Group I Objects:

This group consisted of six pairs of objects differing in only one attribute (size, colour, shape or material). The objects were categorised as follows:

**Floating objects**

1. A pair of pencils different only in colour.
2. A pair of candles different only in size.

**Sinking objects**

3. A pair of keys different in size.
4. A pair of plastic pegs different in colour.
5. A pair of stainless steel spoons different in size.

**One floating and one sinking object**

6. A pair of spoons only different in material (one made of plastic and one wooden)

Group II Objects:

This group comprised of a pair of objects differing in three attributes – size, weight and shape. An empty 250g rectangular Prestige margarine container that would float and a 100g cylindrical Blue Band margarine container filled with sand so that it would sink, were used. Both containers were tightly covered with lids to stop water from getting in. This would otherwise increase the weight of the containers making the empty one to sink.
Group III Objects:

In this group was a pair of objects differing in five attributes (material, size, weight, shape and purpose), one floating and one sinking item. Specifically, a small padlock and another bigger padlock tied to a sizeable rectangular piece of rubber measuring 9cm by 13cm were used. The piece of rubber had been cut from an old sleeper.

The list of objects and materials used is given as Appendix I.

3.10.3 Experimental Procedures

This experiment on floating and sinking, adapted from experiments used by Piaget (1930), was based on science activities recommended by the Ministry of Education (NACECE/KIE, 1997) and was used to assess the children in their ability to predict and hypothesise. Piaget himself used floating and sinking activities to study the stages of self-contradiction that a child passes through in the process of learning. Like in Piaget’s study, this study demanded no ingenuous apparatus but only a large basin of water and the obvious variety of objects to be floated or sunk. The objects used were categorised into three groups as shown in Section 3.8.2.

The floating and sinking activities involved putting the objects in water. In each case, the child would be given the objects to handle and observe. He/she would be asked to predict whether the objects would float or sink. He/she
would then be asked to put the objects in water. The child would then be asked to hypothesize the reason for the floating or the sinking observed.

The two process skills -prediction and hypothesizing- were sequentially tested. The child was initially expected to predict and to justify the predictions made before putting the objects in water. The prediction test was aimed at answering the question “What will happen if----and ----is/are put in water?” After the task the child would be expected to hypothesize or give an explanation to the observations made. The hypothesizing test was aimed at giving explanations for the observations made. The specific testing procedure is shown in Appendix II.

3.10.4 Scoring

The researcher designed the method for scoring. In this method, prediction scores were obtained from two sources: the child’s responses to the ‘what will happen if—?’ question as well as from the reason advanced for the response. One mark was awarded for correct prediction. Another mark was awarded for correct justification or reasoning. As a result, each question was awarded two marks. Prediction was either correct or wrong. As such the mark awarded was either one or zero. However, there was a possibility of a child giving a partially correct justification for the prediction he/she gives. Such an answer was awarded half a mark. Though the study was concerned with testing
performance in the skill of prediction, the reason behind the prediction was also important because it shed light on the child’s thinking and also distinguished prediction from pure guessing. Hence the awarding of scores for the reason was justified. Scores were given for partially correct answers because children at this level think intuitively and may not manage to verbalize their thoughts. A child who predicted and reasoned out correctly scored a total of two marks for each object. This gave a total of 32 marks for all the sixteen objects used in the test.

The following table shows the available alternatives and the scoring used for the prediction test.

Table 3.2: Scoring for Prediction Test

<table>
<thead>
<tr>
<th>Category of alternatives</th>
<th>Prediction</th>
<th>Justification</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Correct (1 mark)</td>
<td>Correct (1 mark)</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Correct (1 mark)</td>
<td>Partially correct (½ mark)</td>
<td>1½</td>
</tr>
<tr>
<td>3</td>
<td>Correct (1 mark)</td>
<td>Wrong (0 mark)</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Wrong (0 mark)</td>
<td>Correct (0 mark)</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Wrong (0 mark)</td>
<td>Partially correct (0 mark)</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Wrong (0 mark)</td>
<td>Wrong (0 mark)</td>
<td>0</td>
</tr>
</tbody>
</table>

Hypothesizing scores were obtained from a child’s explanation as to why an object sank or floated. Two marks were awarded for correct hypothesizing.
while one mark was awarded for partially correct hypothesizing. A child who gave correct hypotheses for the sixteen objects scored a total of 32 marks. The following table shows the available alternatives and the scoring used for the hypothesizing test.

Table 3.3: Scoring for Hypothesizing Test

<table>
<thead>
<tr>
<th>Hypothesizing</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct</td>
<td>2</td>
</tr>
<tr>
<td>Partially Correct</td>
<td>1</td>
</tr>
<tr>
<td>Wrong</td>
<td>0</td>
</tr>
</tbody>
</table>

The marks obtained from the two tests were recorded in a mark sheet as shown in Appendix III.

3.11 Hypotheses to be Tested

The following hypotheses were tested during the process of data analysis as described in Chapter 4.

Ho₁: There is no significant difference between the scores obtained by pre-school boys and by pre-school girls in the prediction test.

Ho₂: There is no significant difference between the scores obtained by pre-school boys and by pre-school girls in the hypothesizing test.
$H_0_3$: There is no significant difference between the scores obtained by rural pre-school children and by peri-urban pre-school children in the prediction test.

$H_0_4$: There is no significant difference between the scores obtained by rural pre-school children and by peri-urban pre-school children in the hypothesizing test.

$H_0_5$: There is no significant difference between the scores obtained by rural pre-school girls and by peri-urban pre-school girls in the prediction test.

$H_0_6$: There is no significant difference between the scores obtained by rural pre-school girls and by peri-urban pre-school girls in the hypothesizing test.

$H_0_7$: There is no significant difference between the scores obtained by rural pre-school boys and by peri-urban pre-school boys in the prediction test.

$H_0_8$: There is no significant difference between the scores obtained by rural pre-school boys and by peri-urban pre-school boys in the hypothesizing test.

$H_0_9$: There is no significant relationship between the scores obtained by...
pre-school children in the prediction test and in the hypothesizing test.

$H_{010}$: There is no significant relationship between the scores obtained by boys in the prediction test and in the hypothesizing test.

$H_{011}$: There is no significant relationship between the scores obtained by pre-school girls in the prediction test and in the hypothesizing test.

3.12 Summary

This chapter discussed the research design and methodology used for the study. A quasi-experimental design in a naturalistic setting was used. Purposive and stratified, clustered random sampling was the method used to select 40 pre-school children from Ngong and Isinya regions. The chapter further discusses Piaget's floating and sinking experiment which was used in this study to test children's performance in predicting and hypothesizing. The chapter then presents geographical region, gender and the children's performance in the two process tests as the variables identified for the study. The chapter further presents the specific testing procedure as well as the scoring method. The chapter concludes by presenting eleven hypotheses that are to be tested in chapter four that follows.
CHAPTER FOUR

DATA ANALYSIS AND RESEARCH FINDINGS

4.0 Introduction

Chapter 4 presents a description of the process of data analysis. The research findings are then presented and corresponding hypotheses tested where relevant. The chapter ends with a discussion of the research findings.

The research findings are reported in the light of the study’s main objectives. There were four objectives related to the findings, namely:

1. To assess the performance of pre-school children in the prediction and hypothesizing skills in science.

2. To find out whether there would be any gender differences in performance in the skills.

3. To find out whether there would be any differences in performance in the skills between rural and peri-urban pre-school children.

4. To determine whether there would be any relationship between pre-school children’s performances in prediction as compared to the hypothesizing skills.
4.1 The Process of Data Analysis

The data collected were described using the range, mean and standard deviation. Statistical tables and line graphs were also used to present the data. Eleven hypotheses were tested at a significant level of $\alpha = 0.05$. The first eight hypotheses - $H_{01}$ to $H_{08}$ - were tested to determine existence of significant differences between means and were tested using the t-Test for independent samples (Ingule and Gatumu, 1996). The last three hypotheses - $H_{09}$, $H_{10}$ and $H_{11}$ - were to determine the existence of significant relationships and were tested using the Pearson’s Product Moment Correlation. The statistical analyses were performed using version 11.5 of the Statistical Package for Social Scientists (SPSS) for Windows. The hypotheses tested were:

$H_{01}$: There is no significant difference between the scores obtained by pre-school boys and by pre-school girls in the prediction test.

$H_{02}$: There is no significant difference between the scores obtained by pre-school boys and by pre-school girls in the hypothesizing test.

$H_{03}$: There is no significant difference between the scores obtained by rural pre-school children and by peri urban pre-school children in the prediction test.
Ho4: There is no significant difference between the scores obtained by rural pre-school children and by peri urban pre-school children in the hypothesizing test.

Ho5: There is no significant difference between the scores obtained by rural pre-school girls and by peri urban pre-school girls in the prediction test.

Ho6: There is no significant difference between the scores obtained by rural pre-school girls and by peri urban pre-school girls in the hypothesizing test.

Ho7: There is no significant difference between the scores obtained by rural pre-school boys and by peri urban pre-school boys in the prediction test.

Ho8: There is no significant difference between the scores obtained by rural pre-school boys and by peri urban pre-school boys in the hypothesizing test.

Ho9: There is no significant relationship between the scores obtained by pre-school children in the prediction test and in the hypothesizing test.

Ho10: There is no significant relationship between the scores obtained by boys in the prediction test and in the hypothesizing test.
H$_{01}$: There is no significant relationship between the scores obtained by pre-school girls in the prediction test and in the hypothesizing test.

The last three hypotheses above were tested to determine whether there existed a relationship between performance in the prediction test and performance in the hypothesizing test. In all the three tests, prediction scores were used as the first variable while scores in the hypothesizing test were used as the second variable.

4.2 Research Findings

This section discusses the findings obtained from this study. The discussion begins by presenting results obtained from the analysis of the data collected in the study. The results are discussed under three main areas: overall performance by all pre-school children, pre-school children’s performance in the tests by gender and pre-school children’s performance in the tests by region. In each area, related hypotheses are tested to determine significance of the findings.

4.2.1 Children’s Performance in Prediction and Hypothesizing Tests

The scores obtained in the prediction and hypothesizing tests were analysed for all children. The results are as shown in Table 4.1.
Table 4.1: Prediction and Hypothesizing Scores Obtained by All Children

<table>
<thead>
<tr>
<th>Test area</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prediction</td>
<td>40</td>
<td>12.00</td>
<td>32.00</td>
<td>20.00</td>
<td>19.20</td>
<td>4.614</td>
</tr>
<tr>
<td>Hypothesizing</td>
<td>40</td>
<td>0.00</td>
<td>20.00</td>
<td>20.00</td>
<td>5.975</td>
<td>7.177</td>
</tr>
</tbody>
</table>

From the table, it is observed that though the scores differences in the two tests was the same, the range for the prediction scores started and ended at a higher point than the range for hypothesizing scores. This indicated that the children scored higher marks in the prediction test than in the hypothesizing test. This is supported by the higher mean score for the prediction test compared to that for the hypothesizing test. The mean score for the prediction score is more than three times that of the hypothesizing score, an indication that the pre-school children performed much better in prediction than in hypothesizing.

The table further shows a standard deviation of 4.614 for the prediction scores and a standard deviation of 7.177 for the hypothesizing scores, an indication that the scores for most children in the prediction test were concentrated around 19.200, while those in the hypothesizing test were more spread from the mean of 5.975. Thus, performance in the prediction test was more homogeneous than that of the hypothesizing test. The conclusion derived from the above observations was that the children were developing both the skills of
prediction and hypothesizing but were more advanced in the development of the skill of prediction.

Frequencies of scores obtained by all children in the two tests were also presented by line graphs as shown in Figures 4.1 and 4.2 below.

**Figure 4.1: Prediction Scores for All Children**

Figure 4.1 presents a tri-modal line graph with 14, 20 and 24 as the three modes respectively. The graph indicates that 20 marks had the highest frequency followed by 14 marks and then by 24 marks. The graph also shows that all of the children obtained scores above 12 marks with one child getting a score of 32 marks which was the maximum score. This meant that most of the
children had acquired the skill of prediction.

Figure 4.2: Hypothesizing Scores for All Children

Figure 4.2 presents a graph skewed to the left. The observation was that 18 children (45%) scored zero in the hypothesizing test while only two (5%) children scored the highest mark of 20, out of a possible 32 marks, in the same test, an indication of poor performance in the hypothesizing test. The conclusion was that most children performed poorly in the skill of hypothesizing.

A comparison of Figures 4.1 and 4.2 documents that the pre-school children had performed better in the skill of prediction than in the skill of hypothesizing. This observation is consistent with those made from table 4.1.
The conclusion was that the pre-school children were more competent in the skill of prediction than they were in that of hypothesizing.

4.2.2 Performance Results for the Children by Gender

Scores obtained in both tests were analysed based on gender of the pre-school children. The results are presented in Tables 4.2, 4.3, 4.4 and 4.5.

Table 4.2: Prediction Scores Obtained by All Children by Gender

<table>
<thead>
<tr>
<th>PREDICTION SCORES</th>
<th>Gender</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>20</td>
<td>14.00</td>
<td>32.00</td>
<td>18.00</td>
<td>20.80</td>
<td>4.27</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>20</td>
<td>12.00</td>
<td>26.00</td>
<td>14.00</td>
<td>17.60</td>
<td>4.48</td>
</tr>
</tbody>
</table>

From the table, it is observed that both the minimum and maximum scores obtained by the girls were higher than those obtained by the boys, and, that the girls scored a higher mean than the boys in the prediction scores. This suggested that girls performed better than the boys in the prediction test.

The table further shows a slightly higher standard deviation in the boys’ scores than that in the girls’ scores, an indication that most girls’ performance in the prediction test was generally the same, while there was a slightly wider variation amongst the boys in performance in the test.
Frequencies of scores obtained in the prediction test by all pre-school children by gender were presented by a line graph as shown in figure 4.3.

**Figure 4.3: Prediction Scores for All Children by Gender**

![Line graph showing prediction scores by gender](image)

Figure 4.3 presents line graphs depicting the performance of boys (M) and girls (F) in the prediction test. The line graph for the boys' scores is trimodal with a tendency to skew towards the left. The line graph for the girls' scores is also trimodal but with a tendency to slightly skew towards the right, an indication that most girls obtained higher scores than most boys. From these observations it can be concluded that most girls performed slightly better than most boys in the skill of prediction.
Observations and conclusions made from Table 4.2 and Figures 4.3 seemed to suggest a gender difference in pre-school children’s performance in the prediction test, with girls performing better than boys in the test. H₀₁ was tested to determine the significance of the difference.

H₀₁: There is no significant difference between the scores obtained by pre-school boys and by pre-school girls in the prediction test.

The results from the hypothesis testing are presented on Table 4.3 below.

**Table 4.3: t-Test for Pre-School Boys and Girls in Predicting**

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
<th>65% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig</td>
<td>t</td>
</tr>
<tr>
<td>prediction</td>
<td>.650</td>
<td>.425</td>
<td>-2.312</td>
</tr>
<tr>
<td>Equal variance assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td></td>
<td></td>
<td>-2.312</td>
</tr>
</tbody>
</table>

When tested, the significant value was 0.026 which was less than 0.05. The null hypothesis was rejected and the alternative hypothesis of a difference was thus accepted. It was concluded, therefore, that the performance of pre-school boys in the prediction test was significantly different from that of the pre-school girls.
The results obtained were consistent with the observations and conclusions made from Table 4.2 and Figure 4.3 that the girls performed better than the boys in the skill of prediction. The overall conclusion was that gender differences resulted in differences in performance in the prediction test.

Table 4.4: Hypothesizing Scores Obtained by All Children by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>20</td>
<td>0</td>
<td>20.00</td>
<td>20.00</td>
<td>4.45</td>
<td>6.86</td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>0</td>
<td>20.00</td>
<td>20.00</td>
<td>7.50</td>
<td>7.34</td>
</tr>
</tbody>
</table>

From Table 4.4, it is observed that the range of scores obtained by both boys and girls hypothesizing test were the same, but boys scored a slightly higher mean than the girls in the test. It is also observed that the boys' scores had a slightly higher standard deviation than that in the girls' scores, an indication that some boys had more variation in their performance than most girls. The conclusion was that most boys performed slightly better in the hypothesizing test than most girls.

Frequencies of scores obtained in the hypothesizing test by all pre-school children by gender were presented by a line graph as shown in figure 4.4.
Figure 4.4: Hypothesizing Scores for All Children by Gender

Figure 4.4 presents two line graphs skewed to the left. The graphs indicate that most girls (F) and most boys (M) obtained very low scores in the hypothesizing test. The conclusion is that both boys and girls were not competent in the skill of hypothesizing.

The figure also shows the line graph for the boys' scores being slightly above the line graph for the girls' scores. This indicates that boys performed slightly better in the test than the girls. This suggests that the boys were slightly better in the development of the skill of hypothesis than the girls.
Observations and conclusions made from Table 4.4 and Figure 4.4 seemed to suggest a gender difference in pre-school children's performance in the hypothesizing test, with boys performing slightly better than girls in the hypothesizing test. \( H_0 \) was tested to determine the significance of the difference.

**Ho2: There is no significant difference between the scores obtained by pre-school boys and by pre-school girls in the hypothesizing test.**

The results from the hypothesis testing are presented on Table 4.5 below:

**Table 4.5: t-Test for Pre-School Boys and Girls in Hypothesizing**

<table>
<thead>
<tr>
<th>Hypothesizing</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
<th>95% Confidence Interval of the Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal variance assumed</td>
<td>( F = 1.358, \text{Sig.} = .490 )</td>
<td>( t = 38, \text{df} = .182 )</td>
<td>( \text{Mean Difference} = 3.05, \text{Std. Error} = 2.25 )</td>
</tr>
<tr>
<td>Not assumed</td>
<td>( F = 37.826, \text{Sig.} = .182 )</td>
<td>( t = 38, \text{df} = .182 )</td>
<td>( \text{Mean Difference} = 3.05, \text{Std. Error} = 2.25 )</td>
</tr>
</tbody>
</table>

Upon testing, the significance level was 0.182 which was greater than 0.05. The null hypothesis was thus accepted, and the alternative hypothesis rejected. The conclusion was that there was no significant difference between the scores obtained by pre-school boys and those obtained by pre-school girls in the hypothesizing test.
The results obtained from testing of this hypothesis discounted the observations and conclusion made from Table 4.4 and Figure 4.4. Though the observations indicated that pre-school boys performed slightly better than girls in the skill of hypothesizing, the difference was insignificant. Thus gender differences did not indicate differences in performance in the hypothesizing test.

Testing of $H_0_1$ and $H_0_2$ indicated that gender was a determinant of performance in the prediction test but not a determinant in the hypothesizing test. The conclusion was that there could be gender differences in pre-school children’s performance in some science process skills but not in others.

4.2.3 Performance Results for the Children by Region

Scores obtained in both tests were analysed based on the regions. It should be noted that the following observation was made during the process of data collection. Some children had difficulty answering in the English language. Contrary to the observations made during the pilot study, a few pre-school children and especially those from the peri-urban region could not give explanations to observations made in English and instead tended to use the Kiswahili language more. Terms such as ‘iko na kilo’, ‘ni mzito’ ‘ni ndefu’, and ‘ni kubwa’ were used to mean ‘heavy’ while terms such as ‘si mzito’, ‘ni ndogo’ were used to mean ‘light’. In such situations, the researcher adjusted to
use English and Kiswahili accordingly to give instructions or to ask questions. In such cases, what is given in English in the findings is the researcher's translation of the pre-school children's responses.

The results are presented in Tables 4.6, 4.7, 4.8 and 4.9 as well as Figures 4.5 and 4.6 that follow.

Table 4.6: Prediction Scores Obtained By All Children by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>20</td>
<td>12</td>
<td>26</td>
<td>14</td>
<td>20.20</td>
<td>3.83</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>20</td>
<td>12</td>
<td>32</td>
<td>20</td>
<td>18.20</td>
<td>5.19</td>
</tr>
</tbody>
</table>

From Table 4.6, it is observed that although the range for the peri-urban pre-school children ended at a higher point, rural pre-school children scored a slightly higher mean than the peri-urban pre-school children in the prediction scores. This suggested that rural pre-school children performed slightly better than the peri-urban pre-school children in the prediction test.

The table further indicates a slightly higher standard deviation in the peri-urban pre-school children's scores than that in the rural pre-school children's scores. This meant that most rural pre-school children obtained scores that were
concentrated around the mean while most peri-urban pre-school children obtained scores that were spread from the mean. The conclusion was that most rural pre-school children performed slightly better in the prediction test than most peri-urban pre-school children, suggesting that rural pre-school children were slightly more competent in the skill of prediction than the peri-urban pre-school children.

Frequencies of scores obtained in the prediction test by all pre-school children by region were presented by a line graph as shown in Figures 4.5.

Figure 4.5: Prediction Scores for All Children by Region
Figure 4.5 presents two line graphs. The line graph representing the scores obtained by rural (R) pre-school children in the prediction test is bimodal with the score of 22 having the highest frequency. The graph appears to be skewed towards the right indicating that most rural pre-school children obtained high scores in the test. On the other hand, the line graph representing the scores obtained by peri-urban (PU) pre-school children in the prediction test is trimodal with the score of 14 having the highest frequency. The graph appears to be skewed towards the left indicating that most peri-urban pre-school children obtained low scores in the test. The conclusion was that rural pre-school children performed better in the prediction test than the peri-urban pre-school children.

Results from Table 4.6 and Figure 4.5 suggested a regional difference in pre-school children’s performance in the prediction test with rural pre-school children performing slightly better in the test. \(H_0\) below was used to test the extent of the difference.

\(H_0\): There is no significant difference between the scores obtained by rural pre-school children and by peri urban pre-school children in the prediction test.

The results from the hypothesis testing are presented on Table 4.7 below.
### Table 4.7: t-Test for Rural and Peri-urban Children in Predicting

<table>
<thead>
<tr>
<th>Levene’s Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
<th>95% Confidence Interval of the Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Sig.</td>
<td>t</td>
</tr>
<tr>
<td>prediction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variance assumed</td>
<td>1.447</td>
<td>.236</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>1.387</td>
<td>34.986</td>
</tr>
</tbody>
</table>

When tested, the significant value was found to be 0.174 which was higher than 0.05. This null hypothesis was thus accepted and the alternative hypothesis rejected. The conclusion was that the performance of rural preschool children in the prediction test was not significantly different from that of peri-urban pre-school children.

The results obtained from testing of this hypothesis did not wholly support the observations and conclusion made from Table 4.6 and Figure 4.5. Though the observations and conclusions suggested a slight regional difference in preschool children’s performance in the prediction test, the difference was insignificant.
From Table 4.8, it is observed that though the range for scores obtained by both the rural and peri-urban pre-school children in the hypothesizing test was the same, the mean score for the peri-urban children was slightly higher than that obtained by the rural pre-school children. This suggested that the peri-urban pre-school children performed slightly better in the hypothesizing test than the rural pre-school children.

 Frequencies of scores obtained in the hypothesizing test by all pre-school children by region were presented by a line graph as shown in figure 4.6.

Table 4.8: Hypothesizing Scores Obtained By All Children by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>5.55</td>
<td>6.76</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>6.40</td>
<td>7.72</td>
</tr>
</tbody>
</table>
Figure 4.6 presents two line graphs both of which appear to be skewed to the left and with the mode being zero in both cases. These indicate that most rural (R) as well as most peri-urban (PU) pre-school children obtained very low scores in the hypothesizing test. This suggested that both rural and peri-urban pre-school children had not quite developed the skill of hypothesizing. The two line graphs appear to be running close to each other with none of the lines making a remarkable deviation from the other. It was not possible, therefore, to make a concrete conclusion of a difference as suggested by Table 4.8. Ho₄ below was tested to establish the existence and the extent of the difference if
Ho₄: There is no significant difference between the scores obtained by rural pre-school children and by peri-urban pre-school children in the hypothesizing test.

The results of the hypothesis testing are depicted in the table below.

Table 4.9: t-Test for Rural and Peri-urban Children in Hypothesizing

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Equal variances assumed</th>
<th>Equal variances not assumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene's Test for Equality of Variances</td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Levene's Test for Equality of Means</td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Equal variances assumed</td>
<td>Equal variances not assumed</td>
</tr>
<tr>
<td>Levene's Test for Equality of Variances</td>
<td>.367</td>
<td>.548</td>
</tr>
<tr>
<td>Levene's Test for Equality of Means</td>
<td>.367</td>
<td>.548</td>
</tr>
</tbody>
</table>

When tested, the significant value was 0.713 which was greater than 0.05. This null hypothesis was thus accepted and the alternative hypothesis rejected. The conclusion was that the performance of rural pre-school children in the hypothesizing test was not significantly different from that of peri-urban pre-school children. The results obtained from testing of this hypothesis did not wholly support the observations and conclusion made from Table 4.8 and Figure 4.6. Though there appeared to be a slight regional difference in pre-school children's performance in the skill of hypothesizing, the difference was
Results obtained from testing hypotheses $H_0^3$ and $H_0^4$ confirmed that there was no significant difference between the scores obtained by rural pre-school children and those obtained by peri-urban pre-school children in either the prediction or hypothesizing tests. The conclusion was that region was not a determinant of performance in either of the tests in as far as pre-school children were concerned.

4.2.4 Results for Female Children by Region

The scores obtained by the girls in the two tests were analysed based on the regions. The results were presented in Tables 4.10, 4.11, 4.12 and 4.13. They were also presented in form of line graphs as shown in Figures 4.7 and 4.8.

Table 4.10: Prediction Scores Obtained by all Female Children by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>10</td>
<td>14</td>
<td>24</td>
<td>10</td>
<td>20.80</td>
<td>3.16</td>
</tr>
<tr>
<td>Peri-Urban</td>
<td>10</td>
<td>14</td>
<td>32</td>
<td>18</td>
<td>20.80</td>
<td>5.35</td>
</tr>
</tbody>
</table>

Table 4.10 indicates equal mean scores for both rural and peri-urban girls. However, the standard deviation and the range were higher and wider
respectively for the peri-urban girls. This suggested that most peri-urban girls may have performed better in the prediction test than most rural girls.

The conclusion made from Table 4.10 seemed to suggest a regional difference in the pre-school girls’ in performance in the prediction test with some peri-urban girls performing slightly better in the tests than the rural girls.

Frequencies of scores obtained in the prediction test by all girls by region were also presented by a line graph as shown in Figure 4.7.

**Figure 4.7: Prediction Scores for all Girls by Region**

![Graph showing prediction scores for all girls by region](image)

Figure 4.7 presents two line graphs both of which are tri-modal and both of which indicate that scores for all the pre-school children were above 14. The line graph representing scores obtained in the prediction test by rural (R) girls
has the highest mode as 20. The line graph representing scores obtained in the prediction test by peri-urban (PU) girls has the highest modes as 20 and 24. The high modes of 20 and 24 seemed to suggest that peri-urban pre-school girls performed better than rural pre-school girls in the prediction test. The observations were consistent with those made from Table 4.10.

Results from Table 4.10 and Figure 4.7 suggested a regional difference in pre-school girls’ performance in the prediction test with peri-urban girls performing slightly better than the rural girls in the test. Ho5 below was used to test the extent of the difference.

**Ho5:** There is no significant difference between the scores obtained by rural pre-school girls and by peri-urban pre-school girls in the prediction test.

The results of the hypothesis testing are depicted in the table below.

**Table 4.11: t-Test for Rural and Peri-Urban Girls in Predicting**

<table>
<thead>
<tr>
<th>Levene's Test for Equality of Variances</th>
<th>t-Test for Equality of Means</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Sig</td>
<td>Mean Difference</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>1.530</td>
<td>.232</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

89
The significant value was 1.000 which was greater than 0.05. The null hypothesis was thus accepted and the alternative hypothesis rejected. Hence, it was concluded that there was no significant difference between the scores obtained by rural pre-school girls and those obtained by peri-urban pre-school girls in the prediction test.

The results obtained from testing of this hypothesis did not support the observations and conclusions made from Table 4.10 and Figure 4.7. Though there appeared to be a regional difference in the performance in the skill of prediction amongst the pre-school girls, the difference was insignificant. The conclusion was that region was not a determinant of performance in the skill of prediction amongst the pre-school girls.

Table 4.12: Hypothesizing Scores Obtained by all Female Children by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Scores Difference</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>10</td>
<td>0</td>
<td>14</td>
<td>14</td>
<td>3.90</td>
<td>6.30</td>
</tr>
<tr>
<td>Peri-Urban</td>
<td>10</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>5.00</td>
<td>7.67</td>
</tr>
</tbody>
</table>

From Table 4.12, it is observed that the range for scores obtained by peri-urban pre-school girls in the hypothesizing test stopped at a higher point than that for scores obtained by rural pre-school girls. This suggests that some peri-urban
pre-school girls performed better than some rural pre-school girls in the test. The table further indicates that the mean score for the peri-urban pre-school girls in the test was slightly higher than that for scores obtained by rural pre-school girls, a further indication that the former performed slightly better than the later.

It is also observed that the standard deviation for the scores obtained by peri-urban pre-school girls was slightly higher than the standard deviation of the scores obtained by rural pre-school girls, an indication that the scores for the peri-urban pre-school girls were more dispersed from the mean than that for scores obtained by rural pre-school girls. This seemed to suggest that some peri-urban pre-school girls performed slightly better than some rural pre-school girls in the hypothesizing test.

Frequencies of scores obtained in the hypothesizing test by all pre-school girls by region were presented by a line graph as shown in Figure 4.8.
The figure presents two line graphs that tend to be skewed towards the left. The skewed graphs indicate that most rural (R) and most peri-urban (PU) girls obtained very low scores in the hypothesizing test. The observation was that most girls performed poorly in the hypothesizing test.

Results from Table 4.12 suggested a regional difference in pre-school girls' performance in the hypothesizing test with peri-urban girls performing slightly better in the test. However, it was not clear from Figure 4.8 whether there was any regional difference. $H_0$ below was used to test the existence and the
Ho: There is no significant difference between the scores obtained by rural pre-school girls and by peri-urban pre-school girls in the hypothesizing test.

The results of the hypothesis testing are depicted in the table below.

Table 4.13: t-Test for Rural and Peri-urban Girls in Hypothesizing

<table>
<thead>
<tr>
<th></th>
<th>Independent Samples Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Levene's Test for</td>
</tr>
<tr>
<td></td>
<td>Equality of Variances</td>
</tr>
<tr>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Hypothesizing</td>
<td>.041</td>
</tr>
<tr>
<td>Equal variances</td>
<td>assumed</td>
</tr>
<tr>
<td>Hypothesizing</td>
<td>not assumed</td>
</tr>
<tr>
<td>Equal variances</td>
<td>assumed</td>
</tr>
<tr>
<td></td>
<td>not assumed</td>
</tr>
</tbody>
</table>

Upon testing the hypothesis, the significant value was found to be 0.730 which was greater than 0.05. This null hypothesis was thus accepted and the alternative hypothesis rejected. Thus, there was no significant difference between the scores obtained by rural pre-school girls and those obtained by peri-urban pre-school girls in the hypothesizing test. The results obtained from testing of this hypothesis did not support the observations and conclusion made from Table 4.12. Though there appeared to be a slight regional difference in the performance in the skill of hypothesizing amongst the girls, the difference
was insignificant. The conclusion was that region was not a determinant of performance in the skill of hypothesizing amongst the girls.

The results obtained from testing of $H_05$ and $H_06$ indicated no significant difference between the scores obtained by rural pre-school girls and those obtained by peri-urban pre-school girls in either the prediction or the hypothesizing tests. The conclusion was that region was not a determinant of performance in the two tests in as far as girls were concerned.

4.2.5 Results for Male Children by Region

The scores obtained by the boys in the two tests were analysed based on the regions. The results for the prediction test were presented in tables 4.14 and 4.15 as well as in and figures 4.9. Results for the hypothesizing test were presented in tables 4.16 and 4.17 as well as in and figures 4.10 that follow.

Table 4.14: Prediction Scores Obtained by all Male Children by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Range</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>10</td>
<td>12</td>
<td>26</td>
<td>14</td>
<td>19.60</td>
<td>4.50</td>
</tr>
<tr>
<td>Peri-Urban</td>
<td>10</td>
<td>12</td>
<td>24</td>
<td>12</td>
<td>15.60</td>
<td>3.63</td>
</tr>
</tbody>
</table>

The table indicates a high maximum score for pre-school boys from both
regions. However, it is observed that the range for scores obtained in the prediction test by rural (R) pre-school boys ended at a slightly higher point than the range for scores obtained by the peri-urban (PU) pre-school boys, an indication that some rural pre-school boys obtained higher scores than the peri-urban pre-school boys. It is also observed that the mean for scores obtained by the rural pre-school boys in the prediction test was higher than that obtained by peri-urban pre-school boys, a further indication that rural pre-school boys had performed better in the prediction test than peri-urban pre-school boys. This suggested that the rural pre-school boys performed slightly better than the peri-urban pre-school boys.

The table also indicates a standard deviation of 4.50 for the scores obtained by rural pre-school boys in prediction scores and a standard deviation of 3.63 for the scores obtained by peri-urban pre-school boys. This suggests that some rural pre-school boys had obtained scores which were slightly higher than those obtained by the peri-urban pre-school boys. The conclusion was that rural pre-school boys performed slightly better than peri-urban pre-school boys in the prediction test.

Frequencies of scores obtained in the prediction test by pre-school boys from both regions were presented on a graph as shown in Figure 4.9.
Figure 4.9: Prediction Scores for all Boys by Region

Figure 4.9 presents two line graphs that tend to be skewed in different directions. This suggests that the rural (R) pre-school boys performed differently from the peri urban (PU) pre-school boys in the prediction test. The scores obtained by peri-urban pre-school boys show a tri-modal pattern with 14 being the highest mode, and 24 being the lowest. On the other hand, the scores obtained by rural pre-school boys were skewed to the right and had a mode of 22. This suggested that most rural pre-school boys had obtained scores that were higher than those scored by most peri-urban pre-school boys. The conclusion was that most rural pre-school boys performed better in the prediction test than most peri-urban pre-school boys.
Table 4.14 and Figure 4.9 seemed to suggest a regional difference between the pre-school boys' performance in the prediction test with rural pre-school boys performing better than the peri-urban pre-school boys in the test. H07 below was used to determine the degree of significance of the difference.

**H07:** There is no significant difference between the scores obtained by rural pre-school boys and by peri-urban pre-school boys in the prediction test.

The results of the hypothesis testing are shown in Table 4.15 below.

**Table 4.15: Test for Rural and Peri-urban Boys in Predicting**

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
<th>95% Confidence Interval of the Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>t</td>
</tr>
<tr>
<td>Predicti Equal variances assumed</td>
<td>.908</td>
<td>.353</td>
<td>2.188</td>
</tr>
<tr>
<td>Predicti Equal variances not assumed</td>
<td>2.188</td>
<td>17.220</td>
<td>.043</td>
</tr>
</tbody>
</table>

The significant value was found to be 0.042 which was less than 0.05. This null hypothesis was thus rejected and the alternative hypothesis accepted. The conclusion was that there was a significant difference between the scores obtained by rural pre-school boys and those obtained by peri-urban pre-school boys in the prediction test. The results obtained from testing of this hypothesis...
were consistent with the observations and conclusion made from Table 4.14 and Figure 4.9 that rural pre-school boys performed better than peri-urban pre-school boys in the skill of prediction. The conclusion was that region was a determinant in pre-school boys’ performance in the skill of prediction.

Table 4.16: Hypothesizing Scores Obtained by all Male Children by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Range</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>10</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>7.20</td>
<td>7.13</td>
</tr>
<tr>
<td>Peri-Urban</td>
<td>10</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>7.80</td>
<td>7.91</td>
</tr>
</tbody>
</table>

From Table 4.16, it is observed that the mean for the scores obtained by peri-urban pre-school boys in the hypothesizing test was slightly higher than that of scores obtained by the rural pre-school boys. It is further observed that the standard deviation for the scores obtained by peri-urban pre-school boys in the hypothesizing test was also slightly higher than that of scores obtained by the rural pre-school boys. This suggested that some peri-urban pre-school boys obtained scores that were slightly higher than those obtained by the rural pre-school boys.

Frequencies of scores obtained in the hypothesizing test by pre-school boys from both regions were presented by a line graph as shown in Figure 4.10.
Figure 4.10: Hypothesizing Scores for all Boys by Region

Observations and conclusions made from Table 4.16 seemed to suggest a regional difference in pre-school boys’ performance in the hypothesizing test, with the peri-urban boys performing slightly better in the test. However, this difference was not clear from Figure 4.10. Ho8 below was used to determine the existence and extent of the difference if any.

Ho8: There is no significant difference between the scores obtained by rural pre-school boys and by peri-urban pre-school boys in the
hypothesizing test.

Results of this hypothesis testing are presented below.

Table 4.17: T-Test for Rural and Peri-urban Boys in Hypothesizing

<table>
<thead>
<tr>
<th>Hypothesizing</th>
<th>Levene's Test for Equality of Variances</th>
<th>Independent Samples Test</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing</td>
<td>F</td>
<td>Sig.</td>
<td>t</td>
</tr>
<tr>
<td>Equal variance assumed</td>
<td>.577</td>
<td>.457</td>
<td>.178</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>.178</td>
<td>17.808</td>
<td>.861</td>
</tr>
</tbody>
</table>

The significant value was found to be 0.861 which was greater than 0.05. This null hypothesis was thus accepted and the alternative hypothesis rejected. The hypothesis seemed to suggest no significant difference between the scores obtained by rural pre-school boys and those obtained by peri-urban pre-school boys in the hypothesizing test. The results obtained from testing of this hypothesis did not wholly support the observations and conclusion made from Table 4. Though there appeared to be a slight regional difference in the performance in the skill of hypothesizing amongst the boys, the difference was not statistically significant. The conclusion drawn was that region was not a determinant of performance in the skill of hypothesizing amongst pre-school boys.
Testing of $H_0_7$ confirmed a regional difference in the pre-school boys’ performance in the prediction test while $H_0_8$ did not confirm a regional difference in the pre-school boys’ performance in the hypothesizing test. The conclusion was that there could be regional differences in performance in some science process skills but not in others.

4.2.6 Relationship in Children’s Performance in the Prediction and the Hypothesizing Tests

Conclusions made from Table 4.1 and Figures 4.1 and 4.2 indicated that pre-school children could perform in both the prediction and hypothesizing tests. The researcher sought to determine whether there was any relationship in the performance in the two tests either amongst all the pre-school children or amongst pre-school children in the different gender. $H_0_9$, $H_0_{10}$ and $H_0_{11}$ below were tested to determine the situation. Pearson Product Moment correlation was used to test these hypotheses. Prediction scores were used as the first variable while scores in the hypothesizing test were used as the second variable.

$H_0_9$: There is no significant relationship between the scores obtained by pre-school children in the prediction test and in the hypothesizing test.

The results of the test of this hypothesis are shown in Table 4.18 below.
Table 4.18: Pearson’s Product Moment Correlation Coefficient of Pre-School Children’s Performance in the Prediction and Hypothesizing Tests

<table>
<thead>
<tr>
<th></th>
<th>prediction</th>
<th>hypothesiz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prediction</td>
<td>Pearson Correlation</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>40</td>
</tr>
<tr>
<td>hypothesiz</td>
<td>Pearson Correlation</td>
<td>-.115</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.479</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>40</td>
</tr>
</tbody>
</table>

The value of $p$ was found to be -0.115 which was closer to 0, suggesting a very weak negative correlation. Further, the significant level was found to be 0.479 which was greater than 0.05, an indication that the correlation was not significant. The null hypothesis was thus accepted and the alternative hypothesis rejected. The conclusion was that the pre-school children’s scores in the prediction test were not linearly related to the scores in the hypothesizing test. Thus, performance in one test did not depend on performance in the other test.

To find out whether any relationships existed within each gender, the following two hypotheses were tested.

**Ho$_{10}$**: There is no significant relationship between the scores obtained by
boys in the prediction test and in the hypothesizing test.

The results of the test of this hypothesis are shown in Table 4.19 below.

Table 4.19: Pearson’s Product Moment Correlation Coefficient of Pre-School Boys’ Performance in the Prediction and Hypothesizing Tests

<table>
<thead>
<tr>
<th>Correlations</th>
<th>prediction</th>
<th>hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>prediction</td>
<td>1.000</td>
<td>-0.058</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.809</td>
</tr>
<tr>
<td>N</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>hypothesiz</td>
<td>-0.058</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.809</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

The value of \( p \) was found to be -0.058 which was very close to 0, suggesting an almost non existent negative relationship. Further, the significant level was found to be 0.809 which was much greater than 0.05, an indication that the correlation was not significant. The null hypothesis was thus accepted and the alternative hypothesis rejected. The conclusion was that the boys’ scores in the prediction test were not linearly related to the scores in the hypothesizing test. The study, thus, suggested that performance of pre-school boys in one test did not depend on performance in the other test.

\( H_{o11} \): There is no significant relationship between the scores obtained by pre-school girls in the prediction test and in the hypothesizing test.
The results of the test of this hypothesis are shown in Table 4.20 below.

**Table 4.20: Pearson’s Product Moment Correlation Coefficient of Pre-School Girls’ Performance in the Prediction and Hypothesizing Tests**

<table>
<thead>
<tr>
<th></th>
<th>prediction</th>
<th>hypothesiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>1.000</td>
<td>-0.027</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.909</td>
</tr>
<tr>
<td>N</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

The value of ρ was found to be -0.027 which was closer to 0, suggesting an almost non-existent negative relationship. Further, the significant level was found to be 0.909 which was much greater than 0.05, an indication that the correlation was not significant. The null hypothesis was thus accepted and the alternative hypothesis rejected. The conclusion was that the girls’ scores in the prediction test were not linearly related to the scores in the hypothesizing test. Thus, pre-school girls’ performance in one test did not depend on performance in the other test.

From Ho9, H010 and H011, the study seemed to suggest no significant relationship between performances in the prediction test and performances in the hypothesizing test by pre-school children. The conclusion was that the two
process tests are distinct and performance in one test was not associated with performance in the other test in as far as pre-school children were concerned.

4.3 Discussion of the Findings

This section discusses the findings from this study.

4.3.1 Performance in Science Process Skills

The findings from this study indicate that the five-year-old pre-school children under study were able to perform in the prediction and hypothesizing tests. These findings are consistent with those of Piaget (Piaget, J. & Inhelder, B., 1941). Piaget reports that five- and six-year-olds can sort objects according to predicted action in water but their classifications are not coherent. The findings are also consistent with those of Almy, Chittenden and Miller, (1966). Their findings indicated that pre-school children could predict but the explanations given were merely naming the objects or the water or just giving the properties of the objects or water.

The results of this study on pre-school children's performance in science process skills were also compatible with Piaget's view that the pre-operational period is a period of "intuitive thought", largely based on perception. It can be concluded, therefore, that Kenyan pre-school children were developing within Piaget's framework of cognitive development. Consequently, the pre-school
children were developing science process skills as dictated by the ECE science curriculum (NACECE/KIE, 1997). Thus, the pre-school children were forming a good foundation for science education. The poor performance in science observed in higher levels was not, therefore, based at the pre-school level. It could be that the poor performance was based at subsequent levels.

The findings of this study also indicated that pre-school children performed much better in the prediction test than in the hypothesizing test. The differential in performance in the two skills may be explained in four ways. First, it could be that the children had been exposed to more prediction than hypothesizing experiences an indication of imbalance in exposure of pre-school children to experiences that could promote performance in the two science process skills. Secondly, it could be that the skill of prediction had been given preference in teaching while that of hypothesizing was ignored. This could happen especially where teachers felt incompetent to handle the hypothesizing skill. Thirdly, it could be that the skill of hypothesizing was more advanced for pre-school children than that of prediction which could mean that inclusion of the hypothesizing skill as content in the curriculum for pre-school education was not developmentally appropriate. A fourth reason could be that the children were not comfortable with the ‘why...?’ question. According to Kiminyo (1973), in African culture, to ask the question ‘why’ after a child has made a statement or carried out an activity may suggest to the
child that the statement or the activity is wrong and therefore it should be corrected. The child may get confused and give a contradictory answer or the child may change the statement to a new one. It may not, at this point, be possible to isolate the reason that could have contributed to the differential in performance in the two tests. Perhaps further research could help identify the possible reason.

4.3.2 Gender Differences in Performance

The results of this study revealed a significant gender difference in performance in the prediction test. This finding supports similar findings of several other researchers. (Comber and Keeves, 1973; Assessment of Performance Unit, 1983; Erickson and Erickson 1984; Twoli, 1986; Otieno-Alego, 1987; Oganda, 1991; Jones, Mullis, Raizen, Weiss and Weston 1992). The findings of these researchers indicated a gender difference in performance in science with the difference being reported as early as age nine and the gap widening as students progressed through other educational levels. This finding of gender difference however disagrees with most other findings that girls were always the ones underperforming. This study showed that girls scored significantly higher than boys in the prediction test an indication that girls could perform just as well as or even better than boys in science process skills. The study did not observe any significant gender differences in performance in the hypothesizing test, an indication that girls performed just as well or as
badly as the boys in the hypothesizing test. The conclusion was that there could be gender differences in pre-school children’s performance in some science process skills but not in others. It was also concluded that girls had the same ability to perform just as well as or even better than boys in the science process skills tested.

The significant gender differences revealed in performance in some science process skills with the performance favouring girls is a shift from findings in most past researches which reported gender differences that were in favour of boys (Comber and Keeves, 1973; Erickson and Erickson 1984; Ogonda, 1991; Jones, Mullis, Raizen, Weiss and Weston, 1992; Twoli, 1986). This could mean that efforts by stakeholders to bridge the gap between boys’ and girls’ performances in science were bearing fruits. Twoli (1985) had suggested that if children are given equal levels of motivation and learning resources, girls may perform just as well as the boys. This study confirms this belief.

4.3.3 Regional Differences in Performance

The results of this study indicated a significant regional difference in performance in the prediction test. This finding supported similar findings of Kodero (1985) and Ogonda (1991) both of who had found out that pupils in rural and urban environments differed on overall performance in academic achievement. However, the results disagreed with their findings that urban
pupils did better overall than their rural counterparts. The study findings indicated that rural boys performed significantly better in the prediction test than the peri-urban boys. However, the study did not observe any significant regional difference in boys’ performance in the hypothesizing test. The study also did not reveal any significant differences among the girls in performance in either of the tests. The conclusion was that region was a determinant of performance in some science skills but not in others.

The study revealed inability of some pre-school children, especially those from the peri-urban region, to explain scientific observations in English. This revelation suggests problems in either development of scientific concepts or development of English language among some pre-school children. These problems could have arisen probably because English was either a second, third or even a fourth language in the regions studied. The children’s understanding and communication could, therefore, have been hampered by multiple languages. According to Aikenhead, Jegede and Kyle (1999), academic knowledge and scientific concepts are mediated through children’s mother tongue—or first language—, but not through a language that is introduced to them in formal education. Unfortunately, most textbooks in the school system in Kenya are written in English and teachers may not have the ability to effectively and accurately translate and/or interpret the English texts into mother tongue (Nzomo et al, 2002). Secondly, the peri-urban region under
study hosted a mixture of communities from different ethnic groups and it would not have been possible for teachers to use any one of the mother tongue languages to teach. As a result, pre-schools were left to choose between Kiswahili and English as the languages of instruction. The two languages were the more heterogeneous languages amongst the different communities in the region. It may be that the pre-schools from where the affected children came chose to use Kiswahili as the method of instruction without blending it with English. It was the view of the researcher that English be blended with a first language in the teaching of science to enable the children reap maximum benefit.

4.3.4 Relationship between Performance in Different Science Process Skills

The findings of this study indicated no significant relationship between performance in the skill of prediction and performance in the skill of hypothesizing. Thus, a child needed not to be necessarily good in the skill of prediction in order to perform well in the skill of hypothesizing and vice versa. The conclusion was that some process skills such as prediction and hypothesizing were distinct science areas and can be learned and assessed independently.

4.4 Summary

This chapter had two main sections. The first section dealt with analysis of the
data collected while the second section discussed the findings arising from the analysis. The data were analysed inferentially using the range, mean and standard deviation. The data were also analysed statistically where eleven hypotheses were tested at a significant level of $\alpha = 0.05$. Analysis of the data resulted in four major findings. The second major section discussed these findings. Chapter Five discusses the implications of these findings and the consequent recommendations.
CHAPTER FIVE
SUMMARY, IMPLICATIONS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of the findings of this study. The implications arising thereof and the conclusions derived from the results of the study are then discussed. The chapter concludes by presenting the recommendations made from the study.

5.1 Summary of Findings

The analysis generated four main findings as follows:

1. Pre-school children could predict and hypothesize outcomes of the sinking and floating activities. However, the children performed much better in the prediction test than in the hypothesizing test.

2. A gender difference in performance in the prediction test was observed with the pre-school girls scoring significantly higher than pre-school boys did in the test. No such differences were observed in performance in the hypothesizing test.

3. There was a regional difference in the pre-school boys’ performance
in the prediction test with rural pre-school boys performing significantly better than the peri-urban pre-school boys. No such differences were observed in the pre-school boys’ performance in the hypothesizing test. Also no such significant differences were observed in the pre-school girls in performance in either of the tests.

4. There was no significant relationship between pre-school children’s performance in the prediction test and performance in the hypothesizing test.

5. Some pre-school children, especially those from the per-urban areas, had difficulty expressing themselves in the English language and preferred to use Kiswahili as their mode of expression.

5.2 Implications

This section presents the implications of each of the findings from this study. In addition, implications of the pre-school children’s inability to explain scientific observations in English are discussed. Finally, implications of the experiments used in the study are discussed.

5.2.1 Implication of Level of Performance in Science Process Skills

The results of this study indicated that pre-school children could perform in the
two science process skills assessed. This reveals that pre-school children are learning science process skills as is expected by curriculum developers. Preschool teachers should therefore be encouraged to continue teaching science process skills as directed by the guidelines for ECE science. Standard I teachers should then build on the foundation laid at ECE level in order to ensure that pupils performed well in science process skills in subsequent levels. This could contribute to improved performance in science at higher levels.

The results also indicated that the pre-school children’s performance was better in the prediction test than in the hypothesizing test. The differential in performance in the two tests may suggest lack of exposure of pre-school children by their parents and/or teachers to experiences that could promote performance in the skill of hypothesizing. This has an implication for parents of pre-school children as well as pre-school teachers. They need to provide activities to develop all of the science processing skills.

The differential could also suggest that, in the process of teaching, the skill of prediction had been given preference while that of hypothesizing had been ignored. This could happen especially where teachers felt incompetent to handle the hypothesizing skill probably due to poor training. Lack of the teachers’ confidence and competence could influence learners’ achievement (Cunningham & Blankenship, 1979; Hone, 1976; cited in Wenner & Stevens,
This has an implication for teacher trainers. They need to assess knowledge and competence of the trainees in both processing skills as well as appropriate activities for children to develop both skills.

The differential in performance in the two tests could also suggest that the skill of hypothesizing was less advanced for pre-school children than that of prediction. This could mean that some content in the curriculum for pre-school education was not developmentally appropriate. This has an implication for the curriculum developers.

The findings also have implications for further research. Studies are needed to determine the causes of differential in performance in different science process skills.

5.2.2 Implication of Gender Differences in Performance in Science Process Skills

The study suggested some significant gender differences in pre-school children’s performance in the prediction test with pre-school girls performing significantly better than the pre-school boys in the test. No such differences were observed in performance in the hypothesizing test, an indication of gender differences in performance in some process skills. These gender differences could mean that pre-school girls were more exposed than the pre-
school boys to experiences that promoted development some process skills such as the skill of prediction. There was need for both pre-school boys and pre-school girls to be equally socialised. This has an implication for parents as well as for pre-school teachers. Both need to encourage and stimulate both boys and girls in the development of prediction and other process skills.

They also have implications for further research to determine whether gender differences existed in other science process skills. The research could also focus on causes of gender differences in pre-school children’s performance in science process skills.

5.2.3 Implication of Regional Differences in Performance in Science Process Skills

The study suggested regional differences in pre-school boys’ performance in the prediction tests with rural pre-school boys performing significantly better than peri-urban pre-school boys in the prediction test. No similar differences were observed in performance in the hypothesizing test. The difference observed could mean that rural pre-school boys were more exposed than the peri-urban pre-school boys to experiences that favour them in the development of the skill of prediction. Perhaps the difference in exposure to a variety of experiences and activities in the different environments has a bearing on the promotion of prediction ability observed amongst the pre-school children in
this study. The researcher’s suggestion was that pre-school children be exposed to different regions so as to gain from experiences from these regions. This finding has implications for parents and teachers. They need to consider situations in their environment that enhance or inhibit the development of process skills and work to enhance their development accordingly.

The finding also has an implication for further research to determine whether similar differences would exist with other science process skills not used for this study. Research could also be carried out to determine the cause of the observed differences.

5.2.4 Implication of Lack of Relationship Between Performance in Science Process Skills

The study indicated no significant relationship between performances in the two process skills assessed. This suggested that the two process skills are distinct and performance in one was not associated with performance in the other an indication that the two skills could be taught and assessed independently. This finding has an implication for pre-school teachers. They need to develop classroom activities that will enhance each of the process skills.

There is also an implication for further research. This research was done in
one area and with a small group of children. The results may not be generalisable to other children of the same age in other geographical areas of Kenya.

5.2.5 Implication of Children’s Inability to Respond in English Language

That children in the peri-urban areas had difficulty responding in the English language has implications for pre-school teachers and their trainers. Teachers need to be trained and frequently assessed in teaching method using multiple languages. Teachers need to develop competence in bridging science concepts from one language to another so that children science concepts are mentally represented in mother tongue, Kiswahili and English.

The observations above have implications for the language policy at ECE level. The policy needs to address the issue of concept formation in multiple languages and issues relating to teacher preparation for this complex teaching methodology.

Finally, there are implications for parents on teaching of languages to their young children during the early years. Parents need to encourage development of multiple language learning as children attend pre-schools.
5.2.6 Implications of the Use of the Floating and Sinking Experiment

The floating and sinking experiment used for this study is simple, interesting and involves the use of objects and materials that are locally available. Secondly, though the experiments in this study indicate an individual approach, there are many possibilities for the teacher to work with several children but at the same time insure freedom for each child to reveal his/her own thoughts. This could be done by guiding the children to discuss in groups as they carry out the experiments. This has an implication on the teaching practices. Pre-school teachers could easily replicate this experiment with similar material obtained from the local environment and use it to teach or investigate the children's achievement of a variety of science process skills with a view to assessing their children's level of predicting and hypothesizing and then by providing them many similar activities with various materials to enable the children to develop these skills.

5.3 Conclusion

From the analysis and discussions made, it emerges that pre-school children in Kenya were forming science process skills. The development of science process skills at this educational level is good news since the skills can be retained for future use (Wideen, 1975; McCathery, 1970; Quinn and George 1975; Wright, 1981). The skills can also enhance the children's attitude towards learning science (Okere, 1997) and may also be transferred to other
areas of learning (Tomera, 1974; Padilla, Cronin, and Twiest, 1985; Thiel and George, 1976; Allen, 1973). Teachers at lower primary should build on this foundation and prepare children to perform well in science at subsequent levels. The problem in performance in science at higher levels is not, therefore, as a result of a poor foundation at the pre-school level. Perhaps the problem occurs during the transition from pre-school to primary Standard I. At this level, a child is overloaded in that there are many other changes taking place at this time. Such changes include introduction of a new system, increase in subjects, change of teachers, new timetable schedules, pressure on teachers to end lessons as stipulated (Nzomo et al, 2002) and, may be, encounter with many other older children in the primary school. The problem in performance in science could also be at other intermediate levels for reasons related to school factors, the societal attitudes, teacher factors or any other unknown factor. There is need for more research to be carried out in science process skills in standard I and in other subsequent levels of education to establish the source of students’ poor performance in science at higher levels of education.

The study also reveals differentials in the development of some of the science process skills. The differential in development should cause concern since many process skills operationally depend on each other (Aikenhead, 1998). There is need to put interventions in place to ensure that pre-school children develop all science process skills as is developmentally appropriate.
The significant gender differences revealed in performance in some science process skills with the performance favouring girls is a shift from findings in most past researches which reported gender differences that were in favour of boys (Comber and Keeves, 1973; Erickson and Erickson 1984; Ogonda, 1991; Jones, Mullis, Raizen, Weiss and Weston, 1992; Twoli, 1986). This could mean that efforts by stakeholders to bridge the gap between boys’ and girls’ performances in science were bearing fruits. Twoli (1985) had suggested that if children are given equal levels of motivation and learning resources, girls may perform just as well as the boys. The researcher would encourage teachers and other stakeholders to continue with whatever interventions are in place and to ensure that both boys and girls are equally catered for.

The study further revealed a regional difference in the boys’ performance in some science process skills with rural boys performing significantly better than the peri-urban boys. This again was a deviation from most past findings that had reported regional differences in performance in science with urban pupils doing significantly better than their rural counterparts (Kodero, 1985; Ogonda, 1991). The observed differences suggested that both rural and urban environments are dissimilar in terms of objects and phenomena. Children should, therefore, be exposed to both environments in order to benefit from both environments. This could enhance their performance in science.
The study also indicates no significant relationship between pre-school children’s performance in different science process skills. The significance in this is that children can develop different science process skills independent of other skills. Pre-school teachers should take advantage of this to teach and assess each skill independent of other skills with a view to ensuring that children develop each of the developmentally appropriate science process skills.

5.4 Recommendations

This study came up with the recommendations for policy makers, curriculum developers, teacher trainers, pre-school teachers and parents. The study also came up with recommendations for further research. The recommendations for each of the players are given in sections that follow.

5.4.1 Recommendation for Policy Makers

Policy makers should review the existing language policy to allow use of English in the teaching of pre-school science. This is important because science textbooks and related resource materials are in English language and teachers are forced to mix languages thereby causing confusion in the child. To deal with this problem some pre-schools, and especially private ones, introduce English language at different times leading to lack of uniformity in use of the
language. There is need to harmonise its use.

5.4.2 **Recommendation for Curriculum Developers**

Curriculum developers should constantly review the Guidelines for Early Childhood Education (ECE) to determine the appropriateness of each of the objectives for pre-school science education. The poor performance in the skill of hypothesizing could mean that the skill was above the level of pre-school children yet the skill is one of those included in the content for pre-school education.

5.4.3 **Recommendation for Trainers of Pre-school Teachers**

The poor performance in the skill of hypothesizing could mean that pre-school teachers did not effectively teach the skill probably due to lack of competence and confidence. Trainers of pre-school teachers should appropriately prepare pre-school teachers to effectively teach and assess all science process skills. This would give the teachers confidence and enable them to teach and assess all science process skills without ignoring some. This done, pre-school children should equally develop different science process skills.
5.4.4 Recommendations for Pre-school Teachers

This study suggested that pre-school teachers:

1. Expose both pre-school boys and girls to similar activities and experiences and encourage both to perform equally well. Teachers should also expect the same from boys as from girls. This could be done through giving similar activities and responsibilities and demanding similar levels of performance from both boys and girls. Following this recommendation could help reduce gender differences in performance in science.

2. Expose children to environment from different regions. This could be done through use of material derived from rural and urban regions. The teachers could also involve children with activities drawn from different cultures. They could also liaise with parents and take the children for purposive trips to different regions or to places such as the Museum, the Agricultural Show grounds or Bomas of Kenya which exhibit activities and materials from different regions and cultures. Teachers could also use videos to present basic scientific occurrences that involve material from different regions. This should help minimise regional differences in performance in science process skills.
3. Blend English and Kiswahili, or Mother tongue when teaching pre-school science so that children can have a double exposure to the science vocabulary. They could do this by first explaining the observations in Kiswahili or Mother tongue and then translating this into appropriate English language. They should then guide the children to explain the observations in English. This should help children to develop English vocabulary that is basic for learning science skills and concepts.

4. Replicate the experiments used in this study with a variety of different objects and materials with a view to assisting the children develop science process skills. In so doing, the teacher should ensure that each child fully participates in the learning process.

5. Constantly evaluate the children’s progress in science process skills that have been suggested by the ECE guidelines and pay attention to the skills that are less developed.

5.4.5 Recommendations for Parents

Parents are invaluable when it comes to educating children. They are closest to their children’s needs and are naturally protective of their children’s best
interest. Parents can then help their children develop science process skills if they followed the suggestions given below:

1. Expose children to science-related experiences and activities from as early an age as possible and discuss with them different occurrences and experiences as they carry out different activities. This would help act as a basis on which the teacher could build scientific knowledge. This could also re-enforce what the child will have already learned in school. This done, children should be able to develop science process skills. Parents should also encourage their children to reason critically through asking the “why” and “why not” questions as they discuss the occurrences. This should help the children develop the process of hypothesizing.

2. Involve both boys and girls in similar activities and experiences at home. For example, parents could expose both boys and girls in domestic chores that involve use of water and hence provide both genders with an opportunity to carry out floating and sinking experiments as they carry out their duties. They could also help both boys and girls develop positive attitudes towards science and also equally encourage them in doing science related courses. This would enable both boys and girls perform equally well in science and hence
reduce gender differences in performance in science process skills.

3. Expose their children to a variety of material and activities from different environments. They could do this by taking their children for visits to different regions or to places that exhibit material and activities from different regions and cultures. This should help minimise regional differences in performance in science.

4. Where possible parents should introduce their children to English language at an early age. They should then gradually use English to introduce basic science vocabulary. In the process, they could help the children distinguish between terms such as "heavy" and "big" which pre-school children in this study seemed to use interchangeably.

5.4.6 Recommendations for Further Research

The following recommendations for further study are proposed:

1. There is need for further research to investigate the performance of pre-school children in other process skills and especially those included in the ECE curriculum. This would give more revelation as to whether or not children in ECE are developing science process. Pre-
school teachers and other stakeholders could then use this information when implementing the ECE curriculum.

2. Research on the performance of pre-school children in science process skills should be carried out in other geographical regions in Kenya. This would shed more light on whether or not geographical region is an important determinant of pre-school children’s performance in science process skills. This could help policymakers and curriculum developers to institute policies and develop curricula that are relevant to the needs of Kenyan children in given regions.

3. There is need for research to determine cause of differentials in performance in pre-school children’s performance in science process skills.

4. There is need for research on other variables that influence science performance at ECE level. This would help determine other variables, if any, that determine performance in science at pre-school level. Identification of such variables would help curriculum developers determine the content to include when developing curricula for ECE science.
5. There is also need for research with other science process skills to determine if there could be any significant relationships between performances in other process skills.

6. There is need for more research to investigate the performance of children in standard I and in other levels of education to determine the source of the poor performance in science in national examinations.
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APPENDIX I: OBJECTS AND MATERIALS USED

The following objects and materials were used for this study:

**Group I objects**

01: An unused full pencil
02: An unused full pencil different in colour as 01 above
03: A small key
04: A large key of same shape as 03 above
05: A small piece of candle
06: A large piece of candle of same shape as 05 above
07: A coloured plastic peg
08: A plastic peg of a different colour as 07 above
09: 10 ml stainless steel tablespoon
10: 5 ml stainless steel teaspoon
11: A wooden 10 ml tablespoon
12: A plastic 10 ml tablespoon

**Group II objects**

13: An empty 250 g prestige margarine container with lid
14: A 100g Blue Band margarine container with lid and filled with sand

**Group III objects**

15: A small padlock
16: A small padlock as in 014 tied to a piece of rubber so that they floated

Other material used:

- Clear water
- Medium sized basin, sufuria or bowl
- Two hand towels - for keeping hands and surface dry
APPENDIX II: TEST ADMINISTRATION PROCEDURE

CHILD NO: ........ SCHOOL: ............. DIVISION: .............
SEX: F/M ........

Activity 1 (Group I objects)
In this activity, the first twelve objects listed in Appendix I were paired as follows: 01 and 02, 03 and 04, 05 and 06, 07 and 08, 09 and 010, 011 and 012. Each object in the pair differed from the other in only one attribute.

Step 1: The child would be shown a pair of objects selected as shown above. Questions would then be asked as follows:
(a) What would happen to each of these objects if they were put in water? Would they sink or would they float?

(b) Why would they sink/float?

Step 2: The child would then be given the objects to put in water, one at a time. The following question would then be asked.

(c) Why did that one sink/float?

Pairs of the objects shown above were sequentially presented. Responses were recorded in schedules as shown in Table I below:
Table 1: Group 1 Objects

<table>
<thead>
<tr>
<th>Object</th>
<th>Sinks</th>
<th>Floats</th>
<th>Reason</th>
<th>Hypothesizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>01: An unused full pencil</td>
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<td></td>
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<tr>
<td>02: An unused full pencil different in colour from 01 above</td>
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<tr>
<td>03: A small key</td>
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<td>04: A large key of same shape as 03 above</td>
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<td>05: A small piece of candle</td>
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<tr>
<td>06: A large piece of candle of same shape as 05 above</td>
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<tr>
<td>07: A coloured plastic peg</td>
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<tr>
<td>08: A plastic peg different in colour from 07 above</td>
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<tr>
<td>09: 10 ml stainless steel tablespoon</td>
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<tr>
<td>010: 5 ml stainless steel teaspoon</td>
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<tr>
<td>011: A wooden tablespoon</td>
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<td>012: A plastic tablespoon</td>
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</table>
Activity 2 (Group II objects)

In this activity, objects labelled as 013 and 014 were used. The objects were different in size, weight and shape. The procedure used in activity 1 above was followed for each pair. Responses were recorded in schedules as shown in Table II below:

Table II: Group II Objects

<table>
<thead>
<tr>
<th>Object</th>
<th>Sinks</th>
<th>Floats</th>
<th>Reason</th>
<th>Hypothesizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>013: An empty 250g Prestige Margarine container with lid</td>
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<tr>
<td>014: A 100g Blue Band Margarine container with lid and filled with sand</td>
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</tbody>
</table>

Activity 3 (Group III objects)

In this activity, the two objects labelled as 015 and 016 were used. These objects were different in shape, size, material, weight and purpose. The procedure used in activity 1 above was repeated. Responses were recorded in schedules as shown in Table III below:

Table III: Group III Objects

<table>
<thead>
<tr>
<th>Object</th>
<th>Sinks</th>
<th>Floats</th>
<th>Reason</th>
<th>Hypothesizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>015: A small padlock</td>
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<tr>
<td>016: A small padlock tied to a piece of rubber so that they float</td>
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</tbody>
</table>
**APPENDIX III: SCORE SHEET**

<table>
<thead>
<tr>
<th>Child No.</th>
<th>F/M</th>
<th>Division</th>
<th>Prediction Score</th>
<th>Hypothesizing Score</th>
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<td>1</td>
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