EFFECTIVENESS OF METHODS OF TESTING CONCEPTUAL UNDERSTANDING IN PHYSICS: A STUDY DONE IN THE CONCEPT OF FLOATING AND SINKING IN FORM 3 STUDENTS AT MBOONI – EAST DISTRICT

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DECLARATION

This project report is my original work and it has not been presented for an award of master's degree in any other university.

Signature……………………………… Date…………………………………

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E58/70485/2013

This project report has been submitted with my approval as a university supervisor

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DEDICATION

This project is dedicated to the creator, Almighty God for good health, sound mind and His divine provision in order to undertake and accomplish this project in time and to my dear wife Brigid Mbithe, children Victor and praise and mum Phyllis Ndulu for according me the encouragement and support throughout the course.

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MAY ALMIGHTY GOD BLESS YOU ALL

THANK YOU.

ABSTRACT

The central problem of this study was to determine the most effective method of testing prior knowledge and conceptual understanding in physics in the concept of floating and sinking among form three students from Mbooni – East district in Makueni County. The study was comparing between Essay tests, Experimental test and Objective tests. It was hypothesized that Experimental method of testing was hypothesized to be the most effective method of testing conceptual knowledge. The study employed a comparative case study design which involved pretest, instruction and then pre-test. A school in Mbooni east was sampled randomly where the research was to be conducted. In the selected school 30 form 3 students were chosen at random in from the form 3 students who take physics randomly. The selected sample was further divided three groups in which a test was administered to the student one group with essay test, the other group with Experimental test while the third group with objective test after which the sample population was taken through an instructional process using guided discovery method for one the once again tested using the same test. The scripts were marked and the scores obtained formed the data for the research. The selected sample was again given questioners to respond to establish the demographic factors of the sample of study. The collected data was analysed using descriptive and inferential statistics. The main technique used to analyse the data was paired t-Test and Analysis of variance (ANOVA), Means, standard deviations and percentages. And reported using tables and frequency graphs. From the study it was established that objective test were the most effective method of testing prior knowledge and conceptual understanding followed by Experimental test and the least effective was Essay tests was recommended that tests should be incorporated in our teaching before and after. In order to test the scope of the prior knowledge and the extent in which the learners have understood the scientific concepts. Finally suggestions for further research were made either to replicate this study to cover a wide area to find out the most effective method of testing conceptual understanding in other areas of the country and in other subjects. Also it can done using a different method of instruction.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Physics being one of the science subjects taught in secondary school curriculum, which deals with matter in relation to energy but it has been facing a lot of challenges in its performance and the number of students taking it up to the form 4 and is a key subject for the progress of Kenya in becoming industrialized in the vision 2030 as projected in the national development plan. This is because the leaners perceive it to be too difficult and abstract this arises simply because of the method of instructions and also the teachers believe that the students can’t make it.

The main problem is the approach in which the teachers use in teaching science physics. This problem has been brought about by the belief by most teachers that students are empty vessel which filled with knowledge. That is they approach teaching as a process of transferring knowledge from the teacher to the student. This problem can be solved by use the constructivist approach of teaching and learning which is one of the most influential contemporary approaches to understanding how children come to learn science in school classrooms. The constructivist perspective maintains the view that children will have formed some representations of many of the phenomena studied in school science based on their previous experiences and reflection on those experiences in order to understand the world around them (Driver, Asoko, Leach, Mortimer &Scott, 1994). These initial representations are proposed to take the form of 'alternative frameworks' because of the explanatory scope that they provide children with. These 'alternative frameworks' contain conceptual understanding that frequently contrasts with scientific explanations of the same phenomena and therefore they are subject to change when children begin their formal science education (Driver & Easley, 1978; Driver & Bell, 1986). Research investigating learning from this perspective has led to the development of a number of explanatory models identifying underlying mechanisms that support such 'conceptual changes' (for example Vosniadou & Brewer, 1987; diSessa, 1988; Sharp & Kuerbis, 2006, summaries in Vosniadou 2008; Limon & Mason, 2002). These modeling of their depth and scope with some placing a high emphasis on purely cognitive processes (Rumelhart & Norman, 1978; Posner, Strike, Hewson & Gertzog, 1982) while others attribute a strong role to motivational and affective factors (Pintrich, Marx & Boyle, 1993, Dole & Sinatra, 1998). The development of ideas of force studied in physics is the focus of diSessa's fragmentation theory (1988). Models also frequently lack consistency between the ages of participants recruited, notably diSessa's original contributions from college students whereas Vosnidou's research recruited school age children. One criticism that is more fundamental originates from the lack of consensus regarding the level of mental representation studied. In some cases the aim is to study individual concepts and in others mental models which result from theory structures are utilized. Taken as a whole, this diversity of subjects studied restricts comparison and evaluation of models across scientific domains and prevents the models being evaluated for their utility in informing teaching across scientific curricula. In order to overcome these difficulties the work presented here evaluates the models within comparative contexts in one science domains, notably in the development of children's ideas in floating and sinking (the Archimedes principle) class.

The core commitment of a constructivist position, that knowledge is not transmitted directly from one knower to another, but is actively built up by the learner, is shared by a wide range of different research traditions relating to science education. One tradition focuses on personal construction of meanings and the many informal theories that individuals develop about natural phenomena(Carey, 1985; Carmichael et al., 1990; Pfundt &Duit, 1985) as resulting from learners' personal interactions with physical events in their daily lives (Piaget, 1970) For instance the concept of floating and sinking is not such a new concept to the learner because the learner have always had an interaction with the knowledge or applied it in one way or the other in their play in their childhood. For example when they are swimming in a swimming pool they find it easier to lift and object while the same object lifted in air is heavier, flying of kites depending on the background of the learner some have seen a steel vessel floating on water.

Therefore learning in classroom settings, from this perspective, is seen to require well-designed practical activities that challenge learners' prior conceptions encouraging learners to reorganize their personal theories. These activities should be designed to explore the following key concepts

- Whether something floats depend on the material it is made of, not its Weight.
- Objects float if they are light for their size and sink if they are heavy for their size.
- An object can be light for its size if it contains air, such as a hollow ball.
- Materials with a boat shape will float because they effectively contain air.
- Water pushes up on objects with an up thrust force.
- Objects float if the up thrust force from the water can balance their weight (gravity force).
- Objects float depending on their density compared to water; for an object to float its density needs to be less than that of water.
- Objects float when air is enclosed in an object; their density is lowered, thereby increasing the likelihood of floating.
- The up thrust depends on the amount of water displaced.
- Objects float better in salt water (density of salt water is greater than that of pure water).
- Water surfaces have a cohesive force (surface tension) that makes them act like a 'skin'.

- Small, dense objects (e.g. a pin; a water spider) can ‘float’ on the surface of water without breaking it, due to surface tension effects.

A different tradition portrays the knowledge-construction process as coming about through learners being uncultured into scientific discourses (e.g., Edwards & Mercer, 1987; Lemke, 1990). Yet others see-it as involving apprenticeship into scientific practices (Rogoff & Lave, 1984). We need to study the ways in which school students' informal knowledge can be drawn upon and interacts with the scientific ways of knowing introduced in the classroom (e.g., Johnston& Driver, 1990; Scott, 1993; Scott, Asoko, Driver, & Emberton, 1994). Clearly there is a range of amounts of processes by which knowledge construction takes place. Some clarification of these distinct perspectives and how they may interrelate appears to be needed. A further issue that requires clarification among science educators is the relationship being proposed between constructivist views of learning and implications for pedagogy. Indeed, Millar (1989) has argued that particular views of learning do not necessarily entail specific pedagogical practices. Furthermore, the attempts that have been made to articulate "constructivist" approaches to pedagogy in science (Driver & Oldham, 1986; Fensham, Gunstone, & White, 1994; Osborne & Freyberg, 1985) have been criticized on the grounds that such pedagogical practices are founded on an empiricist view of the nature of science itself (Matthews, 1992; Osborne, 1993), the study shall present view of the interplay among the various factors of personal experience, language, and socialization in the process of learning science in classrooms, and discuss the problematic relationships between scientific knowledge, the learning of science, and pedagogy. Any account of teaching and learning science needs to consider the nature of the knowledge to be taught. Although recent writings in the field of science studies emphasize that scientific practices cannot be characterized in a simplistic unitary way, that is, there is no single "nature of science"(Millar, Driver, Leach, &Scott, 19931, there are some core commitments associated with scientific practices and knowledge claims that have implications for science education. We argue that it is important in science education to appreciate that scientific knowledge is both symbolic in nature and also socially negotiated.

From the above discussion then it is necessary always to inquire the student’s depth of conceptual understanding or misunderstanding of the concept of floating and sinking before teaching and the conceptual change that has taken place after instruction. This calls for research to determine the most effective ways of testing learner’s conceptual understanding or misconception. This will help the teacher to the method of instruction to use during his teaching. If the learners lack sufficient prior knowledge they are unable to activate the knowledge and may struggle to access participate and progress in the subject matter while those with sufficient prior knowledge find it possible and easy to activate the knowledge, participate during the lesson and progress with the subject matter.

Teachers can facilitate their students' literacy success science by helping them to build and activate background knowledge by first testing them their conceptual understanding on the topic. This can be done by the teacher designing a test which will be administered to the learners before a new concept is introduced and after the instruction, it is marked and scores are analyzed to see how much a person knows about a particular domain. A person who receives a high score on the test is considered to have a deep conceptual understanding of the concept. Both psychologists and consumer behavior researchers have implemented this definition by administering tests to subjects to assess their knowledge of a particular product class. (Bruck forthcoming, Spilich, Vesonder, Chiesi dc Voss 1979, Staelin 1978). The underlying assumption is that people with equivalent scores on the knowledge test should perform in similar ways on tasks such as recall of new information. The tests can take various forms

- Objective questions
- Essay questions
- Practical approach

1.2 Statement of the problem

Much research has indicated that students enter their classrooms with ideas about science that have been influenced by their prior experiences, textbooks, teachers' explanations, or everyday language (Osborne, 1982; Nakleh, 1992; Fleer, 1999;Palmer, 2001; Coştu & Ayas, 2005; Çalık & Ayas, 2005). According to the constructivist view, students often construct their own knowledge and theories about how the natural world works. Therefore, their construction of knowledge or theories may sometimes be contrary to those of scientists (Osborne and Wittrock, 1983; Bodner, 1986; Geelan, 1995). Such views or conceptions have been called misconceptions, preconceptions, alternative frameworks, naïve conceptions or common sense conceptions (Driver & Erickson, 1983; Treagust, 1988; Nakleh, 1992).Over the last two decades, educators have shown great interest in identifying students 'misconceptions about various science phenomena, either prior to or following an instruction. One of the areas that science education and cognitive development.

Students' views on floatation were first reported by Inhelder and Piaget (1958). They revealed that because the formulation of floatation rules requires advanced reasoning skills, it may not be understood by students and it is possible for students to have misunderstandings. Rowell and Dawson (1977a, 1977b,1981) carried out studies related to the results of Piaget's work to elicit students' understanding and help them improve their understanding of the phenomenon of floatation. In addition, there are numerous studies reporting students' misconceptions and investigating the effectiveness of alternative teaching models for floatation and related concepts (Simington, 1983; Biddulph and Osborne, 1984; Smith, Carey, &Wiser, 1985; Halford, Brown, & Thompson, 1986; Smith, Snir & Grosslight, 1992; Hewson & Hewson, 1993; Kariotogloy, Koumaras, & Psillos, 1993).Although there have been many studies on students' conceptions of sinking and floating in the international science literature, few studies are available in Turkey. Gürdal and Macaroğlu (1997) investigated fifth grade students' conceptions of sinking, floating and the Archimedes principle. They also discussed how to teach these phenomena by taking into account primary school students' cognitive skills. Their study revealed that as students did not give correct response to any test item, they couldn't construct scientific understanding about these concepts. Macaroğlu and Şentürk (2001) also carried out a study to elicit fourth grade students' understanding of the floatation. They found that students could not identify whether a material sank or floated, because of their non-scientific rules for sinking and floating. Although there are some studies investigating primary school students' conceptions of sinking and floating, similar studies on grade-eight students' conceptions have not been studied so far in Turkey. As the Archimedes principle and other related concepts are first introduced to students at the seventh grade, one important question should be asked whether students still hold their earlier misconceptions or alternative ideas even after formal instruction in class Therefore, this study was aimed to investigate form three students' conceptions, understandings and misunderstandings of sinking and floating concepts. The main problem under investigation was to investigate the most effective method of testing the prior knowledge and conceptual understanding of learners before and after an instruction.

1.3 Purpose of study

The purpose of the study was to determine the most effective method of determining the students conceptual understanding and misunderstanding of the concept of floating and sinking.

1.4 Research questions

1. Was there an improvement in scores and mean scores in post-test compared to pre- test?
2. Which of the three methods of testing was able to elicit prior knowledge well from the learners?
3. Which of these three methods was able to examine the learner's conceptual knowledge better?
4. What are the factors that may affect conceptual understanding of the learners in the concept of floating and sinking?

1.5 Objectives of the study

The objectives of the study are to investigate;

1. The most appropriate method of eliciting prior knowledge
2. The most appropriate method of testing conceptual understanding
3. The factors that may affect conceptual understanding of the learners.

1.6 Significance of the study

The findings of the study will help teachers greatly especially in testing the learners their prior knowledge which will help them to know what the students know about the topic and their misconception since it will guide them on the most appropriate way of testing prior knowledge it will also help the teachers to know the effectiveness of the method used in teaching a concept by comparing how much the learner has changed his conceptual understanding. This will also enable the teachers to choose the method of instruction. The policy makers will also benefit from the study since they will know the best method of testing conceptual understanding and put it as a requirement to all instructors before introducing a topic and after. They will also be able to know what content to be included at what level of learning.

1.7 Scope and limitations

The study will capture only one concept in one subject of all the possible over 15 subjects. It will also take just a few students in the selected school since physics is an optional subject in the 8-4-4 curriculum. The study will only be done in Mbooni East Sub County only out of the many sub counties in the country.

1.8 Definition of terms used

- **Force:** a push or a pull.
- **Density:** amount of mass per unit mass of an object (i.e. the concentration of mass, or how ‘heavy for its size’ an object is). The density of water is1 kg per litre.
- **Pressure:** amount of force applied per unit area. At a given pressure, twice the area will experience twice the force.
- **Archimedes’ principle**: A floating object will experience an up thrust force from water, equal to the weight of water displaced.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual changes in learning of floating and sinking

Conceptual change is regarded a gradual process (Chi, 1997; Vosniadou, 2001). Vosniadou (1994) argues that student's concepts are embedded in larger theoretical structures constraining them. Conceptual change thus involves the restructuring of underlying concepts, which can take place in various ways. For instance, an understanding of the concept of density requires the simultaneous consideration of the two dimensions of mass and volume. A concept that young children often lack is mass as a continuous and measurable characteristic of the material world (Smith et al., 1985). It is therefore difficult for them to grasp the concept of density as a whole and all its related consequences.

When students are confronted with experiences, information, or instruction that is inconsistent with their existing conception of a phenomena they will gradually assimilate the new information in their existing explanatory framework. While the shift from the misconception to a more coherent pre-conception to the finally scientifically grounded concept occurs, the different concepts remain side by side (Zimmermann, 2007). Dependent on the (learning) situation one of the pre-conceptions is chosen as a basis for an explanation of the phenomenon at hand. The comparison of mass and volume thus require the simultaneous consideration and integration of concepts. At least an intuitional idea of this notion is the first step toward a revise of the pre-conception.

Although, according to Smith et al. (1985), especially young children have a tendency to adopt an undifferentiated conception of mass and density. Kohn (1993) showed in his study that even between preschooler's and adults are considerable parallels with regard to their inadequate strategies for judging an object's floating or sinking. The issues of density and buoyancy force are often presented first in secondary school, based on the argument that students need to be mature enough to be able to grasp the abstract aspects of the involved formulas such as proportions. Nonetheless, there is indication that concept improvement may be reached when early curricula explicitly address these concepts.

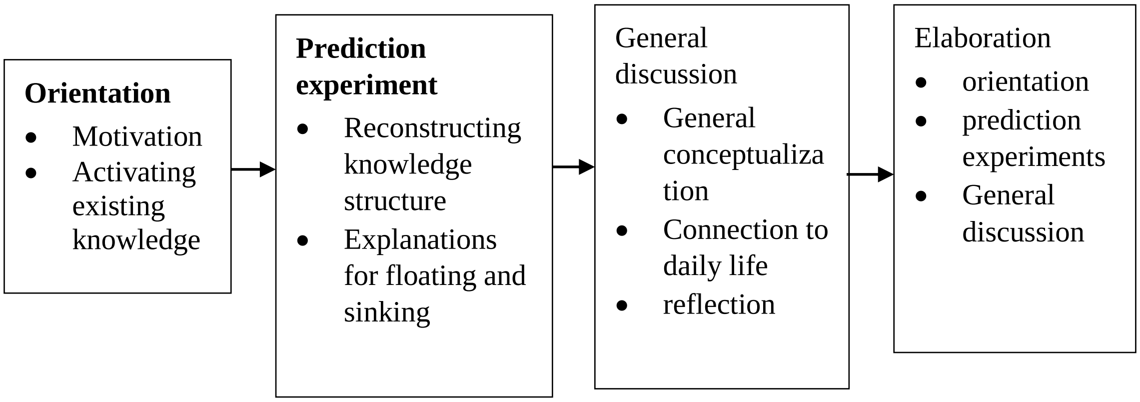
In this line Ilonca Hardy et al. (2006) argues If, however, children were also introduced to the explanations for the behavior of different materials in water, thus receiving the opportunity to revise misconceptions early on, there is good reason to expect that they will be able to profit more from the formulas of density and buoyancy force treated in secondary school. Unfortunately most often contemporary curricula in elementary school only introduce a material based pre-concept, e. g. that solid objects of the same material behave the same way when immersed in water. But even this relative simple pre-concept of continuity of characteristics is easily neglected as students are asked to explain why thinks float or sink (Biddulph & Osborne, 1984).

Conceptual change has generally been investigated only through cognitive functions as a general process without consideration of the context. However, the process of conceptual learning in an instructional context supported by a teacher, as in this study, is not governed only by cognitive factors, and thus conceptual change should be discussed within the context in which the process is taking place. Tyson (1997) and Duit and Treagust (2003) have provided a relevant model for analyzing conceptual change from three different viewpoints: ontological, epistemological and social/affective. The analyses are useful in splitting up the components of the process, but for developmental work in the schools more discussion is needed in order to include the situational and cultural contexts in the cognitive context, as discussed by Halldén (1999), who observed the role of everyday contexts in the use of scientific knowledge and of the explanations in the speech genre. Accordingly, this brings up the question of the holistic interpretation of conceptual change, which is relevant to this study. Halldén's way of thinking can be applied to analyzing young children's conceptual change processes in the instructional context, and especially allows emphasis to be placed on their ways of discussing. The social context of cognitive development, and especially the role of language in the learning process, was initially rooted in L.S. Vygotsky's work. Vygotsky (1962, 1978) saw knowledge construction as an ongoing, zig-zag process in which the child, in collaboration with a teacher or other children, integrates everyday concepts into a system of related concepts and transforms the raw material of experience into a coherent system. In interaction and communication the children start to reflect on their limitations, contradictions, presuppositions and the implications of their conceptions. This kind of awareness constitutes a critical condition for experiencing conceptual change in one's own knowledge structures (Vosniadou 1994) and, consequently, provides a key for encouraging conceptual change in young children. Discursive communication in the classroom provides an opportunity for knowledge construction and reconstruction, which is embedded in the instructional process (Havu 2000). Through the analysis of the instructional process, a deeper understanding is obtained about how conceptual change is reached and what are the elements that are involved in the change process. On the other hand, different problem-solving skills, the social discourse in the context of learning (Boulter 2000), and also an interpretation of scientific world and nature of scientific knowledge (see Osborne 1996) seem to have significant roles in the learning process.

In this study it was considered that the understanding of young children's teaching and learning as a process of conceptual change, underpinned by the view that the social interaction, especially collaborative interaction (Boulter 2000), during the learning process has an impact on conceptual change at an individual level. The model presented next is constructed based on knowledge of previous studies and theories, and shapes the analysis of conceptual change process Young children's processes of conceptual change which occur in an instructional context and in the environment in which a cognitive conflict can be established, happen mostly in social interaction with other peers and the teacher. The children's personal conceptual structures based on their everyday experiences interact with the views of other children and the teacher. The conditions that facilitate or hinder the cognitive conflict, or in some other ways affect the conceptual reorganization, can be either internal or collaborative factors, which are continuously involved in the process of reorganization of everyday experiences. Because the meaning of the collaborative talk has a varying role in knowledge construction or reconstruction, the contexts and their social aspects need to be described and interpreted. Conceptual change itself is an individual cognitive process, in which the new conceptions may change in several ways, ontologically or epistemologically (Chi et al. 1994, Duit and Treagust 2003, Thagard 1992) and through several phases, being continuously in interaction with the child's internal or collaborative learning. The children's epistemological or ontological conceptions may be deeply this study is an attempt to find the answer to how form 3 physics students change their conceptual understanding when instruction has been provided. Hence, it is also essential to pay attention to new verbal interaction and construction of how shared knowledge facilitates the process of conceptual change. This study was to interpret the conceptual change process through children's verbal expressions, which are seen to express their current thoughts and understanding within the limitations of their skills to express themselves. The verification for the interpretations of verbal expressions was derived from analysis of the children's experimental work during the study.

The Orientation (Driver and Oldham 1986: 119), based on general discussion in the classroom, attempted to initiate a discussion of the phenomena. The children were asked to describe, in general, sinking and floating, and to talk about their previous concrete experiences with sinking and floating objects. For conceptual change, orientation is the stage at which the teacher gains an idea about the children's existing knowledge and provides an environment for enriching, reorganizing or changing the children's conceptions. Conceptual change should start and continue in the experimental session, where learning activities will be planned to support the children's conceptual restructuring and make their ideas explicit (Driver and Oldham 1986). The approach for that was collaborative working, in which the children worked in three mixed groups, each having three to four participants. The results of group work will be discussed generally with all children under the teacher's guidance.

The alternative perspectives, like heaviness/lightness, size, materials, and hollowness/vacuum, will be discussed and the general reasons for flotation will be built-up. If necessary, the children's language and new concepts will be 'sharpened up' (Driver and Oldham 1986) by the teacher. The teaching session in the present study progressed as shown in figure below.



According to Inhelder's (1974) arguments that the young children are incapable of differentiating concepts of global quantity (see Smith et al. 1985). The objects for the investigation allow the determination of which of the object's properties influence the subject's judgments and provide several examples of each different dimension used in explaining floating and sinking. In addition, most of these materials were familiar to the children and had a meaningful relation to their everyday life. A similar worksheet was used in all parts of the study, except for the elaboration part, where a special worksheet was prepared. The worksheet for elaboration did not include any particular objects, but rather the children were expected to fill it in with their own objects from home. Children marked their predictions and the empirical results of the experiment on the worksheet. The general discussion with the teacher was based on the observations and on the completed worksheets.

2.2 Factors that may influence conceptual understanding for the learners

2.2.1 Family background

Many researchers and scientists agree that success at school is associated with social background factors (e.g., Giddens, 1997), as these factors can greatly affect young children's cognitive skills. Disadvantaged children (children with poor social background) start schooling with significantly lower cognitive skills than their more advantaged peers. Development according to their abilities and stage of development (by balancing their cognitive, emotional and social development); to convey to them the basic knowledge and skills that will allow an independent, efficient and creative confrontation in the social and natural environment; to develop their awareness of belonging to a specific cultural tradition. Since public school is the institution where students are (supposed to be) considered equal, regardless of their social background, it is expected that factors related to social and family background should be less associated to a student's performance as he/she progresses to higher grades. A research done by Barbaraneza Breck to establish, whether there is a correlation between the students' social and family background and his/her school performance. Whereby he used three populations of Slovene student's fourth graders and eighth graders in primary school, and students in the final year of secondary school were tested. He used population of 1 students aged 9 years (n = 2566), population 2, students aged 13 years (n = 2708), and students in the final year of secondary school population 3 (n = 3372). Analyses were done on weighted data. The data analyzed was derived from student's background questionnaires, where students were (among other things) asked about family and social background. For the analysis of social background the variables indicating social and family background were used, and to study school performance, achievement scores (plausible values for science and math) were used. Population 3 was a bit more development according to their abilities and stage of development (by balancing their cognitive, emotional and social development); it was found that knowing and understanding the language of a test is an important factor in relation to how successful the student would be, it was supposed that students not born in the country, or not speaking the Slovene language at home, would achieve lower results at the beginning of schooling. In the fourth grade 96.1% students were born in the country. Students born in the county are more successful - there are 12.5% not successful students in that group in contrast to 34% not successful students in the group of those who were not born in the country. The differences between groups are statistically significant. In the eighth grade we still observe differences between the two groups but as seen from the figure, the differences tend to be lower. Still students born in Slovenia achieved better results and the differences between the two groups are significant. In the eighth grade there were 96.7% students born in the country. The family background is a key to the student's life and outside of the school since it influences learning for instance parenting practices, aspirations for the future which influences the learner to know more or less in a particular field (Majoribanks 1996) This actually true in Kenya since the children born in the urban areas seems to have more prior knowledge in many issue than those born in rural areas whoever the difference is the only the ability to understand English language. Once this barrier is broken the students from rural areas still find that they still have an ability to understand scientific concepts as well as children from well of families. The study will be done in the public schools where the family background barrier has already been broken and the learner have a feeling as though that the family background has no effect to their performance.

2.2.2 The type of the school

A number of studies have examined the effect of school quality on student achievement (e.g. Ehrenberg and Brewer, 1994, 1995; Hanushek, 1986, 1996). These studies find that, on balance, improving school resources such as the pupil–teacher ratio or per pupil spending do not improve Students' performance on standardized achievement tests. This general conclusion runs counter to the conventional wisdom that the way to improve student achievement at public elementary and secondary schools is to allocate more money to them. Studies which analyze the effectiveness of school quality on student performance have primarily relied on estimation approaches such as Ordinary Least Squares (OLS) or Instrumental Variables (IV), which estimate the mean effect of school resource variables on student achievement. While estimating how 'on average' school resources affect educational outcomes yields straightforward interpretations, the standard methodology may miss what is crucial for policy purposes, namely, how school resources affect achievement differently at different points of the conditional test score distribution. For example, while increases in per pupil spending may not matter for average test scores, it would be useful to know if increased spending increases test scores at the bottom of the conditional distribution. On the other hand students in high cost private schools are more knowledgeable than their counterparts in the public schools since they have a wide range of exposure and therefore they tend to understand concepts in sciences faster than in public school. More so students in public schools they have different levels of understanding simply because of their entry behavior. The ability of the students in the national schools is not the same as the ability of the students in sub county schools. In this study, it will be done with the students of the same level.

2.2.3 Culture of the people where the students comes from

For almost a century of intelligence testing, efforts have been made to develop ‘‘culture free’’ tests (Jensen, 1980). Different attempts are found in the history of psychological testing to construct measures that would be ‘‘culture-free’’ (Anastasi, 1988; Cattell, 1940). For some time, it was supposed that the effect of culture could be controlled if verbal items were eliminated, and only non-verbal, performance items were used. However, this assumption turned out to be wrong. Researchers using a wide variety of cultural groups in many countries have sometimes observed even larger group differences performance and other non-verbal tests than in verbal tests (Anastasi, 1988; Irvine & Berry, 1988; Vernon, 1969). Therefore, not only verbal, but also non-verbal tests may be culturally biased. The use of pictorial representations itself may be unsuitable in cultures unaccustomed to representative drawings, and marked differences in the perception of pictures by individuals of different cultures have been reported (Miller, 1973). Furthermore, non-verbal tests often require specific strategies and cognitive styles characteristic of middle-class Western cultures (Cohen, 1969).Regardless of the contrary evidence, the idea that non-verbal cognitive tests can be culturally free has significantly remained. Currently, there is a diversity of intellectual tests that are presented as ‘‘culture-free,’’ or ‘‘culture-fair’’ just because they include mostly nonverbal items (e.g., Alexander, 1987; Crampton & Jerabek, 2000). This point of view contradicts available anthropology and cross-cultural psychology evidence (Berry, Poortinga, &Segall, 1992; Harris, 1983; Irvine & Berry, 1988). Cole (1999), for example, has argued that the notion of culture-free intelligence is a contradiction in terms. He points out that cross-cultural test construction makes it clear that tests of ability are.

2.2.4 Social economic status of the learner

The social economic status combines both the parents’ education level, occupation status and income level (Jaynes 2002) studies have repeatedly found that social economic status affects student’s outcomes (Jaynes, 2002; Eamon, 2005; Majoribanks, 1996; Hochschild, 2003; Mcneal, 2001 and Jeyried, 1998).

Students who have low social economic score lower in test scores and are more likely to drop out of school (Eamon 2005, Hoch child 2003) it is also believed that students are also influenced by their parents especially in accessing vital resources and the ability to visit as many places as possible which might help in building up the learners experiences of life. With this understanding it can also be concluded that at times the children from low social economic status tend to take long to understand the scientific concepts. This could be because of the level of exposure, the motivation from the parents and more so the siblings the language of such student is really wanting. But in situation where the learners have interacted and the discovered their abilities especially in public schools you even find that students from low socio economic level they even understand better than those from low social economic status. In private schools these differences do exist and the learners from low social economic status tends to feel low and intimidated hence perform poorly. This study will deal with the learners who have grown beyond such boundaries and their performance is likely to almost the same in the two tests.

2.2.5 Peer influence

Peer influence makes students participate in activities which give the learners different experiences of life.(senator 2000) when one is engaged with the right peer group is likely to affected positively than those who are associated with peers with negative behaviors (sentor 2000) those peers with negative behavior they adversely affect ones cognitive abilities. It is generally assumed that active engagement of students during discussion with peers, some of whom know the correct answer, leads to increased conceptual understanding, resulting in improved performance after PI. However, there is an alternative explanation: that students do not in fact learn from the discussion, but simply choose the answer most strongly supported by neighbors they perceive to be knowledgeable. We sought to distinguish between these alternatives, using an additional, similar clicker question that students answered individually to test for gains in understanding. Our results indicate that peer discussion enhances understanding, even when none of the students in a discussion group originally knows the correct answer. In this study group work discussion will be part of the instruction process and this will help the learners to understand the concepts better hence showing a greater margin of improvement in the post test.

2.3 Theoretical frame work

This study borrowed a lot from the constructivist theory of teaching and learning and classical theory of testing.

2.3.1 Constructivist theory of teaching and learning

Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Learners are the makers of meaning and knowledge. Constructivist teaching fosters critical thinking, and creates motivated and independent learners. This theoretical framework holds that learning always builds upon knowledge that a student already knows; this prior knowledge is called a schema. Because all learning is filtered through pre-existing schemata, constructivists suggest that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claim to be based on constructivist learning theory. Most of these methods rely on some form of guided discovery where the teacher avoids most direct instruction and attempts to lead the student through questions and activities to discover, discuss, appreciate, and verbalize the new knowledge.

The constructivist perspective maintains that the view that children will have formed some representations of many of the phenomenon studied in school their previous experiences and reflections on those experiences (Driver Asoko Leach, Mortimer & Scott, 1994).

In order teachers to be able to teach science effectively for the students not only to perform well in exams but also to apply the scientific knowledge in their daily life situations, they need to first find out what the learners know about a concept. Are there misconceptions about the concept do the learners have any idea about the concept and to what extent. This will help the teachers to choose the right approach in teaching the concept. It is also necessary to come up with the most suitable way to test the prior knowledge of the learners.

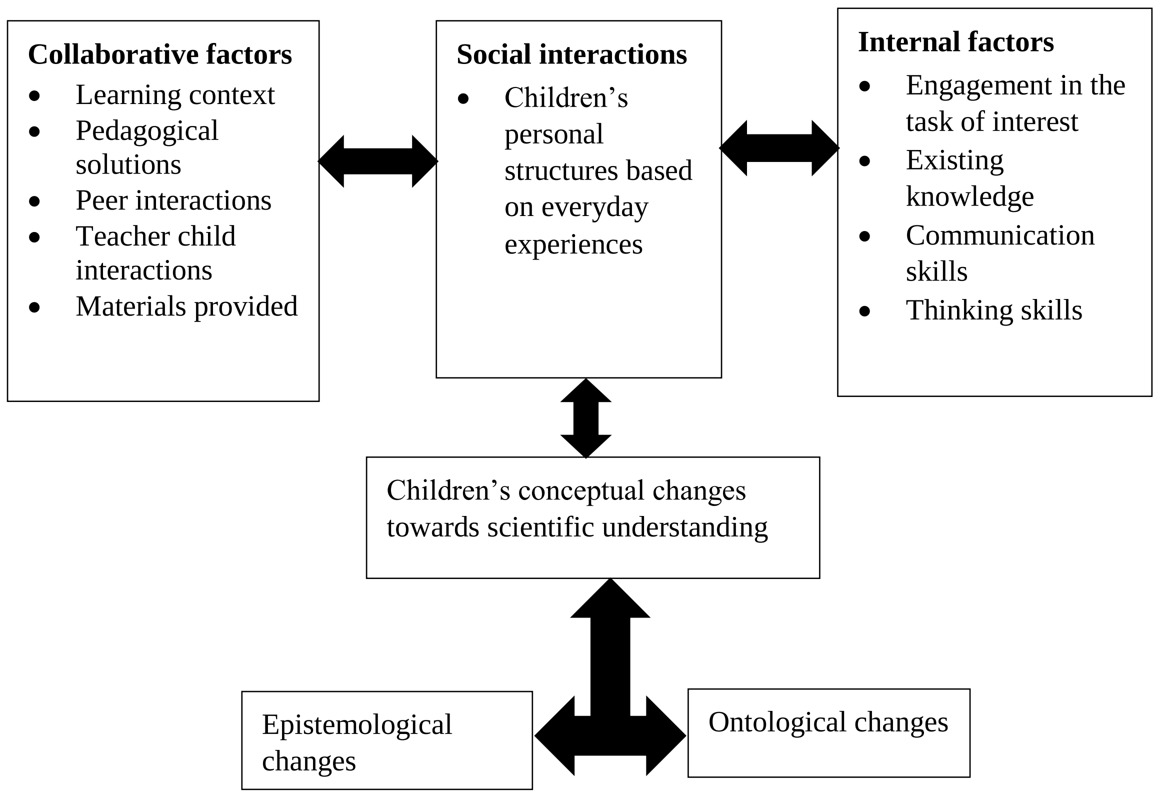
2.3.2 Classical Test Theory

According to Bejar (1983), random sampling theory and item response theory are two major psychometric theories for the study of measurement procedures. In random sampling theory, there are two approaches, the classical theory approach and the generalizability theory approach. A CTT (also known as classical true score theory) is a simple model that describes how errors of measurement can influence observed scores (Marcoulides, 1999) .Classical test theory Ulliksen, 1950) is the earliest theory of measurement. The major target of this theory is estimating the reliability of the observed scores of a test. If the test is applied on a Particular sample of items, at that particular time, in the reliable conditions, this exam gives an observed score of the examinee. Under all possible conditions at various times, using all possible similar items, theme and of all these observed scores would be the most unbiased estimate of the subject's ability. Thus, mean is defined as the true score. In any single administration of a test, the observed score is most likely different from the true score (Suen, 1990). This difference is called random error score. In the framework of CTT each measurement (test score) is considered being a value of a random variable X consisting of two components' true score and an error score (Steyer, 1999).This relationship is represented in below formula: $X=T+E$ Because the true score is not easily observable, instead, the true score must be estimated from the individual's responses on a set of test items. In CTT, the observed score is assumed to be measured with error. However, in developing measures, the goal of CTT is to minimize this error

(Mc-Bridge, 2001) in that case, importance of are reliability of a test and calculating the reliability coefficient increases. If we know reliability coefficient, we can estimate the error variance. The square root of error variance is determined as standard error of measurement (SEM) and helps to define the confidence interval to have a more realistic estimation of the true score. Reliability is considered an attribute of the test data and not the assessment itself in CTT. In fact, APA standards (AERA, APA, & NCME, 1999) state that when reliability is reported, it must be accompanied by a description of the methods used to calculate the coefficient, the nature of the sample used in the calculations, and conditions under which the data were collected. However, reliability estimates calculated through these procedures are sample dependent and, as a result, have a number of practical limitations. When building or evaluating technology-enhanced assessments (Scott and Mead, 2011).The alpha formula is one of several analyses that may be used to gauge the reliability (i.e., accuracy) of psychological and educational measurements. This formula was designed to be applied to a two-way table of data where rows represent persons (p) and columns represent scores assigned to the person under two or more conditions (i). Because the analysis examines the consistency of scores from one condition to another, procedures like alpha are known as internal consistency analyses (Cronbach and Shavelson, 2004).

2.4 Conceptual frame work

Figure 1: Conceptual framework



Conceptual understanding and change and progression of the construction process are approached through a qualitative case study design. The research was constructed in three parts: (a) pre-interview, (b) instructional process, and (c) post-interview. The purpose of the pre-interview was to determine the children exist. Knowledge and experiences of floating and sinking, to help children reflect on their own thinking and on alternative explanations, the semi-structured interview situation was constructed using an interactive approach. The pre-interview will consisted of a written test in which students responded in their scripts.

The instructional process, was conducted one week after the pre-test, it was an attempt to support and develop the children's conceptual understanding of floating and sinking. The teaching approach will be collaborative, using guided discovery learning. Collaborative work places emphasis on social interaction during the sessions, on one's own judgments, and on discussions with peers that help to create situations where cognitive conflict can occur through discussions and sharing meanings. The children had an opportunity to express their current ideas, to make their predictions about flotation, explore the phenomenon with the concrete materials and, afterwards, to give their explanations.

After the test was administered to the students and the items had been marked the scores were analyzed The most appropriate method of testing conceptual understanding was the one the learners were able to create an initiative to inquire more of the topic, the learners expose their misconceptions clearly and the learners can be able to argue well over the topic concepts. The findings obtained in the study will have to be applied in order to improve the achievement of the students in physics

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter was dealing with research design, the study area population and sample, research instruments for data collection and data analysis procedures.

3.2 Research design

The study employed the comparative case study design which will involve pretest, instruction process and finally post-test. The purpose of the pretest was to determine the children's existing knowledge and experiences of floating and sinking. The students were also given a questioner to respond to in order to understand their background. The instructional process was conducted one week after the pre-test, it was an attempt to support and develop the children's conceptual understanding of floating and sinking. The teaching approach was collaborative, using guided discovery learning. Collaborative work places emphasis on social interaction during the sessions, on one's own judgments', and on discussions with peers that help to create situations where cognitive conflict can occur through discussions and sharing meanings. In this study the guided discovery approach to learning was applied using a problem based approach, in which the children actively participated in solving the problems of sinking and floating. The children had an opportunity to express their current ideas, to make their predictions about flotation, explore the phenomenon with the concrete materials and, afterwards, give their explanations.

3.3 Population

The population of the study consisted of form 3 students in Mbooni east who take physics. The area has 40 secondary schools .The students were pretested then instruction was conducted then post tested and results analyzed.

3.4 The study sample

The study area has 40 secondary schools in which the study was done in one of the secondary school in Mbooni East which was selected randomly. The study employed two stage cluster sampling technique. Where by stage 1 involved choosing the school where the study was to be conducted the stage 2 involved selecting 30 students who took part in the study. The selection of the students was done randomly.

3.5 Research instruments

The research instruments t used in this study were short questioner for the students to study their demographic background and three different types of tests to test the conceptual changes in the learners namely;

- objective questions,
- essay questions,
- Experimental tests

The questioner is at appendix I; all the tests are found at appendix II and their marking schemes at appendix III.

3.6 Data collection procedure

The data collection procedure involved designing the tests which the researcher personally, administered the exams and then marking the scripts .The learners were also given a questioner to respond to. The results of the marked scripts will form the data for research.

3.7 Methods of data analysis

Once the tests were done, they were marked according to a prepared marking scheme and the scores obtained by the learners in the both tests formed the research data. The data was used to investigate the most appropriate method of testing conceptual understanding.

The data was entered into a computer for analysis using statistical package for social scientists (SPSS) the data analysis was done using t-test for proportions and analysis of variance (ANOVA) and reported using frequency distribution, histograms and tables.

CHAPTER FOUR

DATA REPRESENTATION AND ANALYSIS

4.1 Introduction

This chapter contains the data analysis method to arrive at the conclusion of the study. The study was to investigate the most effective method to elicit conceptual understanding in the concept of floating and sinking in form three students in Mbooni East District.

The data analysis for the study was conducted sing data collected from 30 students in one particular school which was selected randomly .The data analysis procedure and major findings of the study are discussed below as per each research question.

4.2 Distribution of scores

The first research question was to investigate if there was a change in the results obtained in the post-test from the pre-test scores.

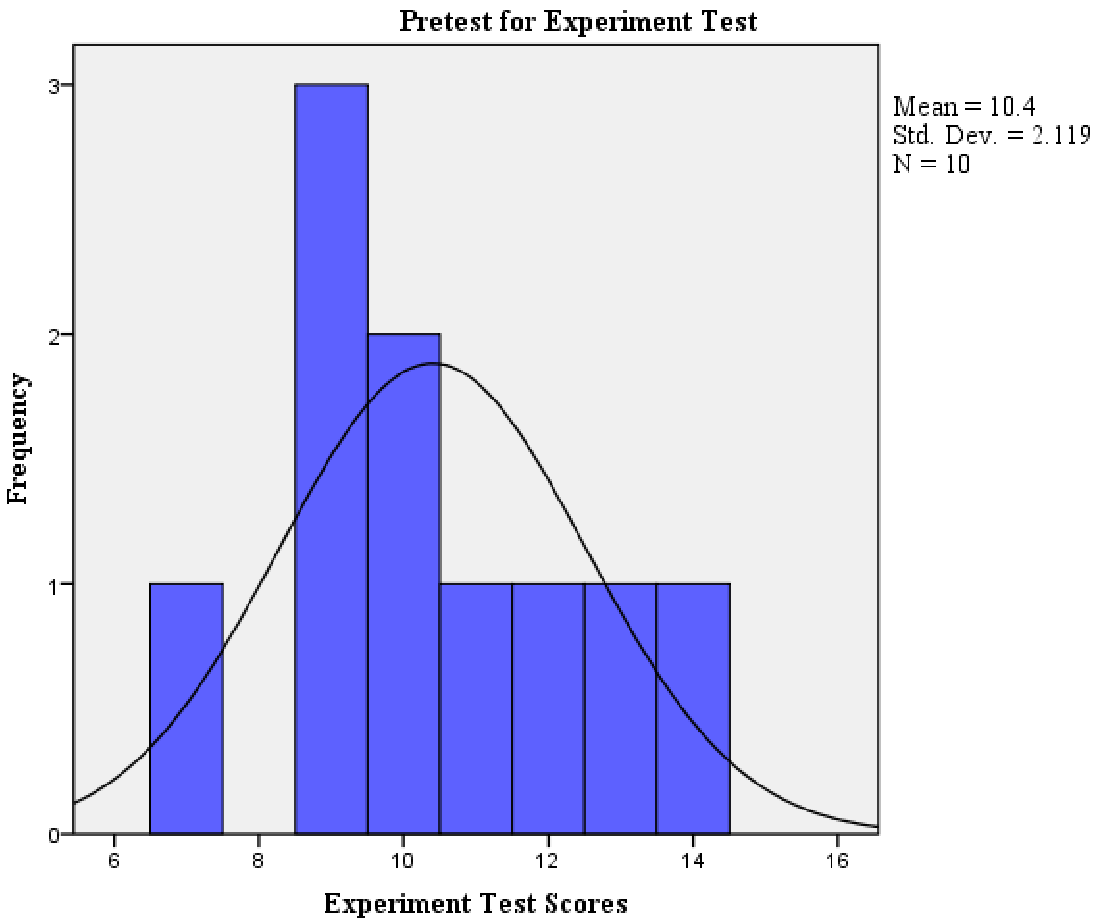
This would establish whether the subjects were homogeneous or otherwise (but not to what extent since the variable was not examined in this study). The distribution of the scores was reported using tables and graphs for both post-test and pre-test scores.

Table 1: Results for Pre-test using experimental test experiment test

Pre-test for Experiment Test					
		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	7	1	10.0	10.0	10.0
	9	3	30.0	30.0	40.0
	10	2	20.0	20.0	60.0
	11	1	10.0	10.0	70.0
	12	1	10.0	10.0	80.0
	13	1	10.0	10.0	90.0
	14	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

In the experimental pre-test results it can be seen that the mean score was 10.4 with a standard deviation of ±2.119. It can also be seen that 60% of the learners scored less than the mean mark while 40% scored above the mean mark. The above information has also been represented using a graph below.

Figure 2: Pre-test using experimental test experiment test



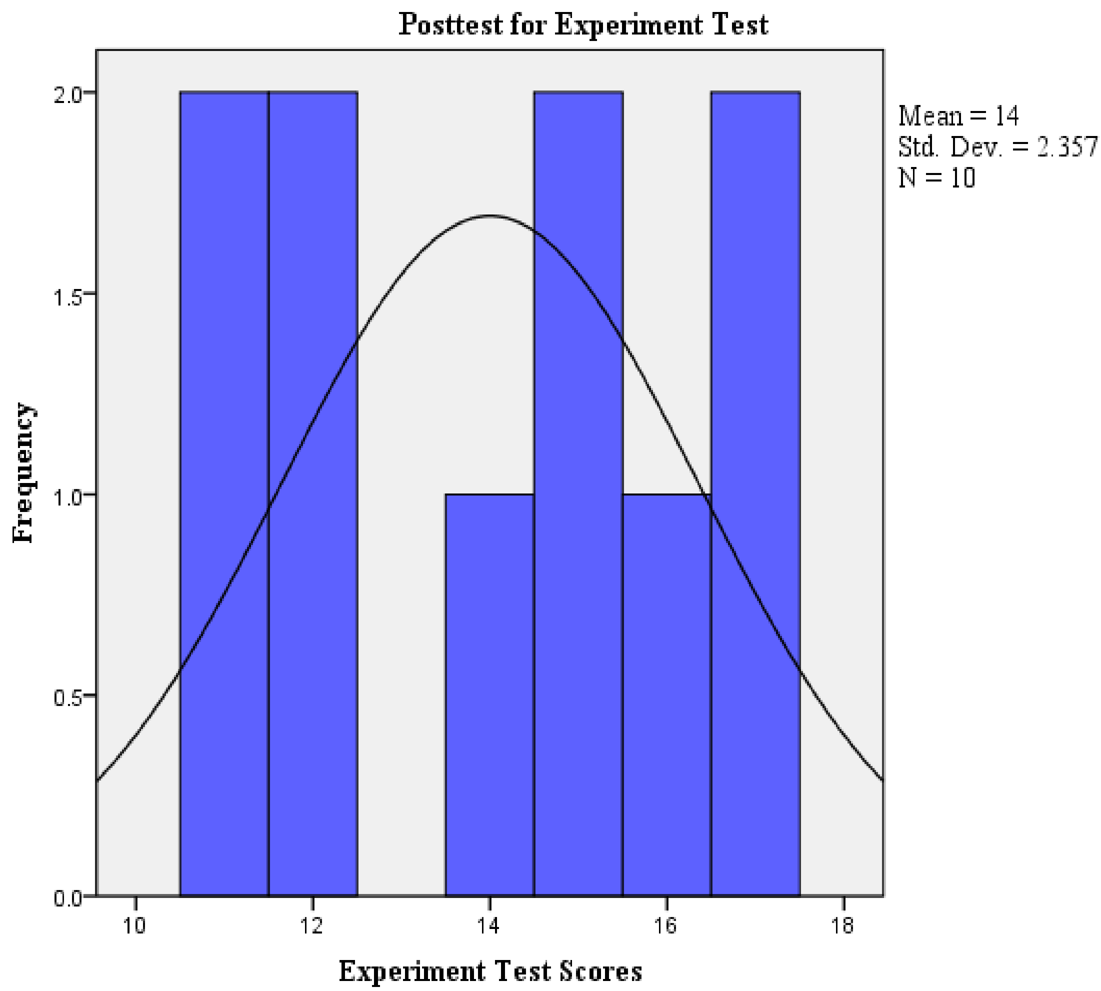
It can be seen from the graph the scores ranged 7 to 15.it was able to execute a normal curve performance. The performance was homogenous with the scores well distributed. 50% of the students lied below the mean while the other 50% lies above the mean.

Table 2: Score distribution for Post-test for experiment test

Post-test for Experiment Test					
		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	11	2	20.0	20.0	20.0
	12	2	20.0	20.0	40.0
	14	1	10.0	10.0	50.0
	15	2	20.0	20.0	70.0
	16	1	10.0	10.0	80.0
	17	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

From the post-test the mean score was 14 and a standard deviation of ±2.357.it can also be seen that 50% of the students score above the mean. The scores were uniformly spread.

Figure 3: Distribution for Post-test for experiment test



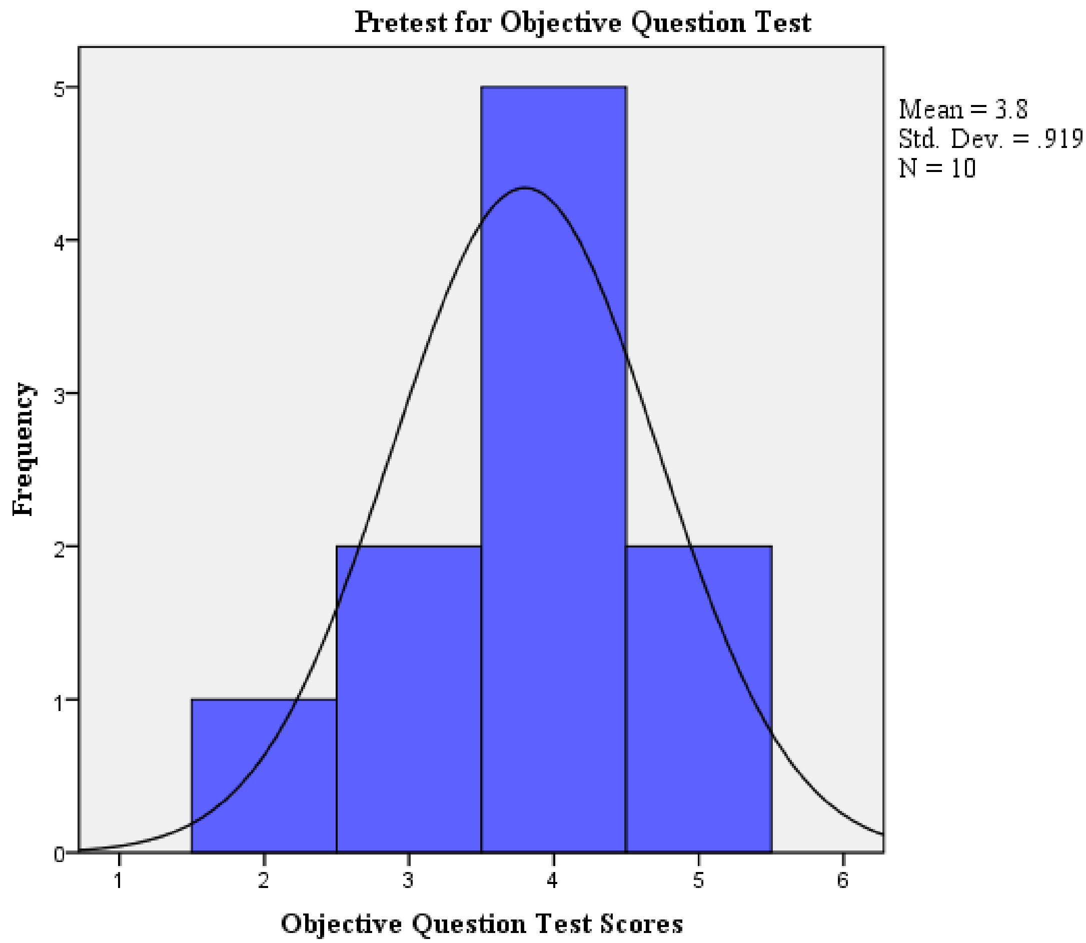
The score distribution ranged between 11 to 17 the performance was actually a homogenous performance. The scores were all alike and well distributed. However no student scored 13

Table 3: The score distribution in Pre-test for objective question test

Pre-test for Objective Question Test					
		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	2	1	10.0	10.0	10.0
	3	2	20.0	20.0	30.0
	4	5	50.0	50.0	80.0
	5	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

As it can be seen from the above table, the performance for the pre-test for objective questions was a homogeneous performance. The mean score was 3.8 and a standard deviation of ± 0.917 the graph for frequency against score for pre-test scores in objective questions can be shown below.

Figure 4: Distribution in Pre-test for objective question test



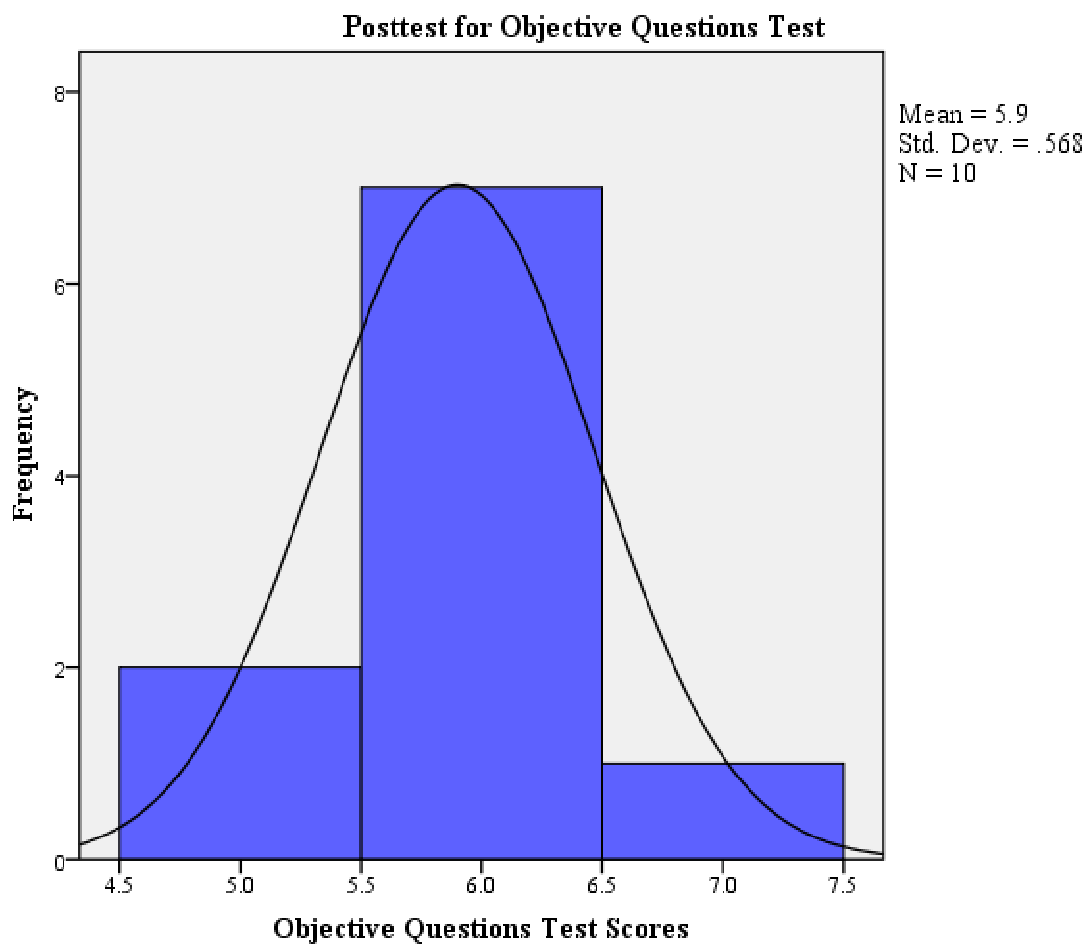
The scores as seen from the graph can show that the performance was more homogenous. The scores were uniformly distributed. With more students performing within the mean score.

Table 4: Scores for Post-test in objective question test

Post-test for Objective Questions Test					
		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	5	2	20.0	20.0	20.0
	6	7	70.0	70.0	90.0
	7	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

The post-test performance still improved with a mean score of 5.9 and a standard deviation of ± 0.568 the performance was more homogenous than in pre-test. Majority of the students about 70% score around the mean score. The graph showing the frequency against the student scores for post-test objective questions is shown below.

Figure 5: Scores for post-test in objective question test



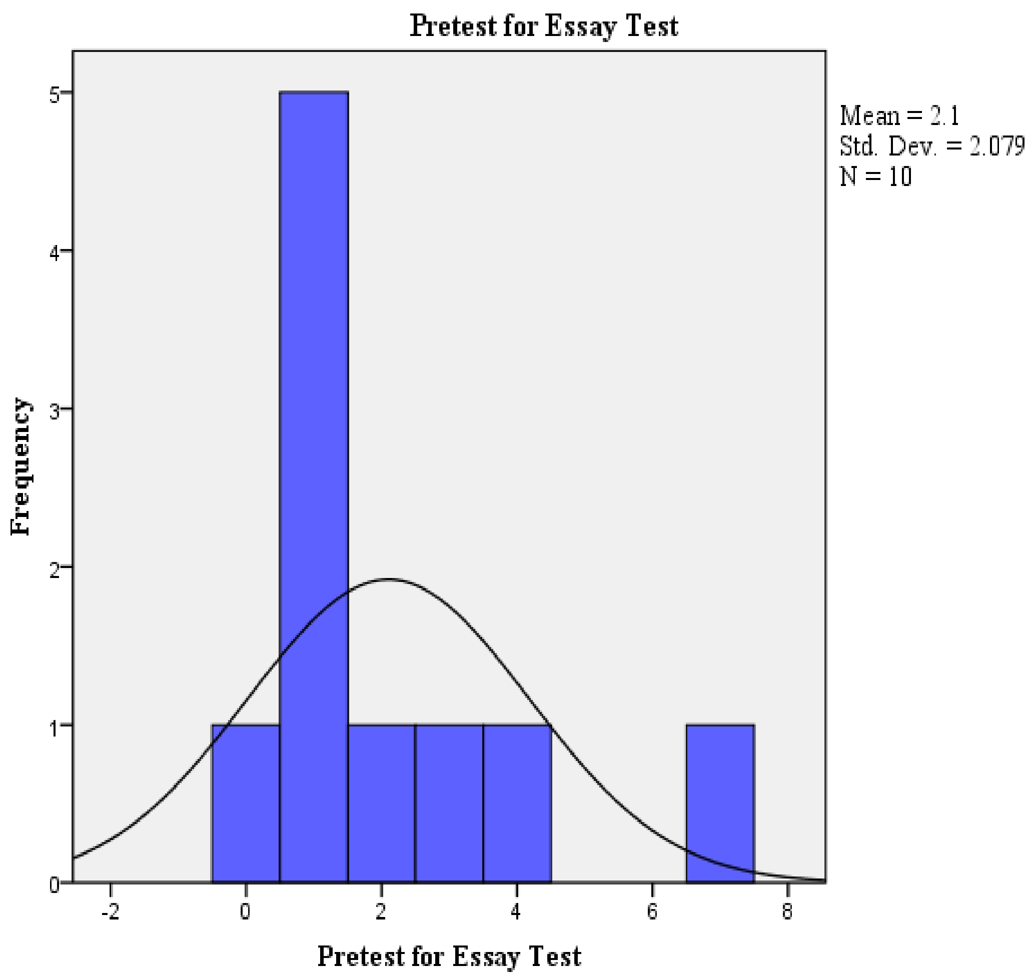
The scores were well distributed. The performance was homogenous performance with the highest number of students lying within the mean score.

Table 5: Results for Pre-test in an essay test

Pre-test for Essay Test					
		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	0	1	10.0	10.0	10.0
	1	5	50.0	50.0	60.0
	2	1	10.0	10.0	70.0
	3	1	10.0	10.0	80.0
	4	1	10.0	10.0	90.0
	7	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

As it can be seen from the table the essay pre-test, the performance was heterogeneous. With a mean score of 2.1 and a standard deviation of ± 2.079.the performance was skewed to the left since 70% of the students scored less than the means score. The graph shown below shows the frequency against the student scores.

Figure 6: Results for Pre-test in an essay test



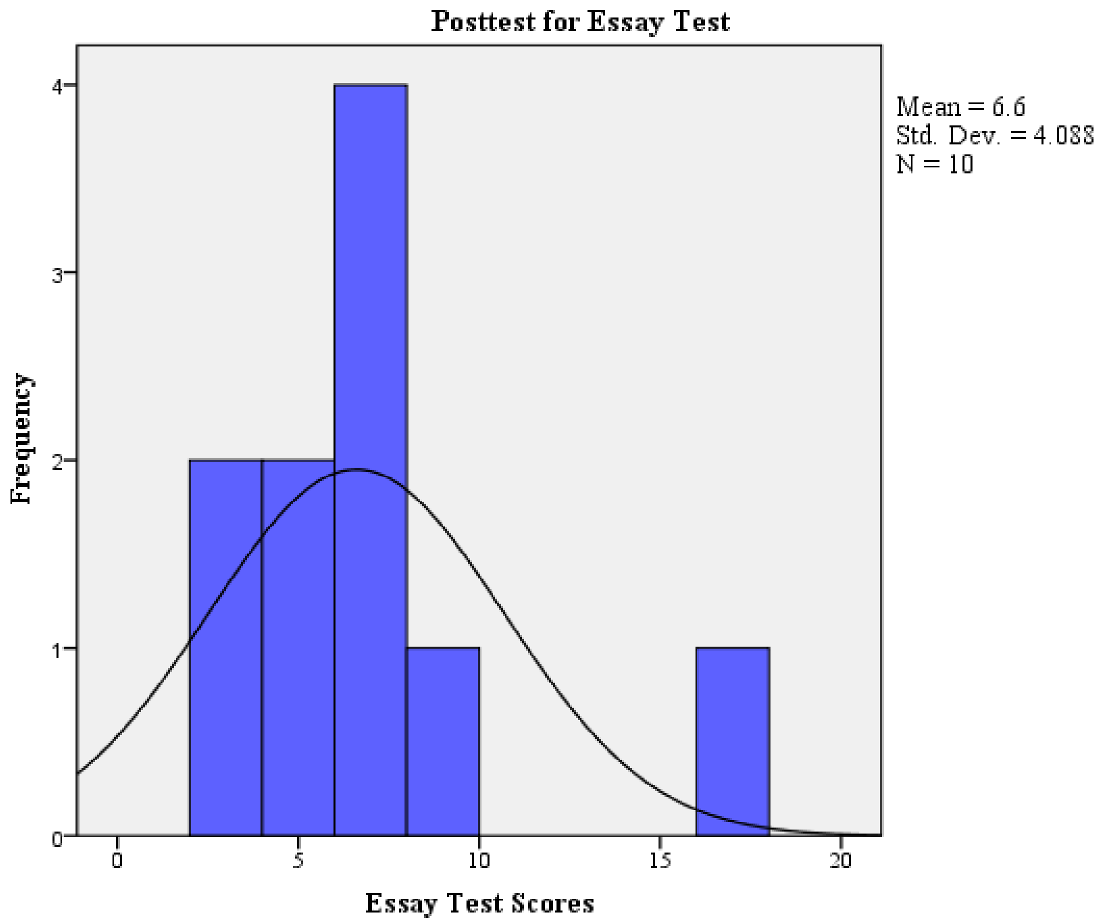
The performance was somehow skewed toward the left though the performance was somehow homogenous, more students performed below the mean score

Table 6: Results for post-test in an essay test

Post-test for Essay Test					
		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	3	2	20.0	20.0	20.0
	4	1	10.0	10.0	30.0
	5	1	10.0	10.0	40.0
	6	3	30.0	30.0	70.0
	7	1	10.0	10.0	80.0
	9	1	10.0	10.0	90.0
	17	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

In post-test, the performance improved the mean score was 6.6 and a standard deviation of ± 4.088.It can be seen that the performance was widely spread but the performance was still skewed to the left since 70% of the students still scored below the mean score. The graph below shows the frequency against test scores.

Figure 7: Results for post-test in an essay test



The performance was more heterogeneous since the score were not uniformly distributed. More students scored less than the mean score. The score ranged between 3 and 10. But only one student scored 17.

4.3 The statistical analysis for the scores for both post and pre-test in science

The second research question was dealing with the statistical analysis of the scores, measures central tendency and measures of dispersion which can be shown in the table shown below.

Table 7: Statistical analysis for both post and pre-test in all categories

Statistics						
	Pre-test for Experiment Test	Post-test for Experiment Test	Pre-test for Objective Question Test	Post-test for Objective Question Test	Pre-test for Essay Test	Post-test for Essay Test
N	10	10	10	10	10	10
Mean	10.40	14.00	3.80	5.90	2.10	6.60
Median	10.00	14.50	4.00	6.00	1.00	6.00
Std. Deviation	2.119	2.357	.919	.568	2.079	4.088
Variance	4.489	5.556	.844	.322	4.322	16.711
Minimum	7	11	2	5	0	3
Maximum	14	17	5	7	7	17

It can be seen that the mean scores improved in the post-test from pre-test with the highest mean score in objective with a mean score of 84%by experimental with a mean score of 82% and the least in essay question in both pre-test and post-test 12% and 35%.the objective test produced the highest improvement index of 30% The standard deviations also increased in both experimental and essay but decreased in objective questions. The standard deviations improved in essay questions with greater index.

4.4 The most effective method to elicit the conceptual understanding science

Since the design of the study was within subject (i.e. one subject was pretested and post-tested), a paired t-test was used to compare the performance for both post and pre-test results across the methods. This helped to eliminate the error of between different subjects. To examine if there existed any significant difference between pre-test and post-test groups, a paired sample t-test was applied. The analysis was reported using tables as shown below.

Table 8: Showing a paired t-test for experimental testing

Paired Samples Test									
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test for Experiment Test - post-test for Experiment Test	-3.600	1.897	.600	-4.957	-2.243	-6.000	9	.000

There is a statistically significant difference between pre and post-test since .000 is less than is less than the critical value of 0.001 at the degree of freedom of 9 and confidence level of 0.05. Hence we can conclude than the treatment worked better (yields positive results).

Table 9: Showing t-test analysis for Objective question test

Paired Samples Test										
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test for Objective Question Test - Post-test for Objective Questions Test	-2.100	.876	.277	-2.726	-1.474	-7.584	9	.000

It can be seen that the calculate t-test value is 0 .000 and it is less than critical value of .001, and therefore the difference is statistically significant between the method

Table 10: Showing a paired t-test for Essay Test

Paired Samples Test									
		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test for Essay Test - post-test for Essay Test	-4.500	2.759	.872	-6.474	-2.526	-5.158	9	.001

It can be seen that the calculated value is 0.001 and it is the same as the critical value at the confidence level of 0.05 and a degree of freedom of 9 which is 0.001, then this implies that there is no statistical significance among the post and pre-test scores hence the treatment yields a negative results. Further analysis was done using analysis of variance as it can be seen below.

Table 11: Showing ANOVA tables

i) Pre-test for Experiment Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33.400	5	6.680	3.817	.109
Within Groups	7.000	4	1.750		
Total	40.400	9			

ii) Post -test for Experiment Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	43.500	6	7.250	3.346	.175
Within Groups	6.500	3	2.167		
Total	50.000	9			

iii) Pre-test for Objective Question Test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.600	2	.800	.933	.437
Within Groups	6.000	7	.857		
Total	7.600	9			

iv) Post-test for Objective Questions Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.900	3	.300	.900	.494
Within Groups	2.000	6	.333		
Total	2.900	9			

v) Pre-test for Essay Test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	34.233	6	5.706	3.668	.157
Within Groups	4.667	3	1.556		
Total	38.900	9			

vi) Post-test for Essay Test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	123.200	5	24.640	3.624	.118
Within Groups	27.200	4	6.800		
Total	150.400	9			

From the above tables generated us ANOVA it can be seen that the F value for pre-test was as follows 3.817, 0.9333 and 3.668 for experimental, objective and essay testing respectively with respective levels of significance 0.109, 0.437 and 0.157. While for post-test was the F values were 3.346, 0.900 and 3.624 and significance index of 0.175, 0.494 and 0.118 for experimental, objective and essay testing respectively all had a degree of freedom of 9.

4.6 Factors that may influence the conceptual understanding of the learners science

This was done by investigating the demographic factors for the leaners. This was done by use of a questioner. It was noted that all the learners were form three boys from a public school which is an extra county school.

The first question was investigating whether one attended a primary public school or a private school.it was discovered that out of 30 students, 20 attended public schools while 10 private schools.

It was also sought to know those who were borders and those were day scholars.13 of those attended public schools were day scholars while 10 of them were borders while those who attended private schools 7 were day scholars while 3 were borders.

The other question sought to know about the family back ground and the social economic factors and the response was as follows.

Table 12: Showing the occupation of the parents of the learners

	Employed	Business	Peasant	Deceased
Father	16	3	9	2
Mother	11	8	9	1

This shows that over 50% of the students their fathers are working class, 10% business men while 30% are peasants and about 40% their mothers are a working class, 27% do business and 30% are peasants.

Table 13: Educational level of the parents

	primary	secondary			
Father	0	7	16	3	5
Mother	2	5	11	11	2

It was also required to know if the students were sponsored or the parents pays their school fees. Out 30 respondents' only three were sponsored.

Table 14: when they do understand physics concept best

When teachers are teaching	4
During discussion with friends	21
Reading alone	5

It can be seen that 70% of the students understand well when they discuss with their peers, 17% when they read on themselves while 13% when teaching.

Table 15: Concerning those who influenced them to take physics

Parents	3
Friends	1
Self	24
Religious leaders	0
Other reasons	2

It can be seen that 80% of the students who take physics choose out of their will while 10% were influenced by their parents but none was influenced by their religious leaders

CHAPTER FIVE

DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 introduction

This chapter contains a summary of findings of the study of effectiveness of the methods of testing conceptual understanding of the students in physics in the concept of floating and sinking in Mbooni east district. The data was collected from a sample and analyzed.

The study findings are being compared with other research work done elsewhere either in the country or outside. There after a recommendation to various stake holders in education sector concerning more inventions and pulling scarce resources towards enhancing improvements of physics performance in secondary schools and finally conclusion

The researcher also made some suggestions of other studies of similar aims in other parts of the country.

5.2 Generalization

5.2.1 Internal validity

The study was aimed at investigating the most effective method of testing conceptual understanding in physics. The study was done by use of three types of tests namely experimental, objective and essay.in each case the sample was pretest, given the same instructional technique and there after post tested.

The purpose of pretesting was to investigate whether the students had a prior knowledge on the concept of floating and sinking or not. It was found in all the three methods the learners were able to show out some elements of having prior knowledge on the concept of floating and sinking.it was also able to show out clearly that there was a bit of misconception especially in the reasons why a body sinks or floats. The learners also had a problem in understanding the concept of buoyancy. Out of the three methods, the objective testing was able to elicit prior knowledge from the learners since the performance of the learners depicted a normal curve. Followed by the experimental testing since objective test produced the lowest F value and highest significance value. In the post testing, the researcher was investigating whether a conceptual change has taken place after instruction.it was discovered that in all the cases there was an improvement of the mean scores and standard deviations this implied that a conceptual change has taken place after instructional process. Therefore this question was well answered by the study

The researcher's big question was, out of these three methods which method is more effective in testing the conceptual change; this was done by carrying out t-test for proportions and ANOVA using the SPSS programmer. For both objective and experimental testing yielded to a positive change but for essay it produced a negative response from the t-test. This means that essay test can't be used to test conceptual change. From ANOVA it was seen that objective questions produced the lowest F value and the highest significance index hence it is able to test conceptual understanding.

Therefore the study had an internal validity since it was able to measure what it ought to measure.

5.2.2 External validity

The results of this study can be statistically generalized since among the students population all the factors that influence conceptual understanding in the concept of floating and sinking are all significant. This can be attributed to a relatively larger sample population. The only challenge is that the population of study was cutting across boys there it might cause some biasness in making the general statement.

To address this challenge in future, it will be necessary to randomly select both boys and girls in order to eliminate the bias and ensure that the findings can be extrapolated to a larger population.

5.3 Discussion of the findings

5.3.1 The most appropriate method to elicit prior in science

It was found in pretest the following results were obtained.in the experimental test the mean score was 10.4 with a standard deviation of ±2.119 while in objective questions the mean score was 3.8 with a standard deviation of ± 0.919 and finally the essay questions with a mean of 2.1 and a standard deviation of ±2.079. This was a very clear indication that the learners possess some prior knowledge however the main agenda here was to investigate which one would be a better method to elicit prior knowledge from the learners. This was done by use of paired t-test and ANOVA and it was found that both experimental and objective test produced positive results while the essay questions gave a negative results. When a further test was done using ANOVA the F value for experimental was 3.668 with a P of value 0.109 done at a degree of freedom of 9 while the objective test had an F value of 0.933 and a P value of 0.437 done at a degree of freedom of 9. This results clearly indicated that the objective questions had a better ability to elicit prior knowledge from the learners.

5.3.2 The most appropriate method to test conceptual understanding science

The pretest scores displayed homogenous distribution. The scores were well distributed assuming a normal curve.it was also found that the students' scores for the posttest marked an improvement of the scores from posttest test in all the tests .this is a clear indication that there was a change on the conceptual understanding for the learners. The mean and the score distribution of the tests in posttest for all the test were as follows for experimental tests was found to be 14 and a standard deviation of ±2.357 In objective questions, the mean score was found to be 5.9 and a standard deviation of ±0.568 the scores for objective test were more concentrated around the mean In essay questions, while in the post- test the mean was 6.6 and a standard deviation of 4.088.for pretest the scores were less spread but in post- test the scores were more spread.

The main objective was to investigate the most appropriate method of testing the conceptual understanding.in this attempt, a paired t –test and ANOVA tests ware done and it was discovered that the objective and experimental tests, they produced a positive change while the essay questions produced a negative change. This implied that the essay testing is not a good test for testing conceptual knowledge. But objective and experimental testing are able to elicit conceptual understanding. However it was observed that, for objective questioning, the scores were more concentrated around the mean and it produced the F value of 0.900 with a degree of freedom of 9 in posttest with significance 0.494 respectively while in experimental method the scores were well distributed when the ANOVA test was done, the F values obtained were 3.624 with a degree of freedom of 9 in posttest and pretest respectively and significance index of 0.175. Therefore, the objective test was able to elicit the prior knowledge and measure the conceptual understanding better than all the experimental testing.

5.4 Factors affecting learner's conceptual understanding science

It has been discovered that the conceptual understanding is not only affected by the instructional methods only but also by other factors such as the type of the school, culture of the school, the family background and the peer influence.

It was found that the respondent in this case all were from the same school environment, the same type of the school. However their family back ground and social economic varied. This greatly affected the language used in explanations and prior knowledge due to the kind of experiences one has come across from child hood.10% of the respondents were sponsored meaning that they come from a humble back ground and therefore

It was also discovered that 70% of the learners understand well when then they discuss with their peers, 17% when they read themselves while 13% are able understand when they read on themselves. 80% 0f the learners choose physics out their own self-drive this means that the population that the researcher used was self-motivated to take physics.

5.5 Contribution of the study to the theoretical framework

The researcher employed two theories in the study namely constructivist theory of teaching and learning and classical test theory. From the pretest the researcher discovered that the learners always possess some scientific knowledge about the topic of floating and sinking as result it is always necessary for the teachers to build what the learners know. According to driver, leach, Asoko ,Mortimer and Scott, the researcher also agreed with them that children will always have some representations of many phenomena studied in school science based on their experience.

The classical test theory was also applied in the scoring of the test especially in objective questions where the learners were prone to guess work hence it helped to obtain the true score of the learner's performance.

5.6 Recommendations

Since it was found that testing learners before instruction and after instruction yielded a positive change, and can also have a great impact on the conceptual understanding, since the teacher will have an understanding of the learners misconception's and their prior knowledge. The researcher makes the following recommendations.

i) The researcher recommends that it is necessary for teachers to give a pretest exam to the learners before commencing any instructional process in order to determine the depth of the learner's prior knowledge.

ii) The researcher further recommends that the same test should be administered to the learners after instruction in order to establish the depth of conceptual understanding.

iii) The researcher recommends to the education stake holders to make a requirement for the teachers to set up such tests for pretesting and post testing in every topic in order to be able to establish the conceptual changes

iv) The teacher training colleges and universities should make it as a part of their requirement especially during teaching practice that the set tests to be administered before instruction and after instruction and make a record of such performance.

5.7 Further research

Further researcher should be carried out in other districts and find out if the same findings will be achieved.it should also be done using the other topics in physics and if possible extended to the other science subject and see its practicability in the entire syllabus.

It is also important that the process can be repeated using other methods of instructions and compare the results with the results in this study.

5.8 Conclusion

The researcher found that there is a positive correlation in the results obtained in the pretest and posttest in all the tests. The method of instruction employed in this case yielded a positive result in conceptual understanding. It was noted further that objective testing yielded to a better method of testing thee conceptual understanding since the performance was a normal curve with more students concentrating around the mean and with the lowest F value and the highest significance index. The learners also took a shorter time to do the test implying that it is more convenient to be administered at the start of the topic. This method of teaching and learning is able to cultivate positive attitude to the learners and motivate the learners to do well in science subjects. Therefore it is worthy method of teaching and learning.

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APPENDICES

Appendix I: Reference letter

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DEPARTMENT OF PSYCHOLOGY

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September 15, 2015

TO WHOM IT MAY CONCERN
RE: JOSEPH NZOMO MWALIMU – E58/70485/2013

The above named is a student in the Department of Psychology studying Masters Psychology in M.Ed of Arts in counseling Psychology programme at the University of Nairobi. He is doing a research on "***Effectiveness of Methods of Testing Conceptual Understanding in Physics: A Study done in the Concept of Floating and Sinking in Form 3 Students at Mbooni – East District in Makueni County***." The requirement of this course is that the student conducts research and collects data in the field on the topic area.

In order to fulfill this requirement, I would like to re-affirm that the said student is a registered student and is intending to go and carry out field work. Any assistance accorded to him will be highly appreciated.

Should there be any queries do not hesitate to contact the Chair of the Department of Psychology, University of Nairobi.

DEPARTMENT OF PSYCHOLOGY
NAIROBI

Dr. Luke Odiemo
Chairman,
Department of Psychology

Appendix II: Questionnaire for the students to investigate demographic factors

Kindly respond to the following questions appropriately noting that the researcher will treat the responses confidential. Note that the success of the researcher will depend on your honesty.

1. What is your gender?

Male ( ) Female ( )

2. Which class are you? …………….

3. What is your age …………………..

4. What type of primary school did you attend?

Private ( ) public ( )

5. Where you a day scholar or a boarder? …………………..

6. Where was your primary school located from your home?

Less than 1km ( ) between 1 -2 km ( ) between 2 – 3 km ( ) over 5km ( )

7. What type of secondary school are you in.

Public ( ) private ( )

8. If public what category is it?

Sub county school ( ) county school ( ) extra county school ( ) National ( )

9. Are you a day scholar or a boarder? ……………………..

10. Who pays your school fees?

My parents ( ) sponsor ( )

11. When do you normally understand physics concepts more?

When a teacher is teaching ( ) when I discuss with my friends ( ) when I read a lone

12. Who influenced you to choose physics?

My parents ( ) my friends ( ) myself ( ) Religious leaders ( )

Any other …………………………………………………

13. The occupation of my father is…………………………..

14. The occupation of my mother is ……………………..

15. The educational level of my father is

Primary ( ) secondary ( ) tertiary ( ) Not applicable ( )

16. The educational level of my mother is

Primary ( ) secondary ( ) tertiary ( ) Not applicable ( )

Appendix III: Exams

(a) Objective questions

Name……………………………………………..…………class………………

Time: 20 mins

Instructions

Choose the correct answer out of the four choices given

Write your name and class in the spaces provided`

1. A piece of paper floats in water because of its

A) Mass

B) Density

C) Volume

D) Shape

2. Why does a piece of wood float in water but a n iron ball sinks

A) Wood is less dense than iron

B) Wood is less dense than water but iron is denser than water.

C) Wood has large volume than iron

D) The mass of wood is less than that of wood.

3. Why does ship and ferry float in water yet they are made of metal.

A) They have large surface area.

B) They are made of less dense metal

C) They have large volume

D) They displace large volume of water

4. Why does increase in weight make a floating body sink in water

A) The weight of the body increases beyond up thrust

B) It breaks surface tension

C) It makes an object more heavy

D) It lowers the up thrust

5. What is the effect of the volume of displaced water to the ability of the object to float or sink?
   A) The more the water displaced the higher the up thrust hence the object floats
   B) Less water displaced the higher the up thrust hence the object floats
   C) The less the water displaced the less the up thrust hence the object sinks
   D) It has no effect.
6. An object floats more in water than in paraffin because
   A) Density of water is less than that of paraffin
   B) Density of water is higher than that of paraffin
   C) Water has high cohesive force than paraffin
   D) Paraffin has higher adhesive force than water.
7. Why does a ship or a ferry have large air spaces below it?
   A) It increases its buoyancy
   B) It makes it less dense
   C) It increases surface area
   D) It lowers its weight

(b) Essay questions

NAME……………………………………………………….CLASS……………
………..

Time: 20 mins

Instructions

Write your name and class in the spaces provided above.

Answer all the questions in the spaces provided above?

1. A boy threw a maize cob and a small stone on the surface of water simultaneously state and explains what will be observed. (4 mks)

2. A student was fetching water from a dam. He observed that it is easier to carry a 20 litter container while in water than in air. Explain this observation. (5 mks)

3. Explain how an inflated tube can help a person to swim across a flooded river (3 mks)

4. A fishing boats can be improvised. Describe the shape and the type of the material used to make the boat giving reasons. (4 mks)

5. Explain what will happen if the tube in question 4 above is deflected when on is swimming .(4mks)

(c) Experimental approach

NAME…………………………………………….CLASS……………………..

Time: 20 mins

Instructions

Write your name and class in the spaces provided above.

Perform the tasks and answer all the questions in the spaces provided above?

1. You are provided with a basin of water, a small piece of wood, a stone, a long tick, a short stick, a plastic pen and a steel ball. Place each one of them in turn on the surface on the surface of water.
   a) Which objects floated in water?

   b) Which items sank in the water

   c) The materials which floated in water are made of

   d) The materials that sank in water are made of.

   e) Compare the mass of the materials that floated in water with the mass of materials that sank in water.

f) Compare the densities of materials that floated and those sank with that of water.

g) In your own opinion explain why some materials float and others sink.

2. You are provided with a basin of water, a bottle top crushed bottle top and small stones. Place each bottle top on the surface of the water each at a time and observe what happens

   a) Which bottle top sank?

   b) Why did it sink?

   c) Add a few stones on the bottle top that floated and observe what happens as you continue adding the stones. Did it sink or float?

   d) Why do you think it happened in **c** above?

3. From the above experiment
    a) State three factors that affect if a body will sink or float.

    b) In your own opinion why does a ship float in water yet it's made of steel.

4. You are provided with a spring balance, eureka can, water, a beaker and a mass.fill the eureka can with water until it the water begins to flow out through the sprout. Wait until it stops and place the empty below the sprout. Weigh the mass in air, and while suspended using the spring balance weigh it again when in water. Also take the weight of the displaced water.
    a) When does a body weigh less? When in water or when in air?

    b) Find the difference between the weight in air and the weight in water and compare it with the weight of displaced fluid.

Appendix IV: Marking schemes

a. Objective questions

1. B	2. B	3. D	4. A	5. A	6. B
7. A					

b. Essay questions

Point note. A comma (,) indicates a making point

1. The stone sank while the maize cob floated, the stone has a higher density than water while the maize cob has lower density than that of water, and the maize cob experiences a higher up thrust than the stone.
2. The up thrust is high in water than in air, since water is denser than air, this makes the resultant weight in air to more than in water.
3. The density of the air in the inflated tube is lower than the density of water, this increases the buoyancy of the tube. The tube also experiences higher up thrust when inflated than when deflated since it displaces more fluid.
4. They should be oval in shape, this will enable it to displace more fluid, hence increasing the magnitude of the up thrust making it possible to float,
5. The air will flow out hence decreasing the amount of fluid displaced thus reducing the magnitude of the up thrust hence the swimmer sinks.

c. Experimental

1 a) Plastic pen, piece of wood, long stick and short stick.

b) Steel ball, a stone

d. metal and stone

e. plastic/wood

f. The one that floated have large mass than the ones that sank.

g. They are less dense than water

h. Because they are made of materials which are less dense than water.

2. a) crushed one

b) It is small in size

c) It will sink

d) Its weight has increased

3. a) i)density of the liquid

ii) Weight of the object

iii) Shape of the object

b) It displaces large volume of water

4. a) when in water

b) When in water it is being pushed upward by up thrust force

c) 1.0 – 0.9 = 0.1N, it is equal to the weight of displaced fluid

Appendix IV: Raw scores for both pre and post test

Post test results

a) Experimental tests

Student	Q1	Q2	Q3	Q4	
1	7	2	1	1	11
2	5	4	2	1	12
3	6	3	4	1	14
4	7	4	3	3	17
5	4	4	1	2	11
6	7	2	3	3	15
7	5	3	3	1	12
8	7	3	3	3	16
9	7	3	3	4	17
10	7	4	2	2	15

b) Pre-test experimental results

Student	Q1	Q2	Q3	Q4	
1	4	2	1	0	7
2	3	3	2	2	10
3	5	3	3	2	13
4	5	4	3	2	14
5	4	3	2	1	10
6	4	2	2	1	9
7	4	2	2	1	9
8	5	3	2	1	11
9	5	2	3	2	12
10	2	3	2	2	9

c) Objective questions pre-test results

Student	Q1	Q2	Q3	Q4	Q5	Q6	Q7	
1	1	1	0	0	0	1	1	4
2	1	1	0	0	0	1	0	3
3	1	0	0	0	0	1	0	2
4	0	1	0	1	1	1	1	5
5	0	1	0	0	1	1	1	4
6	0	0	0	1	1	1	1	4
7	1	1	0	1	0	1	1	5
8	0	0	0	1	0	1	1	3
9	1	1	0	1	0	1	0	4
10	0	0	0	1	1	1	1	4

d) **Post test results, Objective questions**

Student	Q1	Q2	Q3	Q4	Q5	Q6	Q7	
1	0	0	1	1	1	1	1	5
2	0	1	1	1	1	1	1	6
3	0	1	1	0	1	1	1	5
4	0	1	1	1	1	1	1	6
5	0	1	1	1	1	1	1	6
6	0	1	1	1	1	1	1	6
7	0	1	1	1	1	1	1	6
8	0	1	1	1	1	1	1	6
9	1	1	1	0	1	1	1	6
10	1	1	1	1	1	1	1	7

e) Essay post test results

Students	Q1	Q2	Q3	Q4	Q5	
1	4	4	2	3	4	17
2	1	2	2	0	1	6
3	1	2	1	3	2	9
4	1	1	1	0	2	5
5	1	2	0	0	0	3
6	2	1	1	1	1	6
7	1	3	1	1	0	6
8	1	1	0	1	0	3
9	1	1	0	1	1	4
10	2	0	0	4	1	7

f) Results for essay pre-test results

Student	Q1	Q2	Q3	Q4	Q5	
1	3	1	1	0	2	7
2	1	1	1	0	0	3
3	1	0	0	0	0	1
4	1	1	0	0	0	2
5	1	0	0	0	0	1
6	1	0	0	0	0	1
7	1	1	2	0	0	4
8	0	1	0	0	0	1
9	0	0	0	0	0	0
10	1	0	0	0	0	1