EFFECT OF EXPERIMENTAL METHOD OF TEACHING ON RETENTION AND APPLICATION OF MOMENT CONCEPTS IN PHYSICS IN SECONDARY SCHOOLS OF MARAKWET WESTSUB-COUNTY, KENYA.

BY

SAMUEL KIPROP CHEPKWONY

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DECLARATION

DECLARATION BY THE CANDIDATE

This is the work of my hands and it has not been presented for any degree or diploma in any other institution of learning. Therefore, no part of this work may be presented without the consent of the author and / or University of Eldoret.

SIGN…… DATE …….

SAMUEL KIPROP CHEPKWONY
EDU/S/PGSE/003/15

DECLARATION BY THE SUPERVISORS

This thesis is the work of the candidate whom we supervised and approved for submission to examination as university appointed supervisors.

SIGN…… DATE……

DR. COSMAS K. RONNO
Department of Physics
School of Science
University of Eldoret
P.O BOX 1125-30100 ELDORET
.
SIGN……... DATE……

DR. DINAH C. SAMIKWO
Department of Science Education
School of Education
University of Eldoret.
P.O BOX 1125-30100 ELDORET.

SIGN……... DATE……

DEDICATION

This thesis is dedicated to my fellow Physics teachers who are working tirelessly in ensuring learners are getting quality Physics Education.

ABSTRACT

The study investigated the effect of experimental method of teaching on retention and application of Moment Concepts in Physics among Form Two students. The objectives were as follows: to investigate the effect of experimental method on:(i) retention of Moment concepts (ii) application of Moment concepts and, (iii) the challenges facing physics teachers when using experimental method to teach Moment concepts. Quantitative Research methods and a quasi-experimental pretest, posttest nonequivalent group design were employed. The study adopted stratified random sampling, simple random sampling and purposive sampling techniques to sample the respondents. The target population was 1500 Form two students and 41 Physics teachers. The sample size comprised of 271 Form two students and 20 physics teachers. Tests for students and questionnaires for physics teachers were used as instruments for data collection. Reliability was determined through testing and re-testing technique whereas the validity of the Tests was approved by KCSE Physics Paper One examiners and that of the questionnaire by the university supervisors. Analysis was done using inferential statistics on SPSS (version 23.0) and Excel. The study established that there was no significant mean difference in pretest hence, the two groups were equivalent in ability. Moment Test 2(Posttest) showed significant mean difference in both retention and application of moment concepts between learners taught through experimental approach and those taught through lecture method of teaching. Experimental method of teaching was therefore seen as effective in enhancing higher retention and application than lecture method. Teachers of physics face the following challenges: Heavy workload, overpopulated classes and inadequate teaching resources. Finally, it was recommended that experimental method of teaching to be adopted to improve retention and application of moment concepts in learners. These results will form the basis of advising physics instructors, Teachers' employer and curriculum developers about necessity of designing students' experiments which will enhance their Retention and Application of Moment concepts.

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LIST OF ABBREVIATIONS AND ACRONYMS

The abbreviations and acronyms together with their accompanying meaning were provided as follows:

CBC:	Competence- based Curriculum
COG:	Centre of gravity
IBL:	Inquiry-Based Learning
ISCED:	International Standard Classification of Education
STEPS TWO:	Stakeholders Tune European Physics Studies Two
UK:	United Kingdom
WG:	Work Group

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter captures the background information where various studies regarding the area investigated are highlighted, the problem to be solved, specific objectives to be met in this study, hypotheses tested, justification, importance, assumptions which were made, scope and limitations of the study, theoretical framework, conceptual framework, operational definitions of terms and finally the summary.

1.2 Background Information.

Physics is a branch of science which deals with the study of matter and its relation to energy. This branch of science forms the foundation for other physical sciences such as chemistry, geology and astronomy. In secondary school physics curriculum, physics is divided into six branches namely: Waves, Mechanics, Thermodynamics, Optics, Atomic Physics and Electricity and Magnetism. The concepts of moment fall under mechanics since this branch deals with motion of bodies under influence of force. The rationale for teaching physics in secondary school is to lay foundation for future careers (Serway, Moses & Moyer, 2004). According to Kola (2013), physics concepts are corner stone for technological infrastructure and catalysts for scientific advances as well as discoveries.

Kola's assertion concurs with that of Ng'ethe (2016) who asserted that physics plays a fundamental role in the growth of innovations and inventions necessary for the attainment of vision 2030 in Kenya. This shows that without physics the future of our country is doom. Despite physics being an important subject in the production of trained manpower able to contribute in a crucial way to the growth and competitiveness of any country's economy, students' interest in physics has been reported to be declining. For instance, a study by Amunga, Musasia and Musera (2011) highlighted that Physics Achievements and enrolment in schools is relatively lower as compared to other subjects. This implies that students' attitude towards physics is negative. Numerous actions have been taken to investigate this trend and the most featuring factor found was how physics is taught (European Commission Report,2010).

Teacher's pedagogical approach has been reported to influence the learning process. Therefore, teachers have been advised to know how to develop teaching methods for a specific topic utilizing student-student interactions or students' collaboration (Etkina,2010). According to analyzed results presented in Stakeholders Tune European Physics Studies Two project by Working Group Two (STEPS TWO WG2) cited by Tugulea, Jones and Naudts (2011), student- centered learning approaches accounted for an average of approximately 50% of credits in both the bachelor and master phases. This implies that student centered methods enhance better retentions and applications of scientific concepts.

According to International Standard Classification of Education (ISCED) in European countries for instance, hands-on activities are regarded the most appropriate approach for teaching science in lower secondary education level (Educational Information Network in the Europe Union,2006) to enable learners acquire complex scientific skills such as formulation and testing of hypotheses while tests and examinations are used to identify whether students are able to recall and apply these skills in familiar or unfamiliar situations. Scholars have also argued that hands-on experiments can be used to illustrate and verify scientific laws in an intuitive manner to learners (Haigh & Forret, 2005). Based on evidence that experimental approach enhanced better learning, students' negative perception on moment concepts is an indication that this method is not utilized by majority of our physics teachers.

A study by Baram-Tsabari and Yarden (2005) revealed that students like hands-on experiments and disliked teacher-centered approaches since they give them little opportunity to explore their ideas. This explains why for instance in USA where student-centered approaches are employed, learners are eager to learn (McWilliam, Poronnik & Taylor, 2008). Therefore, there is sufficient evidence to question teacher's pedagogy whenever students develop negative perception in a subject. In other countries such as South Africa, physics is taught majorly through lecture method and the main purpose of using this approach is to enable students to memorize facts and score good grades in the national examinations. This approach is similar to what is happening in Kenya where teachers prefer lecture method to enable them complete syllabus early (Menjo, 2013).

In Uganda, similar practices have been observed. A study by Guloba, Wokadala, and Lawrence (2010) highlighted that teacher-centered approach is greatly blamed as the most contributing factor as to why students score low grades in physics National Examination in the country. This implies that teachers dominate the learning process hence, inhibiting students' expressions and exploration. It has also resulted to teachers failing to address learners' misconceptions. Hands-on experiments have been recommended as the best approach that enhance better learning of science (Norman, 2005). However, it has been reported that science teachers hardly employ this approach (Jones & Wyse,2004). Failure to use this approach in daily science lessons is shocking in that it is through student-experiments that encourage and sustain learners' interest in learning (Worth,2010). It is evidenced from these studies that hands-on activities are crucial for students to acquire scientific concepts and skills. However, this will not be possible if science teachers do not use this approach as pointed out by Jones and Wyse (2004).

Physics and mathematics are sound subjects required in many careers, in contrast, a study by Esiobu (2005) indicated that the performance in the two subjects is very poor. The same observation was made by Agwagah (2005) who asserted that the trend in the performance of the two subjects has been declining in secondary schools over the years. This study believes that low achievement in physics is contributed by students' negative perceptions in some topics such Moments among other topics in physics curriculum. Concepts of moment tested in Kenya National Examination Council in secondary Physics are: The SI unit of moment of a force, Principle of moments, Problems on principle of moments (Single pivot only) and Problems on Centre of gravity and moments of a force (Single pivot only).

The topic on moments is tested in Physics Theory Paper One and Physics Practical (Paper Three) in KCSE physics examination. In Physics Practical, for instance, the learner is required to apply principle of moments to determine up thrust in a liquid (Archimedes principle and moments) or apply principle of moments to determine spring constant (Moments and Hooke's law). Moment concepts are also applicable in real life situations such as support and movement, construction industry, transport industry and garages. Despite moments being widely applicable in many sectors of economy, a study done in United Kingdom (UK) by William, Stanisstreet, Spall, Boyes and Dickson (2003) indicated that students perceive the topic on moments as difficult. A similar observation was made by Streveler (2006) who asserted that students show poor mastery of many vital concepts in moments.

Other studies which have highlighted students' difficulty in learning moments include a study by Erinosho (2013) which indicated that Equilibrium of forces which is a concept of principle of moments is difficult to students. The findings showed 20% of the students sampled cited the topic moment as difficult giving the cause of difficulty as hard to recall concepts and too little practical work done. A study by Kiptum, (2015) on difficult physics topics in Kenyan Secondary schools in Uasin Gishu County also found that 28% of the students perceived the topic moment as difficult and 44.4% of teachers indicated the topic as challenging to students. A study by Menjo (2013) also indicated that students find difficult to understand the topics moment in physics due to attitude related reasons and poor teaching approach. Difficulty in learning moment concepts by students could be linked to lecture method as pointed out in a study by Ganyaupfu (2013) that low achievement in Physics has been contributed by lecture method.

Lecture method could be the cause of students being unable to apply the principle of moments and other moment concepts as pointed out in the Kenya National Examination Council (2016) Physics report. The report further underscored that most of the physics topics would be best understood by students if a practical approach is used. The present study filled the gap by subjecting a group of students to intensive hands-on experiments on moments while teaching the other group of students using lecture method. A study by Musasia, Abacha and Biyoyo (2012) reported that predominant Physics teaching method in Kenyan schools is the lecture method and hence, they argued that this method is the cause of low grades in physics in most schools. A recent study by Musasia, Ocholla and Sakwa (2016) underscored that lecture method has limited most students' visualization on how the physical world works. This is an indication that lecture method is ineffective method of teaching in fostering acquisition of scientific concepts among students.

Experiments are believed to play a significant role in developing students' mastery of scientific skills as well as sense of ownership which in turn promotes learner's motivation (Dillon,2008). Hence, researchers have attributed poor mastery of Physics and Mathematics concepts to inappropriate pedagogical strategies mostly the lecture method believed to contribute largely to poor retention and application of physics and mathematical concepts by students (Ifeanacho, 2012; Agwagah, 2005; Agommuoh, 2004). Students perceive 33% of the physics topics as difficult, among them is Moment of a Force (Waititu,2004). The cause of difficulty cited by students being difficulty in memorizing terminology, facts, laws and equations. This could be attributed to teacher-centered approaches of teaching as pointed out in the study by Musasia, Abacha and Biyoyo (2012).

From this background, it is evident that students perceive Physics topics such as topic on moments as difficult due to inappropriate teaching methods as it was highlighted in a study by Jones and Wyse (2004) that science teachers hardly employ learner-centered approaches which has resulted to poor performance in Physics subject. The present study therefore, seeks to find out whether or not the experimental method of teaching will improve students' retention and application of moments concepts in physics and perhaps change their negative perception towards moment concepts.

1.3 Statement of the Problem

Kenya Certificate of Secondary Examinations (KCSE) Physics reports have indicated poor achievement in Physics subject country wide for the last five years as shown in appendix XIII. Learners' achievement in Physics in Marakwet West has also continued to be consistently poor over the years as evidenced in Sub –County Education KCSE Analysis Reports shown in appendix XIV. The most mentioned factor being students' negative perception on moment concepts which are majorly tested in Physics Paper One and Physics Paper Three in KCSE Physics examination. Students' poor mastery of moment concepts could be linked to poor performance in the subject. For instance, KNEC (2016) Physics report indicated that students were unable to apply the Principle of Moments correctly. It has been argued that poor achievement in Physics is attributed to the way Physics concepts are presented to the learners (Ornek, Robinson & Haugan, 2008).

A study by Musasia, Abacha and Biyoyo (2012) pointed out that lecture method is predominantly use by physics teachers and the outcome being students are denied the chance to feel, explore, make hypotheses, test these hypotheses, carry out experiments and come up with their findings so that they can understand how nature works. It is believed that appropriate teaching strategies eliminate students' learning difficulties in Physics concepts (Ogunneye, 2013). For this reason, the study aspired to employ experimental approach to determine how it influence retention and application of Moment Concepts.

1.4 Purpose of the Study

The main purpose for carrying out the present study was to compare the level of retention and application of Moment concepts between students taught through experimental approach with those taught through lecture method since the literature reviewed indicated that lecture method is predominantly use in daily physics lessons.

1.5 Objectives of the Study

1.5.1 Main Objective

To determine the effect of experimental approach to teaching on retention and application of moment concepts.

1.5.2 Specific Objectives

1. To determine effect of experimental method of teaching on retention of moment concepts in physics between learners taught using experimental and those taught using lecture methods.

2. To find out the effect of experimental approach on application of moment concepts in physics between learners taught using experimental and those taught using lecture methods.
3. To find out challenges hindering physics teachers from using experimental method of teaching to teach moment concepts.

1.6 Research Questions

1. Is there any difference in retention of moment concepts between learners instructed through experimental and those instructed through lecture methods of teaching?
2. Is there any difference in application of moment concepts between learners instructed through experimental and those instructed through lecture methods?
3. What are the challenges facing physics teachers when using experimental method to teach moment concepts?

1.7 Hypotheses

The study was guided by the following null hypotheses:

H_{01}: There is no significant mean difference in retention of moment concepts between students taught using experimental method and those taught using lecture methods.

H_{02}: There is no significant mean difference in application of moment concepts between students taught using experimental method and those taught using lecture methods.

1.8 Justification

Science is an integral part of every person's life. This is because the knowledge of science equips people with appropriate scientific skills and attitudes necessary for day-to-day running of activities (Hirschfield, 2012). It is said that Physics plays a crucial role in accelerating technological advancement in the world (Amunga, Musasia, & Musera, 2011) and also provides trained personnel needed to spearhead innovations and harness natural resources such as energy to better human life (Freeman, 2012). It is therefore expected that the scientific skills acquired by learners apply these sills to real life situations (Lunetta, Hofstein, & Clough,2007). Hence, appropriate pedagogies which foster students' retention and application of scientific knowledge and skills should be adopted in science lessons.

According to Agostini and Delizoicov (2009, hands-on experiments enhance quality science teaching. This implies that the declining performance in sciences especially Physics is due to limited or absence of experiments. Experiments enable learners to confirm and conceptualize scientific knowledge, hence, owning the learning process as they investigate and question nature (Musasia, Ocholla, & Sakwa, 2016). Unfortunately, studies have revealed that physics teachers mostly use lecture method to deliver physics concepts (Musasia, Abacha & Biyoyo,2012). The usage of this method is said to have contributed significantly to students' negative perceptions towards physics topics such as those on moments.

It was confirmed by Menjo (2013) in his study that students perceive moment concepts as difficult due to poor teaching approach and little practical work. A study by Jones and Wyse (2004) indicated that limited number of science lessons are taught through student-centered approach which has resulted to poor performance in Physics subject. Therefore, there was need to find out how experimental method influence retention and application of moment concepts in Physics.

1.9 Significance of the Study

Physics plays a fundamental role in enhancing innovations and developments necessary to catalyze attainment of Kenyan 2030 vision. Therefore, students getting low grades in physics not only discourages but it also diminishes country's hope in attaining this goal. This study therefore is of great significance in that its findings will form the basis of advising the institution in charge of designing Physics content in Kenya.

Secondly, Ministry of Education is likely to benefit and equip the schools' laboratories to facilitate effective usage of experimental method. Thirdly, the findings will offer advice to Physics teachers on appropriate teaching methods which enhanced students' Retention and Application of Physics Concepts. Furthermore, scholars and academicians will use these findings to enrich their knowledge on how to enhance retention and application of moment concepts. Lastly, this study will close knowledge gap, hence, this knowledge will be useful to scholars pursuing this field.

1.10 Assumptions of the Study

These are things that are somehow out of control of the researcher and if they disappear the study would become irrelevant (Simon, 2011). They are so basic that without them, the research problem itself could not exist (Leedy & Ormrod, 2010). Therefore, the study was guided by the following assumptions:

1. that the selected schools will cooperate with the researcher. The cooperation of the respondents was enhanced through self-introduction to the respondents and producing supporting documents showing research authorization.
2. that Physics teachers given questionnaires will give true and honest responses. This was ensured by giving the teachers anonymous questionnaires and assuring them the confidentiality in reporting their responses.
3. that the learners will respond to the test items without fear. This was ensured by instructing them not to write their names anywhere in the script.
4. that the number of sampled respondents was sufficient for results to be generalized from. The researcher systematically used stratified, purposive and simple random sampling to select the schools that participated in the study.
5. that t-test will give a clear influence of experimental method of teaching on students' retention and application of moment concepts.

1.11 Scope of the Study

The study examined the effect of experimental method of teaching on retention and application of moment concepts among secondary school learners in Marakwet West Sub-County, Kenya. The study focused on the use of experimental method of teaching versus the lecture method of teaching where the teacher explains, give notes, asks questions and gives feedback in class without the learners interacting with apparatus. The primary task was to establish whether or not the learners' retention and application of moment concepts will improve when taught through experimental approach as compared to those taught by lecture method. The study respondents were drawn from Form Two students. Other classes were not used because the topic on Moments is taught in Form Two. The topic Moments was used among the many other topics in Physics subject because it is a topic most teachers view to be easy but the students perceive it to be difficult and even fail to apply its basic concepts to solve problems involving moments (Kiptum, 2015). The study concentrated to schools located in Marakwet West Sub-County among other sub counties in Elgeyo Marakwet County because the Sub- County had continually registered dismal performance in Physics at KCSE level as shown in Appendix XIV.

1.12 Limitations of the Study

According to Simon (2011), limitations are potential weaknesses of a study which are out of control of the researcher. The study was limited in the sense that:

1) It was done in one sub-county in Elgeyo Marakwet county hence generalization of results is limited.

2) Topic on Moments amongst several other topics in Physics syllabus taught in Form Two was investigated.

1.13 Theoretical Framework

The study was based on Experiential Learning Theory theorized by psychologist Kolb (2014) who was influenced by the work of other theorists including John Dewey, Kurt Lewin, and Jean Piaget. This theory involves knowledge created through the transformation of experience. This approach is more details than both cognitive and behavioral approaches in the sense that all factors influence the learning process are taken into considerations. It was relevant to present study since it emphasizes learning by doing to create concrete experience. Most importantly, the theory advocates that learners to be given opportunity to participate in doing, reflecting and applying the skills to similar or different situations.

The theory underscores four stages of learning, namely: Experience, sharing, reflection and generalization. These steps were applied in the present study in the following ways:

1. In order to ensure that learners gain the concrete experience, they were put into groups and provided with various apparatus such as metre rule, masses, cotton thread, pivot (knife edge). Learners were then given the practical manual showing all the activities to be done.
2. Sharing was enhanced through group presentations where students from one group share their understanding with members of the other groups.

3. Learning by reflection was enhanced by asking learners to describe using their acquired experience the meaning of state of equilibrium of a metre rule, clockwise moment and anti-clockwise moment.
4. Generalization. In this stage learners were expected to apply the skills and concepts gained from the experiments to similar or different situations to demonstrate deep understanding which was key to the present study. The teacher utilized this stage by giving the learners assignments on diagrams showing the state of equilibrium of a metre rule when masses are hanged at various points. Learners were then asked to identify and record masses responsible for clockwise motion and those that were responsible for anti-clockwise motion.

In conclusion, this theory was relevant in the sense that learners were expected to gain deep understanding on clockwise and anticlockwise moments and also apply the knowledge gained in solving problems involving moments. The study employed the concepts of this theory in respond to students' negative perception on moment concepts as it was pointed out by examining body that candidates are not able to apply the principle of moments correctly. Candidates' failure to apply the principle of moments was an indication that they had never experienced the phenomenon.

1.14 Conceptual Framework

The study was conceptualized as shown by figure1.1

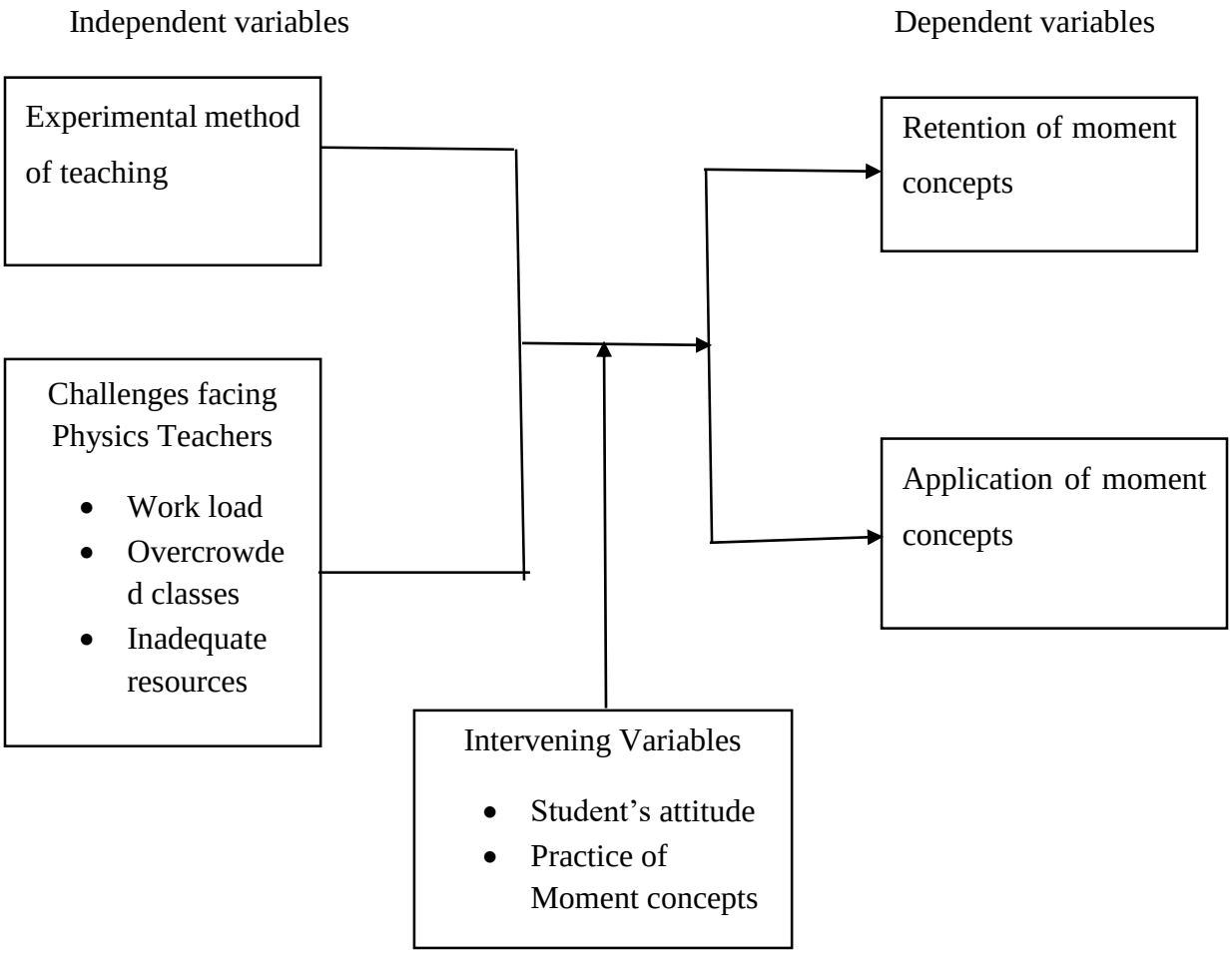


Figure 1. 1 Conceptual framework of the Study

Figure1 shows that the independent variables of the study are experimental method of teaching and challenges facing physics teachers when using experimental approach to teaching moment concepts. Experimental approach was conceived to positively influence students' retention and application of Moment Concepts. However, for this approach to be effective, challenges facing physics teachers must be reduced as much as possible.

For instance, challenges such as teacher's work load, overcrowded classes and inadequate teaching and learning resources were minimized through induction of physics teachers, provision of teaching manuals and suggestions for improvisation in the absence or inadequate teaching resources in some selected schools. Students' retention and application of moment concepts were conceptualized to be dependent variables. The independent variables however, can be intervened by student's attitude towards physics and practice of moment concepts. The intervening variables were controlled in such a way that they did not affect the outcome of the study. For example, students' negative attitudes were controlled by involving students in setting of experiments, recording of data and discussion of the results. To enhance practice of learned moment concepts, students were given assignments and the teacher marked and gave feedback to the learners before the next lesson.

1.15 Operational Definition of Terms

It was necessary to operationalized terms used in this study for other scholars to comprehend the purpose of this study. Terms operationalized were:

Experimental method - learner-centered approach in which learners engaged in hands-on activities as the teacher guide the learners in making observations.

Lecture method - teaching approach in which the teacher explains, gives notes, ask and answer questions in class without the learners interacting with the physics apparatus.

Retention - ability of the learner to recall moment concepts after a period of four weeks after teaching which was measured using moment tests

Application - ability of the learner to apply the formula of a moment of a force and principle of moments to solve problems involving moments.

Moments -It is topic taught in Form Two physics syllabus in Kenya. It is also called Turning effect of a force.

Moment concepts -These are basic ideas of moments which include the definition of a moment of a force, SI units, Formulas, principle of moments and its applications**.**

Excellent performance in moments- ability of the learner to score all the marks awarded to a question on moments

Fair performance in moments- ability of the learner to attempt questions on moments and he/she is able to score a mark but not full marks awarded to the question.

Poor performance in moments- refers to a situation in which the learner fails to attempt a question on moments and he/she is awarded a zero mark in the entire question.

Lesson Study -A new teaching approach in which teachers of the same subject discuss the objectives of a lesson and plan for the lesson. The lesson is then taught by one of them while the others observe the lesson presentation in class. After the lesson, they converge and critique the lesson.

1.16 Summary

The chapter began by highlighting the content of the chapter followed by the background information of the study where it emerged that students perceive moment concepts as difficult citing little experiments being done by physics teachers as the cause of the difficulty. This was justified by Menjo (2013) and Kiptum (2015) studies. The statement of the problem gave an indication that there was need to solve poor performance in Physics KCSE examinations through experimental approach. The intention for undertaking this study was to find out if the retention and application of moment concepts between learners instructed through experimental approach and those instructed through lecture method of teaching was different. This investigation was systematically carried out following the objectives, research questions and the formulated hypotheses. The role played by experimental method in enhancing the learners' retention and application of Physics concepts justified the study. Furthermore, the results of this study will be of great significant to Teachers Service Commission, the institution in charge of designing curriculum, Government of Kenya through the ministry of education and Physics teachers as the main actors. The assumptions and limitations which underlie the study were given.

Schools located in Marakwet West sub-county, whose learners were taught Physics by the use of experimental approach formed the boundary of the study. The study was anchored on Experiential learning theory proposed by Kolb (2014), the theory involves knowledge creation through transformation of experience.

The diagrammatic conceptual framework guided the study in which experimental method of teaching was conceptualized as independent variable whereas retention and application of moment concepts were viewed as dependent variables. Finally, the terms used in the study were operationalized.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter addresses information underpinning objectives outlined. Factors influencing retention and application of scientific concepts, influence of experimental method of teaching on retention and application of Physics concepts, influence of lecture method on retention and application of physics concepts, Challenges facing physics teachers when using experimental method of teaching are looked into and lastly the summary of the chapter is provided.

2.2 Factors influencing Retention and Application of Scientific Concepts

Teaching and learning are inseparable in that it is through teaching that gives rise to learning. Therefore, effectiveness of a pedagogy is determined by the learners' outcome in a test or an examination. If the learners demonstrate recall of facts and comprehension of the concept in a test or examination, then the teaching approach used can be said to be suitable for learning.

Bloom's Taxonomy of Cognitive Skills, retention involves the learner remembering facts, conventions, methodologies, structures and principles. Questions that encourage retention often begin with list, define, describe, show, name, what and when. Therefore, retention is a lower level skill which gives rise to other skills. That is, if the learner is not able to retain concepts taught then other skills such as application will be impossible to be acquired.

Application on the other hand involves problem- solving, usage of information in a new way. Questions that encourage this skill often begin with apply, calculate, solve, modify and complete. Retention of concepts by students is regarded as the most important factor in that it is through retention of concepts which facilitates the application of knowledge across the subjects (Gaines, 2001). This implies that for a student to transfer or apply concepts he/she should first retain the concepts taught.

According to Parker (2009), retention refers to the ability of the learner to recall the basic ideas in a subject content whereas application being the ability of the learner to transfer learned ideas to a familiar or unfamiliar context. According to Ginzburg and Dar-El (2000), retention is a factor of time in that it measures the level of knowledge retained over a period of time. The current study took into consideration that retention rate decreases with time and for a learner to retain concepts for longer, means that the learner was motivated and fully engaged in the learning process (Andrews & Fitzgerald, 2010). That is, the longer the period of time a concept is retained by a learner, the more effective the method used to deliver the concept to the learner was. This explained why the posttest in this study took a period of four weeks to be done by the learners. This period was viewed to be suitable in determining the effect of the treatment since retention decreases with time.

A teacher should therefore engage and motivate learners he/she through learner-centered approach such as experimental approach to teaching and learning. The same study by Andrews and Fitzgerald further revealed that Computer-Based instructions can be used to develop accelerated learning and retention because computer-based instructions attracts learners' attention and hence learners become motivated to learn.

Therefore, learner-centered methods enhance learners' retention and application of science concepts. This implies that teacher's pedagogy influences retention and application of concepts by learners (Blume, Ford, Baldwin & Huang, 2010). Concept retention and application in learners is said to rely on effective instruction used by the teacher (Heck, 2007). This effective instruction can be viewed as the teacher's effort to select an appropriate teaching strategy that utilize students' background knowledge and correct some of the learners' misconceptions. It is therefore, imperative to investigate teaching approaches that enhance better retention and application of concepts among the learners. According to Modebelu and Kalu-Uche (2013), teaching is said to be effective when students demonstrate deep understanding evidenced by concepts application to familiar and unfamiliar situations. The findings of the current study established that experimental approach to teaching was more effective than lecture method of teaching.

Low retention of scientific knowledge has been linked to how a subject is taught (DiCarlo, 2009). According to Al-Huneidi and Schreurs (2011), learners should be given the opportunity to interact with the learning materials so that they can create their own understanding through trial and error. Therefore, the manner in which the teacher imparts knowledge to the student affects student's acquisition and extrapolation of scientific concepts. The findings of the current study showed better retention and application of concepts in posttest in learners instructed through hands-on experiments than those instructed through lecture approach. The implies that the teacher's selection of a teaching method matters a lot in fostering student's retention and application of scientific knowledge.

It is reported that students view certain topics or concepts as difficult as a result of misconceptions brought into the classroom and the teacher's approach failing to address these misconceptions (Behar & Polat, 2007).

It is argued that if students' misconceptions are not fully addressed, it will affect scientific knowledge being taught (Chiappetta & Koballa Jr, 2006). For these misconceptions to be overcome, science teachers should adopt evidenced based learning for learners to experience concrete experience for them to change their misconceptions. It was therefore the reason why experimental approach was employed in this study to change learners' misconceptions about moment concepts that they are difficult to be understood.

According to Wooldridge (2009), students apply the acquired knowledge when the teacher make the students be aware that something they have learned is useful in real life situation by explicitly teaching the students when they can use the information, when he /she help the learners to retrieve the information that could be useful by using evidence-based learning strategies such as experimentation and also by helping the students to apply/use the information correctly in the new situation by putting students in groups to solve the problem of how to apply the information. Therefore, evidence-based learning approach enhanced students' retrieval of scientific concepts taught. It was also noted by Omirin and Oladosu (2010) that teacher's attitude and his/her teaching method can influence students' attitude which is the key to success. It was further echoed by Chiesi and Primi (2010), that the manner in which the teacher presents the concepts to the learners, affects the learning outcome. This means that the manner in which the teacher presents the concepts to the learners determine learners' understanding.

It is clear from this review that the major factor among other factors that influence student's retention and application of scientific knowledge is the teacher's pedagogy. Therefore, teaching approaches should be greatly blamed for poor retention and application of science knowledge and skills. This has been supported by the findings of Acharya (2017), that the teacher has a fundamental place in facilitating learners' interest which is termed as the most important factor in learning by creating affecting a suitable environment for learning. This suitable environment involves how the teacher approaches the subject matter and how he/she motivates the learners. However, Acharya's study was addressing ways in which challenges hindering learning of mathematic concepts could be overcome. It was argued that low retention of knowledge in learners could be linked to how a subject is taught (DiCarlo, 2009).

A study by Muhoro (2009) highlighted students' negative attitude towards physics subject which has contributed to low enrolment in the subject. He pointed out that negative attitude could be linked to poor pedagogical practices. These poor pedagogical practices could be linked to science teachers being trained mainly in theoretical content aspects (Masingila & Gathumbi, 2012). This is likely to be an indication that little or no practical lessons are performed and the consequences of insufficient practical lessons being students viewing Physics topics such as topic on moments as difficult (Menjo, 2013). When physics content is presented through inquiry-based learning (IBL) in which students are allowed to explore and make their own explanation based on their observations, desired results is obtained (Mendez & Slisko, 2013). The desired results in this case means students achieving quality grades in Physics.

A study comparing learner-centered approaches and teacher-centered approaches on students' performance on rotational motion indicated that guided discovery was more effective method where lecture method was found to be the least effective approach (Getinet, 2012). Therefore, guided discovery which is a student-centered approach enable learners to construct their own knowledge, hence, enhancing deep understanding of concepts.

2.3 Experimental method of teaching on Retention and Application of Scientific Concepts

Experimental method of teaching is an approach in which the teacher engages learners through hands-on activities where learners manipulate real or improvised objects as the teacher facilitates learning activities (SCORE, 2008). The purpose of using this approach is to change learners' misconceptions brought into the classroom. According to Agostini and Delizoicov (2009), experimental approach is regarded as the most fundamental approach for quality science teaching. This implies that the declining performance in sciences especially Physics is due to limited or no experiments at all. According to Soares, de Campos Thomaz, da Cruz Pereira and Roehrs (2016) science experiments arouses the learners interest to learn, enables the learners to acquire scientific knowledge as well as fostering application of the acquired knowledge on their daily activities. Based on these importance of science experiments, limited or absence of experiments jeopardizes learners' interest to learn, which in turn affect their retention and application of scientific knowledge in their daily life.

Hands-on activities in learning science are said to encourages logical thinking, draws students' attention to the lesson as well as breaking monotony in the learning room (Oliveira, Birth &Bianconi, 2005). It has been pointed out that practical classes simplify complex scientific concepts to the level of students hence enhancing deep understanding (Santana, 2011). This observation agrees with the results of the present study in that students who were taught through experimental approach demonstrated good mastery of moment concepts in both retention and application tests in posttest. The explanation to these results was given by Millar (2004) that practical work despite engaging the learners in making their observations as they manipulate real or improvised materials, it builds learners' experiences and skills in the subject as well as convincing them to change their misconceptions about scientific world.

When students are subjected to hands-on activities, they acquire science process skills which are importance for future survival (Zdenek & Hana, 2008). Experiments are also said to challenge old theories to more modern theories and in the process learner's knowledge about the universe is enhanced (Chris & Vollmer,2006). Physics experiments enable the teacher to persuade learners to explore their observations and come up with concrete scientific findings that will enrich their understanding concerning existing scientific laws and principles (Chiu & Lin,2002). According to Michael and Mollmann (2012), physics concepts are only acquired through experimentation, thus learning physics without experiments is nearly to impossible. The importance of experiments in learning science justify the results obtained in the present study.

Laboratory experiments are also said to support conceptual learning if they are well planned and coordinated by the teacher (Bell, 2005). For this reason, dismal performance in science subject could be linked to ineffective use of this approach by physics teachers. The current study explored this approach in presenting moment concepts to Form Two students and measured students' mastery of moment concepts through retention and application. The results showed that experimental approach was very effective in enhancing better retention and application of moment concepts.

Laboratory experiences are believed to promote students' mastery of scientific concepts and application of scientific skills as well as inculcating the students with scientific virtues such as patience, interest and motivation to carry out inquiry (Hofstein & Mamlok-Naaman, 2007). The above virtues were also observed in students who were learning through experimental approach. Therefore, experimental method is effective in learning science. However, studies by Menjo (2013) and Kiptum (2015) have shown that students view some physics topics as difficult such as topic on moments which implies that physics teachers perhaps do not use this method to teach moment concepts. This is because experimental approach is believed to motivate students and enhanced better learning (Hofstein & Lunetta, 2004). Other researchers have supported laboratory experiments by arguing that they develop students' acquisition of scientific process skills which are vital to become future scientists (Hofstein & Mamlok-Naaman, 2007).

If indeed experiments can instill all these qualities in learners, then the question is: Why then do students perceive moment concepts as difficult? This study therefore intended to answer this question by using experimental approach to teach moment concepts. The findings indicated that experimental approach was effective in enhancing retention and application of moment concepts. It was therefore established that despite the method being effective physics teachers were not employing the method due to various challenges such as heavy work load, overcrowded classes and inadequate teaching resources. Physics experiments are therefore seen as a starting point for student's motivation and construction of his/her own knowledge. It is suggested that teachers should plan and organize inductive-like experiments to enhance critical thinking and exploration in learners (Koponen & Mantyla, 2006). Practical work also is said to be useful in motivating students to learn as pointed out by Michael and Mollmann (2012).

It is viewed that practical approach is sufficient to motivate students even if the teacher fails to offer proper guide to students (Agrawal & Menon, 2010). It is reported that teacher's demonstrations without students being involved in doing experiments do not enhance learners' comprehension of physics concepts as compared to students themselves performing the experiments as the teacher playing the role of a facilitator (Svedruzic,2008). Therefore, physics teachers should give students the opportunity to take the bigger role in carrying out laboratory experiments so that they can construct their own knowledge based on concrete experience. This will make students to develop critical thinking as well as enhancing their application of the acquired knowledge (Zdenek & Hana, 2008). A study by Chris and Vollmer (2006) underscored the importance of experiments in allowing students to carrying out scientific investigations systematically.

Experimental approach has been found to change students' negative perception towards magnetic field concepts (Irma & Daniel, 2012). These results were also in agreement with the results of this study in that it was found that experimental approach enhanced better learning of moment concepts. The current study explored the effect of this teaching approach on retention and application of moment concepts and it was found that the method was still effective.

It can be extrapolated that experimentation is an aid that develops the student's understanding of scientific concepts and absence of experiments will result to students being unable to conceptualize scientific facts. When students are subjected to different type of experiments they will be able to differentiate between observational evidence and observational inferences (Etkina, Van Heuvelen, Brookes & Mills, 2002). Experiments are so basic that without them learning will not take place since they act as a source of new knowledge in which old theories are disapproved or redefined to new theories (McDermott, Shaffer & Constantinou, 2000). This implies that students can be motivated to be inventors and discoverers of new knowledge through experimental approach. A study by Nwagbo and Chukelu (2011) showed that students who are engaged and motivated can learn more meaningfully and the desired learning outcome is achieved. Meaningful and effective learning means learners are able to recall and apply the concepts taught (Lunetta, Hofstein &Clough, 2007). Other scholars have asserted that practical activities promote students' motivation to learn (Musasia, Ocholla & Sakwa, 2016). This shows that practical work enable learners to acquire positive attitude in the subject which is a key factor in learning scientific concepts (Acharya, 2017).

A study by Nduru (2014) showed that through practical approach, better results in physics subject is attained and students' attitude towards physics is enhanced. However, Nduru's study was on general performance in Physics unlike the present study which focused on learners' retention and application of moment concepts. Nduru's findings were in agreement with those of Ng'ethe (2016) which highlighted that hands-on experiments enhanced quality grades, learners developed strong liking towards physics as it was evidenced by an increase in the number of students who opted to choose physics and improved students' acquisition of science process skills. It was on this basis that the current study explored this approach in teaching moment concepts and it also observed that students' retention and application of moment concepts improved. It has also been observed that practical approach is the basic method of imparting science and mathematics concepts in that quality performance is attained as learners demonstrate good mastery of content and science process skill (Knott, 2007).

Similar observation was indicated by KNEC (2013) Physics report which reported that there was a positive correlation between student's overall grade in physics and his/her score in KCSE Physics Paper Three. This implies that students who have mastery of practical concepts can apply those concepts in Physics Theory Papers. The observations made in this report was supported by the findings of Uwaifo (2012) which established that there was a positive correlation between theory and practical scores on all science subjects. A similar observation was also made by Wasanga (2009) that better performance in practical paper led to improvement in general performance.

Engaging students in hands-on experiments motivate them to explore, hence enhancing their cognitive abilities (Lunetta, Hofstein & Clough, 2007). This implies that students' experiments enable students to understand concepts easily without cramming. A study by Martins- Omole, Yusuf, and, Guga (2016) found that the use of experiments enhanced better retention of biological concepts in learners than use of concept mapping and lecture method. The current study focused on experimental approach to teach moment concepts unlike the previous study which was using experimental approach to teach Biological concepts. Though similar results were obtained in that experimental method was found to be effective in enhancing better retention and application of moment concepts than lecture method. A study by Amadalo and Ocholla (2012) also obtained similar results that practical approach improved learners' physics performance. However, conventional learning is commonly used in Kenyan secondary schools as pointed out by Sogoni (2017). A study by Erinosho (2013) on identification of the difficult areas in Physics in Nigeria found that students perceived moment concepts as difficult citing little practical work organized by Physics teachers. This implies that teachers rarely use experiments to teach Physics concepts despite being identified to be the suitable method as indicated by many studies. It is reported that learners' performance is independent of the school category but dependent on teacher's teaching approach (Nemec, 2009). Similar observations were also made in this study that learners' retention and application of moment concepts were independent of the school type.

Similar findings were also obtained in study on diversity of didactic approaches in Geography where it was found that school type does not affects student learning of geographical concepts while the current study was on effect of experimental approach on retention and application of moment concepts. These findings reveal that teacher's pedagogy in the teaching and learning process is paramount as evidenced by better results. The current study used experimental learning in which the learners experience the phenomenon as they learn the concepts of moment unlike the former study which focused on learning geographical concepts, therefore, this study comes in handy to close this gap.

It has been found that there is a direct link between learners' performance and the nature of the teaching method used to deliver the concepts to them (Veselinovska, Gudeva & Djokic, 2011). These findings also underscored that when learners are taught through student-centered approaches such as student experiment and demonstration perform better than the learners taught through teacher-centered approaches such as lecture method. Their results show that retention of biological concepts by learners was higher when experimental approach was used. These findings also approve experimental method as relevant method which can enhance retention and application of scientific concepts. However, the current study was comparing experimental method and lecture method on learners' retention and application of moment concepts in physics unlike the former study which was comparing three methods of teaching namely experimentation, slide demonstrations and lecture method on students' achievement in Biology. An explanation has been made that experiments develop students' knowledge, skills in communicating scientific ideas and fosters the student's ability to construct his/her personal meaning (Millar, 2004).

Experimental approach to teaching and learning should therefore, enhance deep learning of scientific concepts in learners. However, students' poor performance in sciences especially in Physics subject is an indication that this method is not effectively used in schools by Physics teachers. In developed countries such as United Kingdom (UK), student experiments are viewed as vital for effective science teaching in which students' conceptual understanding of scientific concepts are developed. Science is seen as an Evidenced-Based learning in which students acquire hands-on skills necessary for scientific advancement. According to Schoon, Ross and Martin (2007), when students are exposed to many experiments, their confidence in science is build and the result being some opting to be future engineers, mathematicians and technology experts. This supports Tiberghien (2000) argument that practical work help students to connect between what is taught in classroom and what is happening in the physical world. This shows that through experiments students are able to make observations on real objects and generate understanding.

In addition, experimentation is viewed as a basis of formulating new theories or modifying the existing ones (Juan & Ruiz, 2009). Despite experimental approach being the most preferred teaching method for better scientific literacy, a study by Abrahams and Millar (2008 found that science teachers devote very little time to plan for student experiments and support students' development of ideas from the experiments. This shows that teachers are not fully supporting students' deeper understanding through experiments since they devote little time to discuss the results of the experiment with their students in order for students to develop scientific ideas.

The current study explored experimental approach to teaching moment concepts in which the teacher devoted sufficient time to support students' development of ideas and the results showed that students' retention and application of moment concepts were enhanced. The report of Dillon and Manning (2010) in National Endowment for Science, Technology and the Arts (NESTA) survey, showed that UK science teachers believe in experimental learning as an effective method of enhancing students' performance and attainment in science. A study by Dhanapal and Wan zi Shan (2013) also established that hands-on experiments promote students' motivation in learning as it was evidenced by students taught through experiments doing extra study and exploration on their own. These findings are in agreement with other research findings that hands –on experiments enhance effective learning.

Teaching by an experimentation is a powerful ally in the task of forming, educating and transmitting contents and attitudes in the science domains (Olympiou & Zacharia, 2012). However, Jones and Wyse (2004) pointed out that science teachers hardly use student-centered approaches such as hands-on experiments and this could be the reason as to why sciences especially Physics record dismal performance. It is said that student-centered approaches are fundamental to learning science in that students are being motivated and feel ownership of their own learning (Dillon, 2008). This perhaps could be the reason as to why educational reforms are geared towards constructivist perspective where teachers are encouraged to focus more on practical activities during instruction. Constructivism approach has been reported to encourage students to explore during practical activities as much as possible to facilitate construction of their own knowledge (Kapting'ei & Rutto, 2014).

It is evidenced from this literature that experimental approach is the best approach to impart scientific knowledge and skills to learners; however, teachers have been reported not devote sufficient time on students' experiments (Abrahams &Millar,2008).

2.4 Lecture method of teaching on Retention and Application of Scientific Concepts

Lecture method of teaching is an example of a teacher-centered approach in which the role of a learner is reduced to listening and taking notes during the learning process. In this approach the teacher takes the larger part of learning. This method is still relevant up to date in that it is argued that it enables the teacher to cover large amount of the topic content in a single class period in that it does not require learning material and also it enhance students' listening skills as well as communication skills. However, this method has been accused of making students passive as they listen to the teacher and low retention of information by students (Williams & McClure, 2010). This implies that lecture method discourages retention and application of scientific knowledge among the learners. It is important to note that when there is no retention of scientific concepts, application of concepts will not be possible. Lecture method being teacher-centered allows minimal or none student participation and the result being student misunderstanding or loss of information and poor retention. A study by Sakala (2013) established that 68% of high school teachers sampled frequently use lecture method citing overcrowded classes, limited teaching and learning resources, demand for early coverage of syllabus, low caliber of students in terms of subject knowledge and self-expression as the reasons why they prefer lecture method in their daily lessons.

Similar responses were obtained from physics teacher in Marakwet West Sub-County where they cited heavy work load, demand to complete syllabus as early as June every year, students' negative attitude towards experiments and limited teaching and learning resources as the main causes as to why they do not use student-centered approaches such as hands-on experiments. These findings were also similar to what Musasia, Abacha and Biyoyo (2012) observed that conventional learning is commonly used in Kenyan secondary schools. From these findings, lecture method is still in use despite being viewed as traditional method of teaching due to myriad of challenges facing science teachers.

Lecture method of teaching has been viewed by other scholars as dead in every sense of the word citing that the way things were done in past centauries are now irrelevant in 21st century classrooms in the sense that technological integration is viewed as a catalyst of enhancing quality teaching and learning (Bennet & Maton,2010). Bennet and Maton, emphasized computer integration in teaching in order for learning to be more effective. It is reported that lecture method is limited in developing students' scientific skills and also gives limited attention to students' views (Tarekegn ,2009). It was on this basis that the present study explored experimental approach in teaching moment concepts and the results showed that the method was very effective despite over emphasis on integration of Information Technology (ICT) as the only way of enhancing better learning. A surprising observation was also made by Juan and Ruiz (2009) that physics lessons are mostly taught through lecture method in most schools. This implies that lecture method is dominating teaching of physics as evidenced by students' negative perception towards moment concepts and general decline in Physics performance.

A study by Omwirhiren (2015) indicated that students taught through discussion method are able to retained more organic concepts in chemistry than students taught through lecture method. It showed that learners instructed through discussion approach mastered organic chemistry concepts than their counterpart instructed through lecture approach and the reason given was that learners taught through discussion were active and fully engaged. This implies that students' participation in the teaching and learning process as the teacher being facilitator enhance better retention and application of scientific knowledge in learners. These findings were in agreement with those of Getinet (2012) which highlighted that question-answer approach with group discussion yielded better results on students' performance than those taught through lecture method in Mechanics Baseline Test (MBT).

However, contradicting results was shown in a study by Chaudhury (2011) on comparison of the lecture literature method of teaching against student-centered approaches which showed that lecture method was also effective in enhancing students' performance. The results of the current study disagreed with these findings in that the current study showed that lecture method was less effective than experimental method of teaching. The results of the present study have been supported by the findings of Handelsman, Miller and Pfund (2007) in which they highlighted that lecture method inhibit students' inquiry, critical thinking and reasoning. These findings were further supported by Noel, Daniel and Martin (2015) that lecture method was less effective in enhancing higher levels of skills such as application, analysis, synthesis and evaluation in students. They suggested that lecture method be blended with other student-centered approaches such as discussion, problem solving, hands-on experiments just to name a few for students to actively participate in the learning process.

Therefore, replacing lectures with active learning strategies and engaging students in the learning process will improve students' knowledge retention since lecture method inhibits inquiry which in turn affect students' retention and application of scientific knowledge. However, Marmah (2014) reported another contradicting observation that students in institutions of higher learning like lecture method. This observation concurred with that of Qualters (2001) who also observed that students do not like active learning methods.

However, Marmah and Qualters findings differed with the findings of Dhanapal and Wan zi Shan (2013), Olympiou and Zacharia (2012) who established that hands-on experiments impact positively on students learning and retention of scientific knowledge. A study by Amare (2006) glorified lecture method as more superior than power point presentation. The findings of Amare (2006) agreed with those of Bala, Kaur and Kaur (2017) which also highlighted that lecture method was more effective as compared to a smart class method of teaching. Smart class method of teaching involved the teacher using a computer and audio-visual equipment to allow him/her to teach using a wide variety of media. The reasons given as to why students taught through lecture method performing better than those taught through smart class method was that lecture class provided less destructive environment and hence students were more attentive and also lecture method helped them to memorize the topic as notes and other supplementary material were provided to students. It was also noted that lecture method presented more organized content and students were able to clear their doubt in class. The findings of the current study were in total disagreement with these observations.

Another study which supported Bala, et al (2017) findings, was a study by Weltman and Whiteside (2010) which observed that when various statistical concepts were presented to three different groups of students in which different methods were used to instruct each group, it was found that the group which was instructed through lecture method performed better in statistics test than those taught through hybrid method where students were allowed to brainstorm and discuss concepts and those who were instructed through active learning approaches such as small group discussions. The results of this study disagreed with the results of the present study in that the former was focusing on statistical concepts while the current was focusing on moment concepts. The difference in findings could be that statistics are well understood by students when presented through lecture method unlike moment concepts which are well understood by students when presented through experimental approach also concepts of statistics are more theoretical unlike moment concepts which are practical in nature.

Similar results were obtained by Loveland (2014) when she carried out an investigation to establish effectiveness of teacher-centered method and learner-centered method on students' performance in statistics. The findings showed that traditional lecture was more effective than activity-based learning in enhancing students' mastery of statistical concepts. Other studies have disagreed with these findings, for instance, a study by Noel, Daniel and Martin (2015) established that lecture method was not suitable for teaching high order skills such as application, analysis, synthesis and evaluation. These findings were supported by a study by Handelsman, Miller and Fund (2007) that lecture method was ineffective in enhancing students' inquiry and critical thinking which are fundamental attributes for future scientists.

A study comparing traditional lecture versus cooperative learning in teaching a psychology introductory applied statistics course established that cooperative learning was more effective than lecture methods. It was indicated that lecture method do not enhance students' retention of taught concepts while cooperative learning was found to be effective in enhancing retention of learned concept (Moore, 2005). These results concur with the findings of the current study in that experimental approach enhanced learners' cooperation especially during setting of experiments, recording, analysis and interpretation of the results. It was further supported by Aliaga, Cobb, Cuff, Garfield, Gould, Lock and Moore (2010) who argued that lecture method should no longer be used as the sole mode of instruction but rather should be blended with student-centered approaches. It is evidenced from this literature that they are mixed results concerning lecture method. There are those scholars that are against the usage of the method while others find lecture method suitable for teaching and learning. In conclusion, lecture method of teaching should be blended with learner-centered methods.

2.5 Challenges Facing Physics Teachers when using Experimental Method of Teaching.

A challenge may be defined as something difficult which requires great effort and determination in order to be done successfully. In the context of this study, challenges are difficulties hindering Physics teachers from organizing and facilitating students' hands-on activities or experiments to enhance retention and application of Physics concepts.

According to Sakala (2013), teachers prefer teacher-centered approaches in the classroom so that they can rush to cover syllabi on time and have an ample time to revise and prepare for examination or tests; due to poor caliber and background of students; overcrowded classes; inadequate learning resources as well as teachers' fear of being challenged by their students. These findings were the challenges facing teachers in Zambia. The same challenges are also witnessed in Kenya where schools are ranked in terms of performance in KCSE examination. This has resulted to teachers not organizing for student experiments in order for them to cover syllabi on time and have ample time to revise and prepare for national examination. Large class sizes and inadequate learning resources are also common in Kenya.

A study conducted by Kapting'ei and Rutto (2014) highlighted learners' entry behavior, schools lacking laboratories, limited spaces in laboratories in some schools, untrained laboratory assistance, inadequate learning and shortages of teachers as some of the challenges hindering teachers from adopting student-centered approaches such as experimental method. Similar challenges were also indicated by physics teachers in this study when they were asked to indicate challenges hindering them from using experimental method to teach physics concepts in Marakwet West Sub-County. These challenges have indeed affected effective learning of sciences in secondary schools in Kenya which has resulted to poor retention and application of scientific knowledge by learners as evidenced by declining science performance in Kenya National Examination and learners' interest towards science subjects.

Some of these challenges have been observed in other countries, for instance in India where they face challenges such as inadequate laboratories, inadequate equipment to be used while teaching science and shortage of science teachers (Sarangapani, 2014). A study by Makunja (2016) investigating challenges hindering Competence-Based curriculum (CBC) in Tanzania highlighted teachers' lacking knowledge on what CBC entails, inadequate learning resources, overcrowded classes and low students' entry behavior. Some of these challenges such as overcrowded classes, inadequate learning resources and low students' entry behavior were also found in the current study.

However, Makunja's study was on challenges of CBC in Tanzania whereas the present study was on challenges hindering physics teachers from adopting student-centered approaches such as experimental approach in Marakwet West, Kenya. Other challenges which have been found to affect physics performance include inadequate learning resources, students' negative attitude towards physics, poor teaching pedagogy and evaluation mechanism Mekonnen (2014). Similar challenges were also obtained by Okoth (2011) that physics teachers are understaffed, most practical lessons are ignored or not properly organized because of inadequate time available and physics teachers' heavy work load. The study therefore, established that experimental method of teaching despite being recommended as suitable method of learning science is not effectively used due to these myriad of challenges. Consequently, students have viewed physics concepts as difficult to be understood as it was highlighted in the findings of Menjo (2013) that learners perceive moment concepts as difficult citing limited laboratory experiments.

It is reported that teacher's qualification and training are other challenges which have been identified to affect students' performance in science and mathematics (Catherine, 2011). Teacher's qualification and training as factors which influence students' performance were minimized in the current study through induction of physics teachers using the same manual by the researcher. Therefore, it was assumed that these factors did not affect teachers' delivery of moment concepts to students in both experimental and control groups. Another teacher's factor which has been argued to pose a serious challenge to delivery of scientific concepts to students is teacher's experience (Francis, 2007). The issue of experience was also minimized in such a way that it will not affect the results of the study through induction of physics teachers during the early visit of sampled schools.

It was cited by science teachers that active learning which is an umbrella term for learner-centered learning approach requires more time to cover science syllabus than when they use lecture method (Carlson & Winquist, 2011). Therefore, time factor is a big challenge to teachers to employ active learning methods such as experimental approach. The results of the third objective of this study also highlighted teachers' responses that they are rushing to complete syllabus early due to pressure mounted on them by their principals. Physics teachers have therefore opted for lecture method in order to meet this demand. Similar observations were made by Sakala (2013) that teachers prefer lecture method in order to rush to complete syllabi on time so that they can have ample time to revise and prepare for examinations. Loveland (2014) argued that students disliked activity based learning and prefer mostly the lecture method, similar observation was made in a study by Marmah (2014) that students prefer lecture method than student-centered methods such as hands-on experiments.

This observation was also supported by Qualters (2001) who noted that students do not like activity-based learning. These literatures have highlighted various challenges facing implementation of active learning such experimental approach and they are ranging from learning resources, time constraints and learners' factors and teachers' factors. These challenges are indications that science teachers are not using student-centered approaches.

2.6 Chapter Summary

The section has discussed major factors influencing students' retention and application of scientific concepts. These include teacher's style of teaching and learners' motivation. It also revealed that application of scientific knowledge by learners' dependent on background retention of knowledge (Gaines,2001). This implies that without retention of scientific concepts, application of the said concepts will not be possible. Poor retention and application of science concepts by students have been attributed to poor pedagogical practice (Darling-Hammond,2006).

It was supported in a study by Andrews and Fitzgerald (2010) who asserted that learners who are instructed through hands-on experiments and are willing to learn, gain more scientific knowledge and are able to remember concepts for longer period of time. Concepts retention and application by learners largely depends on teacher's instruction (Heck,2007). This shows that teachers' selections of effective teaching methods are vital. Experimental method of teaching falls under the umbrella of active learning methods in which learners are involved in the learning process. Various studies have revealed that experimental method of teaching is more effective in learning of scientific concepts.

A study by Martins-Omole, Yusuf and Guga (2016) on effects of concept mapping and experimental techniques in teaching biology in secondary schools in Federal Capital Territory Abuja, Nigeria established that the use of experiments makes better retention levels in Biological concepts than use of concept mapping and lecture method. This gap was filled by examining the effect of experiments on retention and application of moment concepts in physics.

It was also established that experimental approach enhances retention and application of moment concepts among students. The findings of Amadalo and Ocholla (2012) that intensive practical activities have a positive influence on students' achievement in Physics concur with the findings of the current study. However, the first study was not specific on the content area in physics unlike in the present study which was on moment concepts. Despite experimental approach being seen as the most effective method of teaching and learning science, other studies have shown that science teachers frequently use lecture method. For instance, studies by Sakala (2013); Musasia, Abacha and Biyoyo (2012) and Marmah (2014). Studies by Bala, Kaur and Kaur (2017); Weltman and Whiteside (2010) and Loveland (2014) have showed contradictory results that lecture method is more effective than active learning methods in teaching statistics. It is evidenced from the summary that little or no study has been done on experimental method on retention and application of moment concepts.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This section discusses how the research was carried out to obtain information necessary to attain the goals of the study. The section was organized into the research method used, the designed used, the area where the study was conducted, the respondents of interest to the study and how they were selected. It also presents the tools that were developed to gather for the relevant data addressing the research objectives, and gives an account of the anticipated data analysis schemes. The chapter also explained how the instruments were validated and how they were ensured that they were reliable and lastly, chapter summary is provided.

3.2 Research Methodology

It is a guideline which guides the research on how to organize and analyze data so that the interpretation of the data is clearly understood. It provides the conventions for organizing, planning, designing and carrying out a good research (Legesse, 2014) This study employed quantitative research methods. According to Babbie (2013), the purpose of conducting quantitative research is to measure the influence of independent variables on dependent variables within a population. Since the current study endeavored to establish the relationship between the effect of experimental method of teaching as independent variable to retention and application of moment concepts as dependent variables among Form Two students, hence quantitative research method was suitable for this study.

3.3 Research Design

This is the plan, structure and strategy of investigation of the conceived problem in order to obtain possible solutions to research questions. The study adopted a quasi-experimental pre-test, post-test non- equivalent group design. This design was used because secondary school classes exist as intact groups (Amina,2005). It was convenient to keep these classes intact. This design enables the researcher to see the effects of some type of treatment on a group (Beaumont,2009). According to Cook and Campbell (1979), Adei and Tagoe (2009) quasi-experimental design is one that looks a bit like an experimental design but lacks the key ingredient called random assignment. Aquasi-experimental study is a type of evaluation which aims to determine whether a program or intervention has the intended effect on study participants. This design is used to find out whether the treatment given to the experimental group affects the outcome (Creswell & Creswell ,2017). The treatment is carried out on experimental group only, and after treatment, observation of the dependent variable is made on both the groups to examine the effect of the manipulation of independent variable on dependent variable. The researcher assesses this by providing a specific treatment to one group and withholding it from another and then determining how both groups scored on an outcome. According to Dimitrov and Rumrill Jr (2003), Pretest-posttest designs are widely used in behavioral research, primarily for the purpose of comparing groups or measuring change resulting from experimental treatments. The design is represented in Table 3.1

Table 3. 1: Research design depiction

Group	**Pretest/ Preliminary Observation**	**Treatment**	**Post-test/Final Observation**
Experimental	O_1	X	O_2
Control	O_2	C	O_3

Key:

X - Experimental learning

C -Lecture/ Conventional Learning

O_1 and O_2- Pretest/Preliminary Observation

O_2 and O_3 - Posttest/ Final Observation

The researcher chose this design because it allowed him to compare the final post-test results between the two groups, giving an idea of the overall effect of the treatment. In this study, X was a treatment given to experimental group. Learners in this group actively performed experiments on moments as the teacher facilitates their activities. Experimental method of teaching was therefore manipulated in order to test its effect on the retention and application of Moment concepts in Physics on students instructed through hands-on activities. Another group of learners (control group) was instructed through lecture methods of learning. The results of both groups from the post-test were obtained so that the overall effect can be compared.

3.4 Study Area

The study was carried out in Marakwet West Sub County located in Elgeyo- Marakwet County. It has an area of approximately 804.60km^2 and lies in latitude 1° 0'0''N and longitude 35° 24' 0''E as shown in appendix XVI. It borders the counties of West Pokot to the north, Baringo county to the east, southeast and south, Uasin Gishu county to the southwest and west, and Trans-Nzoia county to the north west. It has a moderate climate which makes the region to be a good agricultural area. The inhabitants of this region are the Marakwet and a few other tribes who have settled for business activities. This area was suitable for the study since it has continued showing low results in Physics subject as evidenced by appendix XIV.

3.5 Target Population

The term population has been defined as a group of individuals with similar characteristics from which the researcher draws the sample (Kombo & Tromp, 2006). The target population is any group of individuals who have one or more characteristics in common that are of interest to the researcher (Best & Bell,2003). The study targeted 1500 Form Two students and 42 Physics teachers in 26 secondary schools of Marakwet West Sub County.

3.6 Sampling Procedures

Stratified, simple random sampling and purposive sampling techniques were used in this study. The researcher used stratified sampling to divide the schools into four strata. The name and the category of each school was written in a small piece of paper, then the paper was folded into smaller size. Schools falling under the same stratum were grouped together.

Simple random sampling was used to select two schools from each stratum, except for a national category. The selected schools from each stratum were mixed up in a small box then simple random sampling was further used to select three schools. The first three schools to be picked from the box were identified and assigned experimental group while the remaining four schools in the box were also identified and assigned control group. The researcher used purposive sampling to select Physics teachers in each school which participated in the study. The total number of Form two students in the 7 schools which participated were 271 while the number of Physics teachers were 20. The control group had 149 students while the experimental group had 122 students making a total of 271 students which was the sample size.

3.7 Sample size

According to Ogula (2005), sampling has been defined a procedure, process or technique of choosing a sub-group from a population to participate. A sample on the other hand has been defined as a subset of the population (Sekaran & Bougie, 2010). According to Webster (1985), a sample is defined as a finite part of a statistical population whose properties are studied to gain information about the whole. A sample in research is of great important in that it saves money and time. The study area had a total of 26 schools. Schools were stratified and simple random sampling was used to select two schools from each stratum except for the national category which had only one school and hence, a total of 7 schools were selected and participated in the study. The total number of students and physics teachers sampled from the 7 schools were 271 and 20 respectively.

Table 3. 2: Sampling frame

Category	**National**	**Extra-county**	**County**	**Sub-county**	**Total**
Number of schools in each category	1	4	5	16	26
Number of schools selected	1	2	2	2	**7**
Physics teachers in each category	4	12	10	15	41
Number of Physics teachers selected	4	8	4	4	**20**
Number of students in each category	219	570	426	285	1500
Number of students participated	31	124	80	36	**271**

3.8 Variables of the Study

A variable can be considered as an operational construct or particular property in which the researcher is interested (Cohen, Manion & Morrison, 2007). The independent variables in this study were experimental method of teaching and challenges facing physics teachers. These were the variables that were manipulated and their outcomes measured on retention and application of moment concepts. There were other factors not being studied but may have affected the outcome of the study (intervening variables) include; students' attitude and students' ability to practice learned moment concepts.

3.9 Treatment Procedure

After allocation of schools into either control or experimental groups, Physics teachers in experimental and control schools were first inducted about the purpose of the study before their participation. During the induction process, Physics teachers were given lesson plans on how to use experimental approach to teach moment concepts for those teachers teaching in experimental schools and lecture method for those who were teaching in control schools before the treatment commenced. The students in both the experimental and control groups were pre-tested using Moment test 1 to find out if there was a significant mean difference between the groups with respect to their performance in Moment concepts in Physics before instructing students in experimental group through hands-on experiments.

After pretest, the control groups were taught through lecture method of teaching where by the students were instructed with traditionally designed Physics lessons in which the teacher majorly used lecture method to teach Moment concepts in Physics while the experimental group on the other hand was instructed through experimental method where the teacher guided the learners as they do experiments involving moments. During the instruction process, moment concepts were covered for one week as per Physics syllabus approved by KICD. The classroom instruction of the groups lasted for 40 minutes for a single lesson and 80 minutes for double lesson.

For teachers teaching the experimental groups, students were allowed to manipulate learning materials to actively explore moment concepts and the teacher discusses the results with the learners at the end of every experiment. The study was done using quasi-experimental pretest, posttest nonequivalent group design.

After the completion of the instruction period of one week, the two groups were given a post test (Moment Test 2) after the period of four weeks to test for the effect of the treatment on the experimental group.

3.10 Data Collecting Instruments

Research instruments are measurement tools designed to obtain data on a topic of interest from research subjects. The following instruments were used for data collection:

3.10.1 Tests

Before the commencement of the main treatment, the subjects in the experimental and control groups were pretested using Moment Test 1 to determine the equivalence of the two groups.

The experimental group was taught through experimental method of teaching while the control group was taught through lecture method of teaching. The researcher was assisted by the teachers of Physics in the selected schools to administer the tests. Moment Test 2 which had two sets of questions that is: retention and application was administered as post-test to both groups after a period of four weeks to assess the effect of the treatment.

3.10.2 Questionnaire

A questionnaire is a tool for data gathering and research that consists of a set of questions in a different form of question type that is used to collect information from the respondents for the purpose of either survey or statistical analysis study (Gillham,2008).

The questionnaire for Physics teachers was administered in the selected schools to obtain information on the teachers' rating on how students perform generally on the topic moment, whether they use experimental method to teach moment concepts on regular basis and challenges they face when using experimental method of teaching.

3.11 Piloting

Piloting is a process of conducting a mini study on a particular group of individuals with the sole purpose of ascertaining whether the research instruments capture what is supposed to be captured during the actual study. Individuals who participate in piloting are normally excluded in the actual study. The pilot study was conducted at St. Paul Kiptoror Secondary school in Trans-Nzoia County. This school was found suitable because it records low achievement in physics. For instance, this pilot school had a mean of 3.45(D) and 3.133(D) in 2016 and 2017 KCSE Physics examination respectively.

The piloting was carried out using form two students because the candidate class was preparing for KCSE 2018 examination and also the topic moment is in Form Two Physics syllabus. This process was necessary to clarify the questions, check on the level of the language used and identify areas of difficulty in interpretation which could affect effective responses. The purpose of piloting is also to reduce study errors.

Test-retest approach was employed in determining how reliable were Moment tests and the questionnaires were. This technique was used to estimate components of measurement error by repeating the measurement process on the same number of students and teachers under similar conditions and comparing the observations.

The researcher visited the pilot school with research authorization letters from NACOSTI, County Commissioner Ministry of Interior and Coordination and County Commissioner Ministry of Education.

During this visit, the purpose of the study was clarified to the research respondents. Moment test 1 and test 2 were administered as one exam. After a period of two weeks from the first test, the same test was administered to the same students and reliability of each test was computed. The researcher rearranged the order of questions in the second test to reduce the effect of the first test since the disadvantage of this method is that it produces great disparity in achievement on the second test due to the first test.

3.12 Validity and Reliability of the Research Instruments

3.12.1 Validity of the Instruments

A research instrument is said to be valid if it gathers quality data and measure what is intended to be measured (Atkinson, Kumar, Cappelleri & Hass, 2005). Validity of a research instrument assesses the extent to which the instrument measures what is designed to measure (Robson,2011). In quantitative research validity is the extent to which any measuring instrument measures what it is intended to measure (Thatcher, 2010). Criterion-referenced tests; Moments Test1 and Moments Test 2 were developed by KCSE Physics Paper One Examiner using Form 2 Physics textbooks approved by KICD and questions from KNEC past papers. The researcher requested the examiner to set the test so that test subjectivity is minimized.

The researcher then presented moment test1 and moment test 2 to two other experienced Physics Paper One examiners to ascertained the content and the face validity of the test. Physics Paper 1 examiners were chosen since the topic moments is tested in Paper 1 in KCSE examination. The construct validity of the tests and the questionnaire were validated by the research supervisors.

3.12.2 Reliability of the Research Instruments

Reliability of an instrument is defined as the extent to which a particular measuring instrument yields consistent results over a number of repeated trials (Orodho,2004). Reliability is used to evaluate the stability of measures administered at different times to same individuals and the equivalence of sets of items from the same test (Kimberlin & Winterstein,2008).

The reliability of the tests, Moment Test1 and Moment Test 2 were pre-tested in the pilot school that was excluded in the actual study. Test- retest technique was used to assess the reliability of the tests. Test-retest reliability indicates score variation that occurs from testing session to testing session as a result of errors of measurements. It is a measure of reliability obtained by managing the same test twice over a period of time ranging from few weeks to months, on a group of individuals. The scores of test1 and test 2 were correlated to evaluate the stability of the test over time. During the retest, the students were given the same tests in different order of questions that were used in the first test. The results were then correlated: Moment Test 1 yielded a reliability of 0.71, Moment Test 2 yielded a reliability of 0.87 while the questionnaire yielded a reliability of 0.83.

According to Madan and Kensinger (2017), a reliability coefficient above 0.7 are considered acceptable. Hence, the tests were acceptable to be administered.

3.13 Administration of Research Instruments

Before piloting the study, a letter showing the approval of the proposal by the department of science education of the University of Eldoret was obtained, then the letter was attached with other documents and permit was applied from National Council for Science, Technology and Innovation (NACOSTI) which is charged with responsibility of issuing the permits for research in Kenya. Upon issuance of the permit by the council, the researcher reported to education offices before conducting data collection. During the first visit of the selected schools the purpose of the research study was explained. The researcher inducted Physics teachers on how to teach the topic moment and administer the tests.

3.14 Data Analysis Techniques

The computation and interpretation was done with the help of statistical package for social sciences (SPSS) version 23 and Microsoft Excel statistical package. The t-independent test was used to test for retention and application of moment concepts in Physics in pre-test and post-test.

3.15 Ethical Considerations of the Study

Ethics is a branch of philosophy that deals with the conduct of people and guides the norms or standards of behavior of people and relationships with each other (Blumberg, Cooper & Schindler, 2005).

It also refers to ethos or way of life, social norms for conduct that distinguishes between acceptable and unacceptable behavior (Akaranga & Ongong'a,2013).

The purpose of observing ethical issues in research is to enable the researcher conceal the identities of the respondents hence protecting their dignity (Fouka & Mantzorou, 2011). The researcher adhered to the following ethical issues: Firstly, Informed consent. The respondents were fully informed about the purpose of the study hence they participated with informed consent. Secondly, the researcher ensured that there was voluntary participation of the respondents. The researcher did self-introduction to the respondents and produced authorization letters to them. Then the purpose of the study was discussed. Hence, those who participated were free from coercion.

Thirdly, confidentiality was adhered to. The respondents were informed their responses or results of the tests for the case of the students were going to be treated with confidentiality and one will be allowed to access except the researcher only. Lastly, the researcher observed anonymity. The respondents' identity was concealed. This was achieved by omitting names of both the teachers and students. They were also assured that during the reporting of the research findings, the names of their schools will not be disclosed.

3.16 Summary

The chapter discussed research methodology employed as mixed method since it involved qualitative and quantitative approaches. The study area was Marakwet West sub-county within Elgeyo Marakwet county.

The research design used was quasi-experimental, pretest, posttest nonequivalent group design, this design was suitable to this study since schools were having unequal number of students. The sample size comprised of 271 Form Two students and 20 Physics teachers.

Stratified, Simple Random sampling and Purposive sampling techniques were used to select the study sample. Reliability and validity determination was also highlighted in this chapter. Lastly, ethical issues that were adhered to during the course of the study are discussed.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION OF RESULTS

4.1 Introduction

The section discussed data collected based on the objectives, analysis, interpretation and discussion of the results based on the stated research objectives. Data collected was analyzed using inferential statistics. Part of the data was outline in the form of bar graphs, pie charts and tables whereas inferential statistics independent t-Test samples were used to test hypotheses at $\alpha=0.05$ significance level.

The analysis endeavors to answer the following questions:

1. Is there significant mean difference in retention of moment concepts between learners taught using experimental and those taught using lecture methods of teaching?
2. Is there significant mean difference in application of moment concepts between learners taught using experimental and those taught using lecture methods?
3. What are the challenges facing physics teachers when using experimental method to teach moment concepts?

In order to effectively deal with each research question, the analysis of the data findings is presented under different headings according to research objectives and related research questions.

4.2 Research respondents

4.3 Pre-test Scores

4.4 Experimental method of teaching on application of moment concepts in Physics

4.5 Challenges facing physics teachers when using experimental method of teaching to teach moment concepts.

4.2 Research respondents

The study sample comprised of 291 respondents. Out of this, 271 of the sample were Form Two students and 20 were Physics teachers. The number of students in experimental group were 122 while in control group were 149. Experimental and control groups were not equal in size because the schools were taken as intact groups which had different number of students. The information regarding research respondents was represented in a pie chart as shown in Figure 4.1:

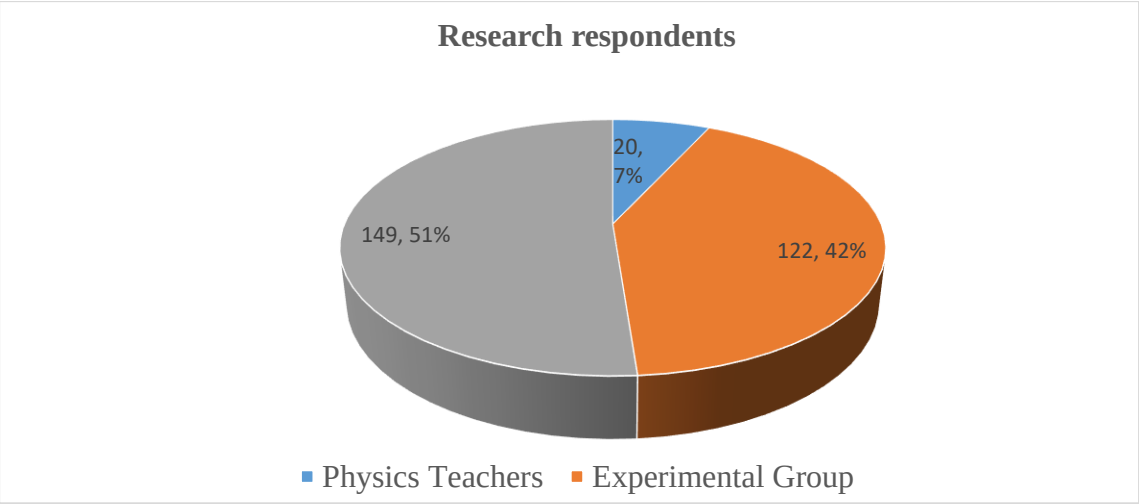


Figure 4. 1: Research respondents

The Figure 4.1 shows the percentage of Physics teachers who participated in the study as (7%) while students in experimental and control groups were (42%) and (51%) respectively. From the Figure 4.1, there were more students in the control group than in the experimental group since the schools were taken as intact groups. It was also noted that more boys choose physics than girls in that the number of boys was 166 while that of girls was 105. The questionnaires given were satisfactorily fill and returned.

4.3 Pre-test Scores

The researcher being assisted by research assistants administered a pre-test to both experimental and control groups at the beginning of the research period. The results obtained were as follows:

Table 4. 1: Students' Mean and Standard Deviation in Pre-test

	Type of Group	N	Mean	SD
Pre-test Score	Control Group	149	36.95	13.095
	Experimental Group	122	36.16	13.201

Table 4.1 shows the means and standard deviations of the control and experimental group during the pre-test. The mean recorded by students instructed through lecture method during the pre-test was 36.95% while that of the students instructed through experimental approach was 36.16%. The mean difference between the two groups was 0.79%. The researcher subjected the pre-test scores of both the experimental and control groups to a t-test to determine the equality of their means. The results were as presented in table 4.2 as follows:

Table 4. 2: T-test for Equality of Means in Pre-test

	t-test for Equality of Means						
	T	Df	Sig.(2-tailed)	Mean Difference	Std.Error Difference	95%Confidence Interval of the Difference	
						Lower	Upper
Pre-test Scores	-0.496	269	.620	-0.7973	1.6060	-3.9593	2.3647

Table 4.2 contains the results of a t-test that was comparing the mean scores of the pre-test between the control and experimental groups. The p-value obtained from Table 4.2 was p-greater than alpha value, it was inferred to means that the students in both control and experimental groups had similar ability. It was therefore concluded that students were of equal ability which was a necessary condition for the research to have proceeded.

4.3.1 Treatment

After the pretest (Moment Test 1), the control groups were taught through lecture method of teaching where by the students were instructed with traditionally designed Physics lessons in which the teacher majorly used lecture method to teach Moment concepts in Physics while the experimental group on the other hand was instructed through experimental method where the teacher guided the learners as they do experiments involving moments. During the instruction process, moment concepts were covered for one week as per Physics syllabus approved by KICD. The classroom instruction of the groups lasted for 40 minutes for a single lesson and 80 minutes for double lesson.

For teachers teaching the experimental groups, students were allowed to manipulate learning materials to actively explore moment concepts and the teacher discusses the results with the learners after every experiment. At the end of the instruction period of one week, the two groups were subjected to posttest (Moment Test 2) after a period of four weeks.

4.3.2 Post-test Scores

At the end of the treatment period a post-test was conducted to the same respondents after four weeks to test for the retention and application of Moment concepts. The results are illustrated in Table 4.3.

Table 4. 3: Students' Means and Standard Deviations in Post-test Retention tests

Type of Group	N	Mean	SD
Control group	149	43.32	12.999
Experimental Group	122	54.93	10.745

Table 4.3 contains the means and standard deviations of the Retention scores during the post-test for both the experimental and control groups. The percentage mean of the Retention test for control group was 43.32% while that of the experimental group was 54.93%. It was observed that experimental group retention score was higher than that of the control group. Since the first objective was to investigate the effect of experimental method of teaching on students' retention of Moment concepts in Physics.

This objective was guided by the research question: Is there any significant mean disparity in retention of moment concepts between learners instructed through experimental approach to teaching and those instructed through lecture method of teaching? and the hypothesis: no significant mean difference in the retention of moment concepts in physics between learners taught through experimental method and those taught using lecture method of teaching.

4.3.2 Hypothesis Testing

Hypothesis (H_{01}) stated no significant mean disparity in retention of moment concepts in physics between learners instructed through experimental method and those instructed using lecture method of teaching. This hypothesis was tested by conducting a t-test on the post-test retention scores. The results are shown in Table 4.4

Table 4. 4: T-test for equality of Means in Post-test Retention-test

	t-test for Equality of Means						
	T	Df	Sig. (2-tailed)	Mean Difference	Std.Error Difference	95%Confidence Interval of the Difference	
						Lower	Upper
Post-test Retention Scores	7.900	269	.000	11.611	1.470	8.717	14.505

Table 4.4 contains results of a t-test that was carried out on retention of moment concepts after a post-test had been administered to the respondents. The p-value that was obtained was 0.000. Since, the p-value was less than alpha at 0.05, the null hypothesis was rejected. Hence, it was concluded that there was sufficient evidence to reject the null hypothesis since there was a significant mean difference in moment concepts retention between the two groups.

4.3.3 Discussion

The analysis of pretest scores revealed that learners in both experimental and control groups had equal ability since the p-value was greater than 0.05. Hence, there was no significant difference in the means of control and experimental groups. The post-test Retention Test mean showed that students instructed through hands-on experiments perform better than those instructed through lecture approach. The results further showed that there was a significant mean difference in the retention of moment concepts between learners taught through experimental method of teaching and those through lecture method of teaching. The researcher attributed the difference in performance to the treatment. This is because the experimental group performed moment experiments throughout the teaching period. The students were able to explore moment concepts which let to deeper understanding of the concepts of moments. The students in the control group performed lower than their counterpart despite having similar cognitive abilities because they were taught through lecture method which hindered students' discovery and conceptualization of moment concepts, hence affecting their retention.

Experimental method was more effective than lecture method since learning science through hands-on experiments encourage students to experience and discover from their observations or feelings, in addition to accompanied teacher's explanation (Worth,2010). The results of this study concurred with the findings of Nduru (2014) hands-on experiments enhanced better performance of physics at KCSE. However, Nduru (2014) study was on general performance of students in physics unlike this study which is specifically on Moment concepts.

The results of the current study were also consistent with the findings of a study by Martins-Omole, Yusuf and Guga (2016) on effects of Concept Mapping and Experimental Techniques in teaching Biology which found out that the use of experiments makes better retention levels than use of concept mapping and Lecture method. However, the current study was focusing on experimental method of teaching versus lecture method on moment concepts unlike the latter study which was focusing on experimental techniques verses concept mapping and lecture method in teaching biological concepts. A study by Amandalo and Ocholla (2012) on Intensive Practical Activities on students' academic achievement in Physics found out that practical activities have a positive influence on student's achievements in physics and it improves physics academic performance of the learner also concurs with the findings of this study. The results of this study further agreed with those of Worth (2010) that learning science through hands-on experiments are better in encouraging and motivating students to explore from their observations or feelings. Experimental method of teaching has been found to enhanced retention and application of science and mathematics skills.

A study by Duru (2010) on the effect of experimental teaching in some topics geometry found out that learners who were instructed through experimental approach performed better than those who were instructed through lecture method in knowledge and comprehension level of geometrical concepts. These observations were similar with the observations made in the present study. Norman (2005) pointed out that hands-on experiments encourage students' interest in science and other subjects. Evidenced from the findings of this study that students who were instructed through experimental method developed positive interest in the topic moments as indicated by their better performance in both retention and application tests compared with those instructed with traditional lecture method. However, results of the current study were inconsistent to those of Chaudhury (2011) on analysis of the lecture method which revealed that lecture method was effective as any other method of teaching. This implied that lecture method yielded similar results as those of experimental method which was not the case in this study. Another study which disagreed with this study is a study by Loveland (2014) who found out that students disliked activity based learning.

4.4 Experimental method of teaching on application of moment concepts

The second objective of the study was to examine the effect of experimental method of teaching on application of moment concepts in physics between learners instructed using experimental method and those instructed through lecture method.

The question to be answered was whether there was any mean difference in application of moment concepts between learners taught using experimental and those taught using lecture methods at the end of the treatment period. Students in both groups were post-tested using (Moment Test 2) after a period of four weeks. The observations were as shown in Table 4.5

Table 4. 5: Students' Means and Standard Deviations in Post-test Application Tests

Type of Group	N	Mean	SD
Control group	149	40.68	11.265
Experimental Group	122	55.02	10.082

Table 4.5 shows the means and standard deviations of the Application Test scores of the post-test for both the experimental and control groups. The mean score of application test for control group was 40.68% while that of the experimental group was 55.02%. It was observed that experimental group performed better than the control group in application test since the mean difference was 14.34%.

4.4.1 Hypothesis Testing

The second hypothesis (H_{02}) stated that mean difference in the application of moment concepts in physics between learners instructed through experimental method and those instructed through lecture method of teaching was insignificant. This was determined by conducting a t-test on the post-test application scores and the results were as shown in Table 4.6

Table 4. 6: T-test for equality of Means in Post-test Application Test

	t-test for Equality of Means						
	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Post-test Application Scores	10.926	269	.000	14.340	1.313	11.756	16.924

Table 4.6 shows the results of a t-test that was carried out on moment application test scores administered to the students. The p-value that was obtained was 0.000. Since, the p-value was less than alpha at 0.05, the null hypothesis was rejected. Hence, it was concluded that there was a significant mean difference in the application of moment concepts between learners taught through experimental method and those taught through lecture method. This implies that experimental method enhanced application of moment concepts better than the lecture method of teaching.

4.4.2 Discussion

The findings show that learners instructed through experimental method of teaching were able to apply moment concepts taught than those learners instructed through lecture method. The researcher attributed variation in the means to treatment.

Hands-on experiments to teaching enhanced better application of moment concepts among the learners than the lecture method because it enabled students to experience the phenomenon being discussed in the classroom. This could be explained by Experiential Learning Theory by Kolb (2014) that learning through reflection on doing enable individuals to make discoveries and experiments with first-hand knowledge, instead of hearing or reading about other's experiences.

This method is more efficient than lecture method of teaching in that it incorporates 5Es instructional model in the teaching process. That is, learners are engaged (E), they explore (E), explain concepts using their own language (E), elaborate the concepts by giving related examples (E) and evaluate their understanding (E). This enhances deep learning as evidenced by the post-test scores of the experimental group. The researcher viewed experimental approach as the best method to conceptualize moment concepts. Experimental method of teaching enables students to retain and apply scientific concepts as pointed out by Norman (2005) that hands-on experiments encourage students' interest in science and other subjects. However, the findings of this study disagreed with the findings by Bala, Kaur and Kaur (2017) which established that lecture approach was more suitable than ICT integrated teaching. Other studies which have disagreed with the findings of this study include the study by Marmah (2014) which found that students like lecture method of teaching, a study by Amare (2006) which found out that lecture approach is the most effective approach when compared with other approaches of teaching and a study by Qualters (2001) which found out that students disliked active learning methods.

4.5 Challenges facing Physics teachers when using experimental method of teaching to teach moment concepts.

Under this subheading, the objective was to find out factors which hinder physics teachers from using experimental method to teach moment concepts. This objective was intended to answer research question; what are the challenges faced by physics teachers when using experimental method to teach moment concepts? A questionnaire was designed to collect data for purposes of answering this question. The questionnaire was in the form of structured and open ended questions to be responded to by physics teachers. They were asked to answer the following questions:

a) How students perform in questions from the topic moments
b) Whether they use experimental approach to teach moment concepts on regular basis
c) Challenges they faced when using experimental method to teach moments
d) Other challenges they faced apart from the one which were on the questionnaire

4.5.1 Physics Teachers' Responses on students' performance in Moments

When physics instructors were asked to indicate how students perform in the topic moments given the three rating; Excellently, Fairly and Poorly. The results were as presented in Table 4.7

Table 4. 7: Students' Performance on Moments

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fairly	14	70.0	70.0	70.0
	Poorly	6	30.0	30.0	100.0
	Total	20	100.0	100.0	

Table 4.7 shows that 70% of the physics teachers showed that learners perform fairly, 30% indicated that students perform poorly and 0% of the teachers indicated that students perform excellently in moments. This results show that students don't score full marks in questions on moments.

4.5.2 How frequent do Physics Teachers use experimental method to teach moments

When physics instructors were asked to indicate whether they have ever used experimental method to teach moments, their responses were as shown by Table 4.8

Table 4. 8: How frequent do Physics teachers use experimental method to teach moments

When Physics instructors were asked to indicate whether they use experimental method to teach moment concepts, their responses were as presented in the Table 4.8 below.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	19	95.0	95.0	95.0
	Yes	1	5.0	5.0	5.0
	Total	20	100.0	100.0	

Examination of Table 4.8 indicates that ninety-five percent of the physics teachers who were sampled in the study don't use experimental method to teach moments while five percent use this method. Teachers who showed that they use experimental approach to teach moments were further asked to state whether students' performance improved and their responses were summarized in Table 4.9

Table 4. 9: Teachers Responses on students' Improvement on Moments when experimental method is used.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	100.0	100.0	100.0
	No	0	0.0	0.0	100.0
	Total	1	100.0	100.0	

Table 4.9 showed that the teacher who had indicated that he/she used experimental method to teach moment concepts has also indicated that students' performance on the topic moments improved.

4.5.3 Challenges facing physics teachers when using Experimental method.

When Physics instructors were asked to show the challenges highlighted in the questionnaire when using experimental method to teach moment concepts, their responses were presented as shown in Figure 4.2

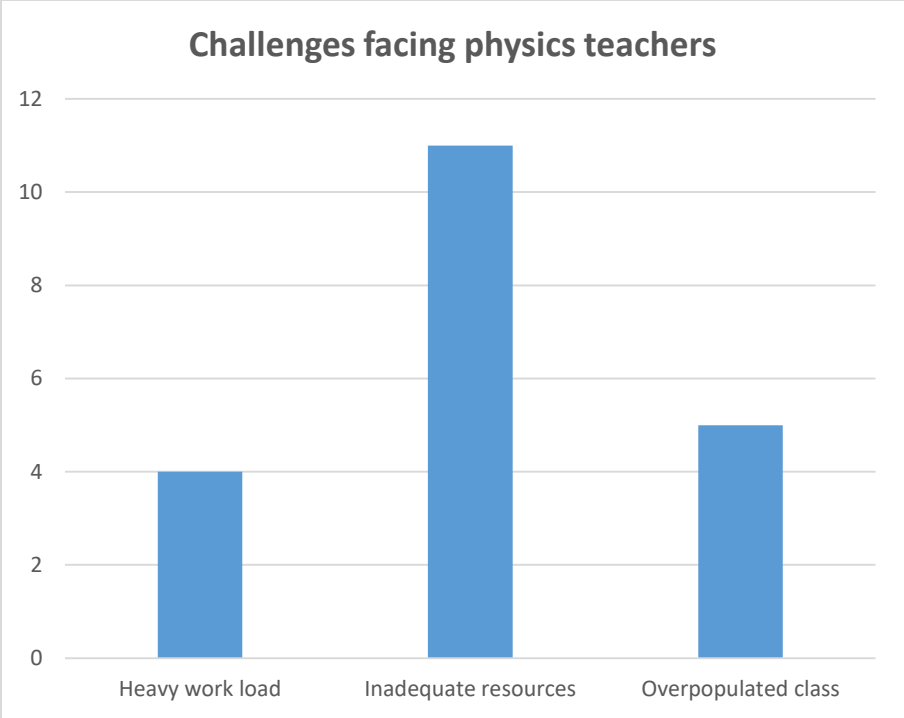


Figure 4. 2: **Challenges facing physics teachers**

From Figure 4.2 it is clearly seen that the major challenge facing physics teachers when using experimental method is inadequate learning resources followed by overpopulated class and lastly heavy work load.

4.5.4 Other challenges facing Physics teachers

When physics teachers were asked to give other challenges they are facing apart from those which were in the Questionnaire, the challenges they gave were summarized in Table 4.10

Table 4. 10: Other challenges facing physics teachers

Challenge	**Number of Teacher indicated**	**Percentage (%)**
Students' negative attitude towards physics	10	50
Students' negative attitude toward experiments	2	10
Rushing to complete syllabus for the sake of exams	5	25
Students cannot relate practical to theory	3	15

Table 4.10 shows the responses given by Physics teachers when they were asked to give other challenges they face apart from those which were given in the questionnaire. Out of 20 physics teachers who participated in the study,10 teachers which was equivalent to 50% indicated that students' negative attitude towards physics subject was a challenge to them. That is, learners are not willing to cooperate and follow instructions given by the teacher.

Negative attitude towards experiments was cited as another challenge facing physics teachers when using experimental method of teaching to teach moment concepts. This challenge was given by two physics teachers which was equivalent to ten percent of the total physics teachers. That is, learners have a phobia towards experiments.

Five teachers which was equivalent to 25% of the total physics teachers indicated that they don't perform experiments on moments due to rush to complete syllabus and three teachers which was equivalent to 15% of the total physics teachers indicated that students don't relate concepts gained from the experiments to theory questions.

4.5.5 Discussion

The analysis of the responses given by physics teachers on the questionnaire gave an indication that learners performance in questions from topic on moments is poor. Teachers admitted that students do not score full marks in questions from the topic moments. The results show that 70% of physics teachers responded that students perform fairly in questions on moments,30% indicated that students perform poorly on moments and 0% indicated that students perform excellently on moments. These findings show that students have a low mastery of moment concepts.

Teachers' responses also show that 95% of the physics teachers do not use experimental method of teaching to teach moment concepts on regular basis due to various challenges such heavy work load, inadequate learning resources and overcrowded classes. The findings further revealed that instructors in well-equipped schools face the are hindered by heavy work load and overcrowded classes while physics teachers teaching in county and sub-county schools face the challenge of inadequate learning resources. The findings of this study also found out that topic on moments was challenging to students as evidenced by teachers' responses that students do not score full marks in questions from the topic moments. These findings were in agreement with what Menjo (2013) and Kiptum (2015) found that moment concepts were difficult to students. The study also revealed that 95% of physics teachers had not used experimental method to teach moments which concurs with the findings of Musasia, Abacha and Biyoyo (2012) findings that lecture method is predominately used by physics teachers.

The findings of this study agreed with those of Mekonnen (2014) on Problems Challenging the Academic Performance of Physics in Higher Governmental Institutions in the Case of Arbaminch, Wolayita Sodo, Hawassa and Dilla Universities which found out that lack of learning resources, lack of interest to physics subject by students and difficulty to understand some concepts in physics by the students were challenges facing academic performance of physics.

The findings of (Okoth ,2011) highlighted factors such as Physics teachers being understaffed, practical lessons being ignored or not properly organized because of inadequate time available and physics teachers' heavy work load as challenges affecting students' achievement in physics. Little or no experiments have let to students failing to relate practical to theory work as pointed by teachers as one of the challenges they face. The study therefore, established that experimental method of teaching despite being recommended as suitable method of learning science is not used effectively as evidenced by the challenges faced by physics teachers.

In both categories of schools little or no experiments are done on moments. The researcher attributed other challenges cited by physics teachers such as students' negative attitude towards physics, negative attitude of students towards experiments and students failing to relate knowledge gained from experiments to theory questions to little or no experiments done on regular basis. That is, physics teachers don't give the learners the opportunity to interact with learning resources due to various challenges they encounter.

4.6 Summary

The chapter began by highlighting the contents of the chapter, the results were presented as per the stated objectives guided by the research questions. Hypotheses tested indicated significance mean difference in both retention and application results between experimental and control groups. Lastly, discussions were made based on the results of the study.

CHAPTER FIVE

SUMMARY OF FINDINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides the summary of the major findings as presented in chapter four. It draws conclusions based on the research findings and gives recommendations. The chapter ended with what other researchers ought to look into in future.

5.2 Summary of the Findings

5.2.1 Experimental method of teaching on Retention of Moment concepts in Physics

The objective to find out the effect of experimental method on students' retention of moment concepts in physics. In response to the question as to whether there was a significant mean difference in retention of moment concepts between learners instructed through experimental approach and those instructed through lecture method, the research findings established that students taught moment concepts through experimental approach performed better than students instructed through lecture method.

5.2.2 Experimental method of teaching on Application of Moment concepts in Physics

The objective to find out the effect of experimental method on students' application of moment concepts in physics.

In response to the question as to whether there was a significant mean difference in application of moment concepts between learners taught through experimental approach and those taught using lecture method, the research findings established that students who were taught moment concepts through experimental method applied moment concepts significantly better than students taught using lecture method. The third objective of the study was to find out challenges faced by physics teachers when using experimental method to teach moment concepts. This objective was guided by the research question; what are the challenges faced by physics teachers when using experimental method to teach moment concepts? A questionnaire was designed to collect data for purposes of answering this question.

The questionnaire was in the form of structured and open ended questions to be responded to by physics teachers. Physics teachers were required to indicate in the questionnaire the challenges they were facing and other challenges they face apart from those which were captured in the questionnaire. The challenges faced by physics teachers were summarized as follows:

- Heavy work load of physics teachers
- Overpopulated classes
- Inadequate learning resources
- Students 'negative attitude towards experiments
- Students' negative attitude towards the subject
- Teachers are rushing to complete syllabus for the sake of exams as pressurized by the school administration

- Students failing to relate concepts gained from practical to theory.

It was also found that teachers teaching in well-equipped schools rarely organize experiments for students due to heavy work load, over populated classes and rush to complete syllabus early despite having enough learning materials while teachers in less equipped schools face the challenge of inadequate teaching and learning resources, students' negative attitude towards physics, negative attitude of students towards experiments and students failing to relate knowledge gained from experiments to theory papers. In both levels of schools little or no practical work is done which has resulted to students developing negative attitude towards the subject and physics experiments. The findings also revealed that 70% of the physics teachers indicated that students perform fairly in moment concepts while 30% indicated that students perform poorly in moment concepts.

5.3 Conclusion

From the results of this study, first, it can be concluded that experimental method was the suitable method in enhancing mastery of Moment concepts in Physics than lecture method of teaching. Experimental method of teaching therefore, has the ability to improve the students' retention of moment concepts in Physics. Secondly the research findings established that experimental method of teaching was more effective in enhancing students' application of moment concepts in Physics as compared to lecture method of teaching. Therefore, experimental method has the ability to enhance students' application of moment concepts in Physics as evidenced in the post-test results.

Lastly the research findings established that experimental method of teaching was not being effectively used by Physics teachers despite the method being cited by many researchers as the most effective in enhancing students' Retention and Application of scientific concepts due to heavy work load, over populated classes and inadequate learning resources. Therefore, due to these challenges Physics teachers have opted for lecture method of teaching. These challenges should be addressed in secondary school education for Kenya to move towards attaining vision 2030 since physics concepts are the corner stone of the vision.

5.4 Recommendations

The findings and conclusions reached in this study warranted the following recommendations:

1) Experimental method should be adopted by all the physics teachers in teaching moment concepts in order to improve students' retention. This was evidenced by students' improvement in retention of moment concepts in posttest when this method of teaching was used.
2) Experimental method should be adopted by all the physics teachers in teaching moment concepts in order to improve students' application of moment concepts. Based on the findings of this study, students taught through experimental method performed better in application tests in posttest hence this method is recommended for teaching and learning of moments.
3) Teachers Service Commission to employ more physics teachers to reduce heavy work load among the physics teachers. Heavy work load has resulted to physics

teachers not having adequate time to plan for practical activities hence students have developed negative attitude towards physics subject and physics experiments.

4) The Ministry of Education should strictly ensure that all schools are covering syllabus up to third term as most schools' administrations put a lot pressure to physics teachers to complete syllabus as early as March. This has resulted to teachers rushing without organizing for students' practical activities.
5) The KICD should increase the number of lessons for covering moment concepts from four lessons to eight lessons so that the concepts of moments can be adequately covered experimentally.
6) The government through the Ministry of Education should increase funds allocation to schools so that schools can equip their laboratories. This will reduce the challenge of inadequate resources.

5.5 Suggestions for Further Research

The following are suggested for future studies:

1) The study to be repeated in other sub-counties to ascertain consistence in the effectiveness of experimental of teaching on retention and application of moment concepts in Physics among secondary school students.
2) Different design to be used topics in handling the same topic.
3) The topic moments be taught through experimental method planned through Lesson Study.
4) Studies involving ICT in teaching moment concepts.

REFERENCES

Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education*, *30*(14), 1945-1969

Acharya, B.R. (2017). Factors affecting difficulties in learning mathematics by mathematics Learners. *International Journal of Elementary Education*. Vol.6, No.2,2017, pp. 8-15.doi: 10.11648/j.ijeedu.20170602.11

Adei, E.& Tagoe, M. (2009). *Research methods in information Studies*. Accra: IAE(UG).

Agommuoh, P. C. (2004). *Effects of videotaped instruction on secondary school students' physics*. An unpublished MED thesis, University of Nigeria, Nsukka.

Agostini, V.W. & Delizoicov, N.C, N.C. (2009). *Trial Teaching in Basic Education: Impasse and Challenges.* National Meeting of Research in Science Education-VII Enpec- Floranopolis.

Agrawal, D.C. & Menon, V.J. (2010). Errors of observations and our understanding of physics. *Latin-American Journal of Physics Education, vol.*4(1): 67-73

Agwagah, U. N. V. (2005*). Teaching mathematics for critical thinking, essential skill for effective living*. *ABACUS*, *30*(1), 38-45

Akaranga, S.I & Ongong'a, J. (2013). Work Ethics for University Lecturers: An Example of Nairobi and Kenyatta *International* Journal of Arts and Commerce,2(8)8-22.

Al-Huneidi, A., &Schreurs, J. (2011). Constructivism based blended learning in higher education. In World Summit on Knowledge Society (pp. 581-591). *Springer,* Berlin, Heidelberg.

Aliaga, M., Cobb, G., Cuff, C., Garfield, J., Gould, R., Lock, R., Moore, T. (2010). *Guidelines for Assessment and Instruction in Statistics Education (GAISE)*. College Report. Alexandria, VA: American Statistical Association.

Amadalo, M.M. & Ocholla A. A. (2012). Effect of Practical Work in Physics on Girls' Performance, Attitude change and Skills acquisition in the form two-form three Secondary Schools' transition in Kenya, *International Journal of Humanities and Social Science,* 2(23), 151-166

Amare, N. (2006). To slide ware or not to slide ware: Students' experience with power point versus lecture method. *Journal of Technical Writing and Communication*. 36(3),297-308.

Amina, M. (2005) *Social Science Research, Conception, Methodology and Analysis*.

Amunga, J.K., Musasia, M.A., & Musera, G. (2011). *Disparities in the physics Achievements and Enrolment in Secondary Schools in Western Province*: Implications for Strategy and Renewal, Problems of Education in the 21st Century,31(31),18-32, ISSN: 1822-7864

Andrews, D., & Fitzgerald, P.C. (2010). Accelerating learning of competence and increasing long-term learning retention. *AIR FORCE RESEARCH LAB MESA AZ WARFIGHTER READINESS RESEARCH DIVISION,2010*

Atkinson, M. J., Kumar, R., Cappelleri, J. C., & Hass, S. L. (2005). *Hierarchical construct validity of the treatment satisfaction questionnaire for medication (TSQM version II) among outpatient pharmacy consumers*. Value in Health, 8(s1).

Babbie, E.R. (2013). *The Basics of Social research*. Cengage Learning.

Bala, P., Kaur, T., & Kaur, M. (2017). Study on effectiveness of lecture and smart class method of teaching on academic achievements among upper primary school students. *International Letters of Social and Humanistic Sciences*,76,25-29.https://doi.org /10.18052 /www.scipress.com /ILSHS.76.25

Baram-Tsabari, A. &, Yarden, A. (2005). Characterizing Children's spontaneous Interest in science and technology. *International Journal of science Education*,27(7),765-80

Beaumont, R. (2009). *Research Methods and Experimental Design*. Retrieved from http://www.robin-beaumont.co.uk/virtualclassroom/contents.html.on12th February 2018.

Behar, M. &, Polat, P. (2007). *The science topics perceived difficult by pupils of primary 6-8 classes. Diagnosing the problems and remedy solution*s. Educational Sciences: Theory and Practice. 7(3).1113-1130.

Bell, P. (2005). *The school science laboratory: Considerations of learning, technology, and scientific practice*. Paper prepared for the national Academies Board on Science Education, High school labs Study Committee.

Bennet, S. & Maton, K. (2010). *Beyond the 'digital natives' debate*: Towards a more nuanced understanding of students' technology experiences. Journal of computer assisted learning. 26.5(2010): 321-331.

Best, R. & Bell, L. (2003). A bibliography of articles on technology in science education. *Contemporary Issues in Technology and Teacher Education,2(4),*427-447

Blumberg, B, Cooper, D.R, & Schindler, P.S. (2005). *Business Research methods, Mc Graw Hill:* Berkshire.

Blume, B.D., Ford, J.K., Baldwin, T.T., &Huang, J.L. (2010). Transfer of training: A meta-analytic review. Journal of management,36(4),1065-1105.

Carlson, K.A. & Winquist, J.R. (2011). Evaluating an active learning approach to teaching introductory Statistics: A classroom workbook approach. *Journal of Statistics Education,*19(1).

Catherine, W.W. (2011). *Performance determinants of Kenya Certificate of Secondary Education(KCSE) in mathematics* of secondary schools in Nyamaiya Division, Kenya. Asian Social Science,7(2),107.

Chaudhury, S.R. (2011). The lecture. *New Directions for Teaching and Learning,*2011(128*),*13-20

Chiappetta, E.L. & Koballa Jr, T.R. (2006). *Science Instruction in the Middle and Secondary Schools. Developing Fundamental Knowledge and Skills for Teaching; 6th ed.; Pearson: Merrill Prentice Hall*; Ohio

Chiesi, F., & Primi, C. (2010). Cognitive and Non-cognitive factors related to Students' statistics Achievement. *Statistics Education Research Journal,9(1)*

Chiu, M. & Lin, J.W. (2002). Using multiple analogies for investigating fourth graders' conceptual change in electricity. *Chinese Journal of Research in Science Education,*10: 109-134

Chris, C. & Vollmer, M. (2006). 'Learning Physics from the Experiments', workshop report in *Informal Learning and Public Understanding of Physics, Selected Contributions of 3rd International Girep Seminar 2005*, edited by G. Planinsic and A. mohoric (Univ. of Ljubljana, Slovenia,2006), pp. 185-190.

Cohen, L., Manion, L., Morrison. (2007). *Research methods in education (6th ed.)* London: Taylor and Francis e-library.

Cook, T.D. & Campbell, D.T. (1979). *Quasi-experimentation*: Design and *analysis issues for field settings.* Chicago: Rand Mc Nally college publications company.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Darling-Hammond, L. (2006). *Securing the right to learn*: Policy and practice for powerful teaching and learning. Educational Researcher,35(7),13-24.

Dhanapal, S., & Wan Zi Shan, E. (2013). A study on the Effectiveness of Hands-on Experiments in Learning Science among Year 4 Students. *International Online Journal of Primary Education(IOJPE) ISSN:1300-915X,3(1).*

DiCarlo, S. E. (2009). *Too much content, not enough thinking, and too little FUN!* Advances in Physiology Education, 33(4), 257-264.

Dillon, J. (2008). *A review of the research on practical work in school science.* King's College, London, 1-9.

Dillon, J., & Manning, A. (2010). Science teachers, science teaching. *Good Practice in Science Teaching*: What Research Has to Say: What research has to say,6.

Dimitrov, D. M., & Rumrill Jr, P. D. (2003). *Pretest-posttest designs and measurement of change Work, 20*(2), 159-165.

Duru, A. (2010). *The experimental teaching in some topics geometry*. Educational Research and Reviews,5(10),584-592.

Educational Information Network in the Europe Union (2006). *Science teaching in Schools in Europe: Policies and Research.*

Erinosho, S.Y. (2013). How do students perceive the difficulty of physics in Secondary school? An exploratory study in Nigeria. *International Journal for cross-disciplinary Subjects in Education(IJCDSE),*3(3)),1510-1515.

Esiobu, G. O. (2005). *Genre Issues in Science and Technology Education Development*. Science and Technology Education for Development, Uwowi, UMO (Ed.). NERDC Press, Lagos, 137-156.

Etkina E. (2010*). Pedagogical Content Knowledge and Preparation of high school physics teachers*. Phys.Rev. Special Topics-Physics Education Research 6,020110.

Etkina, E., Van Heuvelen, A., Brookes, D. T., & Mills, D. (2002). Role of experiments in physics instruction—A process approach. *The Physics Teacher*, *40*(6), 351-355.

European Commission (2010). Teachers' professional Development-Europe in *international Comparison-Analysis of teachers' professional development based on the OECD'S Teaching and Learning International Survey(TALIS).* Luxembourg. (200pp) ISBN 978-92-79-15/86-6, doi 10.2766/63494.

Fouka, G., & Mantzorou, M. (2011). What are the major ethical issues in conducting research? Is there a conflict between the research ethics and the nature of nursing? *Health science Journal*,5(1),3-14

Francis, M. (2007). *Life Skills Education*. Retrieved from http:// Changingminds.org/articles/ Life_ Skills_ education.htm.

Freeman, T., (2012). The Lancet highlights role of Physics in Medicine, *medical Physics web*, April 20, http://www.iop.org/mt4/mt-tb.Cgi/4415Frost J., (2010)

Gaines, M. (2001). What Factors Effect Retention in the Classroom. *Journal of Education, 1*, 1-7.

Ganyaupfu, E.M. (2013). Teaching Methods and Students Academic Performance. *International journal of Humanities and Social Sciences.* Vol.2. Issue 9, September 2013, 29-35.

Getinet, T. (2012). Effect of instructional intervention on students' learning gains: An experimental research. *Latin- American Journal of Physics Education, vol*. 6(2),187-195

Gillham, B. (2008). *Developing a questionnaire (2nd ed.*). London, UK: Continuum International Publishing Group Ltd.

Ginzburg, S., & Dar-El, E.M. (2000). Skill retention and relearning-a proposed cyclical model. *Journal of work place Learning,*12.8:327-332

Guloba, M., Wokadala, J., &Lawrence, B. (2010). *Does teaching methods and availability of teaching resources influence pupil's performance?* evidence from four districts in Uganda.

Haigh, M. & Forret. (2005) Is 'doing science' in New Zealand classrooms an expression of scientific enquiry? *International Journal of Science Education*,27(2),215-26.

Handelsman, J., Miller, S., & Pfund, C. (2007). *Scientific teaching*. Macmillan

Heck, R. H. (2007). Examining the relationship between teacher quality as an organizational property of schools and students' achievement and growth rates. *Educational Administration Quarterly*, *43*(4), 399-432.

Hirschfield, D. (2012). *Interest in science careers wanes in Latin America*, Science and Development Network,4 January 2012

Hofstein, A., & Lunetta, V. (2004). *The laboratory in science education*: Foundations for the Twenty-First Century. Science Education, 28-54.

Hofstein, A., & Mamlok-Naaman, R. R. (2007). The laboratory in science education: The state of art. *Chemistry Education Research and Practice*,8: 105-107.

Ifeanacho, A. O. (2012). Effect of Kumon teaching strategy on junior secondary school students' achievement, interest and retention in statistics. *An Unpublished Ph. D thesis, University of Nigeria, Nsukka*.

Irma, M., & Daniel, S. (2012). Modifying high school student's ideas about Magnetic Field Concept. *Lat.Am.J.Phys.Educ., vol*.6(1): 208-212.

Jones, R.& Wyse, D. (2004). *Creativity in the primary curriculum*. London: David Fulton publishers Ltd.

Juan, C., & Ruiz, M. (2009). Totalizing of the didactic teaching-learning process of physics: An alternative for the development of Student. *Lat.Am.J.Phys.Educ., vol*.3(1): 13

Kapting'ei, P., & Rutto, D.K. (2014). Challenges Facing Laboratory Practical Approach in Physics Instruction in Kenyan District Secondary Schools. *International Journal of Advancements in Research & Technology.*

Kenya National Examinations Council, (2013). *Year 2012 Kenya Certificate of Secondary Education Examination Candidates Physics performance report.* Nairobi

Kenya National Examinations Council, (2016). *Year 2015 Kenya Certificate of Secondary Education Examination Candidates Physics performance report*. Nairobi

Kimberlin, C.L., & Winterstein, A.G. (2008). Validity and Reliability of Measurement Instruments Used in Research. *American Journal of Health-System Pharmacists,*65(1),2276-2284

Kiptum, M.G. (2015). Difficulty Physics topics in Kenyan Secondary Schools: A case Study of Uasin Gishu County. *Scholarly Journal of Education,*4(4),72-81

Knott, T. (2007). *Teaching Science to young children*: Practical advice. http://cnx.org / Content /m14527/ Latest.

Kola, A. (2013). Importance of Science education to national development. *American journal of educational research,*1(7),223-229

Kolb, D.A. (2014). Experiential learning: Experience as the source of learning and development. FT press.

Kombo, D. K., & Tromp, D. L. (2006). *Proposal and thesis writing*: An introduction. Nairobi: Paulines publications Africa, 5,814-30

Koponen, I.T., & Mantyla. T. (2006). Generative Role of Experiments in Physics and in Teaching physics: A suggestion for Epistemological Reconstruction. *Science & Education, vol*. 15(1): 31-54

Leedy, P.D. & Ormrod, J.E. (2010) *Practical Research: Planning and Design,* Ninth Edition. NYC: Merril

Legesse, B. (2014). *Research Methods in Agribusiness and value Chains*. School of Agricultural Economics and Agribusiness, Haramaya University.

Loveland, J.L. (2014). *Traditional Lecture Versus an Activity approach for teaching Statistics:* A comparison of outcomes.

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. *Handbook of research on science education*, 393-441

Madan, C.R., & Kensinger, E.A. (2017). *Test-Retest Reliability of Brain Morphology Estimates.* Brain Informatics, 4,107-121.

Makunja, G. (2016). Challenges facing teachers in implementing competence-based curriculum in Tanzania. The case of community secondary school in Morogoro municipality. *International Journal and Social Science*,3(5),30-37.

Marmah, A.A. (2014). Students' perception about the lecture as a method of teaching in tertiary institutions. Views of students from college of technology, Kumasi (COLTEK). *International Journal of Education and Research*,2(6),601-612

Martins-Omole, M.I., Yusuf, H.O., & Guga, A. (2016*).* Effects of Concept Mapping and Experimental Techniques in Teaching Biology in Secondary Schools in Federal Capital Territory Abuja, Nigeria*. European Journal of Education Studies.*

Masingila, J.O., & Gathumbi, A.W. (2012). *A Collaborative project to Build Capacity Through Quality Teacher Preparation,* http:// soeweb.syr.edu/centers_ institutes/ Kenya partnership projects/ default.aspx

McDermott, L. C., Shaffer, P. S., &Constantinou, C. P. (2000). Preparing teachers to teach physics and physical science by inquiry. *Physics Education, 35*(6), 411.

McWilliam, E., Poronnik, P., & Taylor, P.G. (2008). Re-designing Science Pedagogy: Reversing the flight from science. Journal of Science Education and Technology,17(3),226-235

Mekonnen, S. (2014). Problems Challenging the Academic performance of Physics in Higher Governmental Institutions in the Case of Arbaminch, Wolayita Sodo, Hawassa and Dilla Universities. *Natural Science*, 6, 362-375. http: // dx.doi.org/10.4236/ns.2014.65037

Mendez, C.D., & Slisko, J. (2013). The influence of active physics learning skills of prospective elementary teachers: A short initial study with ISLE methodology, *Latin-American Journal of physics Education, vol.*7(1) 3-9

Menjo, E. (2013). An Assessment of Effectiveness of the Secondary School Science Pedagogy and Curriculum Relevance to Students' Needs in Baringo Central, Kenya. *Journal of Emerging Trends in Educational Research and Policy Studies*,4(3),433.

Michael, V., & Mollmann, K. (2012). Low cost hands-on experiments for physics teaching. *Latin-American Journal of physics Education, vol*.6(1): 3-9

Millar, R. (2004). The role of practical work in the teaching and learning of science. Paper presented at the '*High school science laboratories*: Role and vision' Meeting.

Modebelu, M. N., &Kalu-Uche, N. (2013). Managing Science Teachers' Productivity Challenges for Quality Science Education. *Academic Journal of Interdisciplinary Studies, 2*(6), 119.

Moore, D.S. (2005). Preparing graduates students to teach Statistics: Introduction. *The American Statistician,*59(1)

Muhoro, B.O. (2009). *Factors Contributing to low enrolment of Students in Physics at secondary school level in Central Division Garissa District*, Kenya; unpublished Med Thesis Kenyatta University

Musasia, A. M., Abacha, O. A., & Biyoyo, M. E. (2012). Effect of Practical Work in Physics on Girls' Performance, Attitude change and Skills acquisition in the form two-form three Secondary Schools' transition in Kenya. *International Journal of Humanities and Social Sciences, 2*(23), 151-166.

Musasia, A. M., Ocholla, A. A., & Sakwa, T. W. (2016). Physics Practical Work and Its Influence on Students' Academic Achievement. *Journal of Education and Practice, 7*(28), 129-134.

Nduru, M.D. (2014). *Practical work and performance of learners in physics: a study of secondary schools in Meru central district, Meru county*, Kenya.

Nemec, L. (2009). *Diversity of didactic approaches in teaching Geography.* Celebrating Geographical Diversity,51.

Ng'ethe, M.A. (2016). *Effects of Practical Work on Students' Achievement in Physics at secondary school level* in Murang'a East Sub-County, Kenya (Doctoral dissertation, SCHOOL OF EDUCATION, KENYATTA UNIVERSITY)

Noel, M.D., Daniel, F.M. & Martin, P. (2015). The Future of lecture Method as a Teaching Strategy in Community Nursing Education. J Family Med Community Health 2(8): 1067

Norman, W. (2005). *End the biggest educational and intellectual blunder in history; a $100,000 challenge to our top educational leaders.* Florida; Scientific method publishing Co.

Nwagbo, C., &Chukelu, U. C. (2011). Effects of biology practical activities on students' process skill acquisition. *Journal of Science Teachers Association of Nigeria, 46 (1), 58, 69.*

Ogula, P.A. (2005). *Research methods.*

Ogunneye, W. (2013). Students' understanding of the concept of Gradient in Physics. A case study of physics students from Tai Solarin College of Education, Ijebu-Ode. *Journal of the Science Teachers' Association of Nigeria,*38(1),100-106

Okoth, B.K. (2011) *Impact of Resource Utilization on the Performance of Physics in KCSE in public secondary schools* in Ugunja/ Ugenya Districts, Kenya.

Oliveira, P.S., Birth, M.C., & Bianconi, M.L. (2005). *Conceptual changes or behavioral?* Science and Culture. Vol.57, N04.

Olympiou, G., & Zacharia, Z.C. (2012). *Blending physical and Virtual manipulatives: An effort to improve students' conceptual understanding through science laboratory experimentation.* Science Education,96 (1),21-47

Omirin, M. S., &Oladosu, C. T. (2010). Influence of Teaching Methods On Students' Attitude Towards Mathematics in Osun State, Nigeria. *Journal of Sociology, Psychology and Anthropology in Practice: Int'l Perspective*, *2*(1-3).

Omwirhiren, E. M. (2015). Enhancing Academic Achievement and Retention in Senior Secondary School Chemistry through Discussion and Lecture Methods: A Case Study of Some Selected Secondary Schools in Gboko, Benue State, Nigeria. *Journal of Education and Practice*, *6*(21), 155-161.

Ornek, F., Robinson, W. R., &Haugan, M. P. (2008). What Makes Physics Difficult? *International Journal of Environmental and Science Education*, *3*(1), 30-34.

Orodho, A. (2004). *Techniques and Social Science Research Methods Nairobi.*

Parker, P. (2009).AC2009-2013: *Factors Affecting Concept Retention.* Age,14,1.

Qualters, D.M. (2001). Do students want to be active? *Journal of Scholarship of Learning and Teaching,* 2,51-60.

Robson, C. (2011). *Real World Research: A Resource for Users of Social Research Methods in Applied Settings, (2nd Ed.).* Sussex, A. John Wiley and Sons Ltd.

Sakala, J. (2013). *Factors Contributing to Excess Use of the Lecture method of Teaching in Selected Schools of Kitwe and Kalulushi Districts*: Lessons for Educational Administrators (Doctoral dissertation, University of Zambia).

Santana, L.C. (2011). *Use and School Laboratories Management*. Federal University of Santa Maria.

Sarangapani, P.M. (2014). *Three Challenges facing Indian School Science education*. Science education: Few takers for innovation,32-35

Schoon, I., Ross, A., & Martin, P. (2007). Science related careers: aspirations and outcomes in two British cohort studies. *Equal Opportunities International*, *26*(2), 129-143.

SCORE (2008). Practical work in science: *A Report and proposal for a strategic frame work. Retrieved from www.Score-education.org.*

Sekaran, U., &Bougie, R. (2010). Research Methods for Business: A Skill. *Building Approach. UK: John Wiley.*

Serway, R. A., Moses, C. J., & Moyer, C. A. (2004). *Modern physics*. Cengage Learning.

Simon, M.K. (2011). Dissertation and scholarly research: *Recipes for Success* (2011 Ed.). Seattle, WA, Dissertation Success, LLC.

Soares, B.C., de Campos, M.E.C., Thomaz, J.R., da Cruz Pereira, G., & Roehrs, R. (2016). The importance of experimentation in the teaching of sciences to elementary school. *Revista Monografias Ambientais*,15(2),1-17

Sogoni, P.K. (2017). *Performance in Kinematics using Cooperative Learning Among secondary school students* in Sabatia Sub-county, Kenya

Streveler, R. (2006). 2006-1653: Identifying and Investigating Difficult Concepts in engineering mechanics and Electric circuits. *age*, *11*, 1.

Svedruzic, A. (2008). *Demonstration in teaching physics*. Metodika,17(2): 442-450

Tarekegn, G. (2009). Can Computer Simulations substitute real laboratory apparatus? *Latin-American Journal of Physics Education, vol*.3(3): 506-517

Thatcher. (2010). Validity and Reliability of Quantitative Electroencephalography. *Journal of Neurotherapy,* 14,122-152.

Tiberghien, A. (2000). Designing teaching situations in the secondary school. *Improving science education: The contribution of research*, 27-47.

Tugulea, L., Jones, G., & Naudts, J. (2011). Teaching Physics in Europe. *Activities, Outcomes & Recommendations of STEPS TWO Project. ARSDOCENDI, Universitatea Din Bucuresti*

Uwaifo, V.O. (2012). A comparative Study of Students Performance in Technology based Theory and Practical subjects in Nigerians universities. *International Journal of Scientific & Technology Research*. 1(1),1-3, ISSN 2277.8616

Veselinovska, S.S., Gudeva, L.K., & Djokic, M. (2011). The effect of teaching methods on cognitive achievement in biology studying. *Procedia-Social and Behavioral Sciences*,15,2521-2527

Waititu, M. (2004). Exploring and Students Perception of Difficulty in Topics Areas of the Kenya Secondary School Physics Syllabus. *Unpublished Master's Thesis, Kenyatta University*.

Wasanga, P.M. (2009). *The Role of Examination Results as a Feedback Tool*: The Kenyan Experience, First Read Global Conference: Developing a Vision for Assessment System, September,30-October 2, pp 13-15

Webster. (1985). Webster's ninth new Collegiate dictionary. Meriam- Webster Inc.

Weltman, D. & Whiteside, M. (2010). Comparing the effectiveness of traditional and Active learning methods in business Statistics: Convergence to the mean. *Journal of Statistics Education*,18(1).

Williams, C., Stanisstreet, M., Spall, K., Boyes, E., & Dickson, D. (2003). Why aren't secondary students interested in physics? *Physics Education, 38*(4), 324.

Williams, J. McClure, M. (2010). The Effects of Teaching Methods in Leadership Knowledge Retention: *An Experimental Design of Lecture, Experiential, and Public Pedagogy.* J. Leadersh. Educ.9(2): 86-100.

Wooldridge, V. W. (2009). *A quantitative study on the relationship between teachers' technology perceptions and math proficiency*. University of Phoenix.

Worth, K. (2010) *Science in early childhood classrooms: Content and process*. Massachusetts; Educational Development Center, Inc. Retrieved from http: // ecrp. Uiuc. Edu /beyond /seed /worth. html

Zdenek, K., & Hana, P. (2008). About the project Education at the Secondary School at Czech Republic. *Lat.Am.J.Phys.Educ., Vol.2(3):* 212-213.

APPENDICES

Appendix I: Letter of Information to the Principal

SAMUEL K. CHEPKWONY
P.O. BOX 59-30204,
KAPCHEROP

TO,

15/06/2018

THE PRINCIPAL,

Dear Sir/Madam

RE: COLLECTION OF DATA

The above subject matter refers.

I am a postgraduate student in the department of Centre for Teacher Education, University of Eldoret. I am carrying out a research study entitled: "**Effect of Experimental Method on Retention and Application of Moment Concepts in physics"**. This research is purely academic and any information provided shall be treated with confidentiality. I am kindly requesting for your permission to collect data for this study in your school. During the time of data collection, I will administer a questionnaire to physics teachers and Tests for Form Two students. The output of the study will be used to enhance academic achievement in moment and fostering students' positive attitude towards moment concepts in physics in secondary schools in Kenya.

Your cooperation will be highly appreciated.

Yours faithfully,

SAMUEL CHEPKWONY

Masters student

University of Eldoret

EDU/S/PGSE/003/15

Appendix II: Consent Letter to the Participant.

SAMUEL K. CHEPKWONY
P.O. BOX 59-30204,
KAPCHEROP

15/06/2018

Dear Participant,

I am a Post graduate student in the school of education, University of Eldoret. I am pursuing a master degree in Education Science. For this reason, I would kindly appreciate if you spare your time to fill the questionnaire provided. The main objective of this study is to examine the effect of Experimental Method on Retention and Application of Moment Concepts in Physics in secondary school students.

You are requested to provide sincere and accurate responses to all the items in the research questionnaire to the best of your knowledge. The information you give will be kept confidential and will only be used for academic purpose. Please do not write your name. You may contact the researcher for more information about the study and to communicate the findings of the study.

Thank you in advance for accepting to participate.

Yours faithfully,

SAMUEL K. CHEPKWONY

EDU/S/PGSE/003/15

Appendix III: NACOSTI Authorization

NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349,3310571,2219420
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref No. **NACOSTI/P/18/27996/23722**

Date **19th July, 2018**

Samuel Kiprop Chepkwony
University of Eldoret
P. O. Box 1125-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effect of experimental method on retention and application of moment concepts in physics in secondary schools of Marakwet West Sub County"*** I am pleased to inform you that you have been authorized to undertake research in **Elgeyo Marakwet County** for the period ending **19th July, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Elgeyo Marakwet County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Elgeyo Marakwet County.

The County Director of Education
Elgeyo Marakwet County.

Appendix IV: County Director of Education Authorization

REPUBLIC OF KENYA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
STATE DEPARTMENT OF EARLY LEARNING & BASIC EDUCATION

TELEGRAM:.....
TELEPHONE NO: 0534142207
WHEN REPYLING PLEASE QUOTE OUR REFERENCE
EMAIL: cdeelgeyomarakwet@gmail.com

COUNTY DIRECTOR OF EDUCATION,
ELGEYO MARAKWET COUNTY,
P.O. BOX 214-30700,
ITEN.

DATE: 23rd July,2018

REF No: CDE/EMC/R/26/VOL.II/ 81

Samuel Kiprop chepkwony
University of Eldoret
P.O Box 1125-30100
ELDORET

RE: RESEARCH AUTHORIZATION – SAMUEL KIPROP CHEPKWONY

Following the authorization by the National Commission for Science, Technology And Innovation **(NACOSTI)** to carry out research in **Elgeyo Marakwet County** Vide Authority letter **Ref. No. NACOST/P/18/27996/23722** dated **19th July, 2018** you are hereby formally granted authority by this office to proceed with your study on ***"Effect of Experimental method on retention and application of moment concepts in Physics in Secondary schools of Marakwet West Sub-county "*** for a period ending, **19th July, 2019.**

You are further required to report to the Sub-County Director of Education –Marakwet West Sub-county.

By copy of this letter, the Sub-County Director of Education is requested to accord you the necessary assistance.

FOR: COUNTY DIRECTOR OF EDUCATION
ELGEYO MARAKWET
P.O. Box 214 - 30700, ITEN.

Rose C. Boiyo,
For: County Director of Education,
ELGEYO MARAKWET.

Copy to:
1. The Sub-County Director of Education –**Marakwet West**
2. The Director General/CEO -NACOSTI

Appendix V: County Commissioner Authorization

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR & COORDINATION OF NATIONAL GOVERNMENT

Telegrams:
Telephone: (053) 42007
Fax : (053) 42289
E-mail: ceelgeyomarakwet@yahoo.com
ceelgeyomarakwet@gmail.com
When replying please quote

COUNTY COMMISSIONER'S OFFICE.
ELGEYO-MARAKWET COUNTY.
P.O. BOX 200-30700
ITEN

Ref. PUB. CC. 24/2 VOL.II/103

Date 23rd July,2018

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION
SAMUEL KIPROP CHEPKWONY

This is to confirm that the above named has been authorized to carry out a research on ***"Effect of experimental method on retention and application of moment concepts in Physics in Secondary schools of Marakwet West sub-county, Elgeyo Marakwet County"***. The research will be undertaken for the period ending **19th July, 2019.**

Please accord him necessary assistance.

COUNTY COMMISSIONER ELGEYO MARAKWET COUNTY

K. O. MIFWONI
FOR: COUNTY COMMISSIONER
ELGEYO MARAKWET

c.c. All Deputy County Commissioners
Elgeyo Marakwet County

KOM/njk

Appendix VI: Questionnaires for Physics Teachers

Dear teacher,

I am a postgraduate student of university of Eldoret pursuing master of education in science education (physics option). I kindly request you to provide the information asked in the questionnaire below. The information provided will be solely used for the purpose of this study. Thank you in advance.

Please tick (√) where appropriate.

1.Which category of school are you teaching?

Sub county ☐ County ☐ Extra County ☐ National ☐

2(a) In every physics exam /Cat you administer to your students, how do students perform in questions from the topic moment/Turning Effect of a force?

Excellently ☐

Fairly ☐

Poorly ☐

NB: Excellently means student(s) scoring all the marks awarded to the question

Fairly means student(s) scoring marks less than the total marks awarded to the question

Poorly means student(s) scores zero mark

(b) Have you ever use experimental approach to teach moment concepts?

Yes ☐

No ☐

(c) If your response is YES, did students' performance improved?

Yes ☐

No ☐

(d) If your answer in (b) is Yes and in(c) is No, what alternative method do you suggest for teaching moments……

3.Which of these challenges do you face when using experimental method of teaching?

Heavy work load ☐

In adequate resources ☐

Over populated class ☐

Name other challenges if any

……

Appendix VII: Instructions for Teachers and sample Lesson Plans to be used

Physics teacher teaching experimental groups should begin each lesson with a brief introduction and an overview of the topic Moments/Turning Effect of a force. After introduction, the learners break into groups in which each group to have a maximum of five students. Each group is provided with the following apparatus: A metre rule, a knife edge wooden pivot, various masses(g), glass block and cotton threads. The teacher then guides the learners through the experiments by giving the procedures, asking questions, explaining and answering the questions asked in class. For teachers teaching control groups, the teacher should use lecture, discussion and question and answer methods in class.

The teacher should follow the sample lesson plans:

TEACHER'S MANUAL (LESSON PLAN) FOR EXPERIMENTAL APPROACH ON TOPIC MOMENTS IN PHYSICS

INSTRUCTIONS

i. All the lessons be taught experimentally on topic moments
ii. Provide the learners with the objectives of the lesson and procedures as per the manual before the lesson
iii. Monitor students working in their respective groups by providing corrective feedback as necessary and assess the performance of different groups.
iv. Allow students to perform experiments on their own as you guide them

LESSON 1

TOPIC: TURNING EFFECT OF A FORCE

Subtopic: clockwise and anticlockwise moments

Objectives: By the end of the lesson the learner should be able to:

i. Recall the definition of a force
ii. Define moment of a force and state its SI unit
iii. State the types of moment of a force

INTRODUCTION(5MINUTES)

Teacher overseeing learners forming groups of five, providing the objectives of the lesson and procedures of the experiment.

LESSON DEVELOPMENT(30MINUTES)

Teacher reviewing the definition of a force

Learners to do the followings:

- Place the metre rule on a knife edge pivot and adjust until it balances
- Learners to record the point at which the metre rule balances(pivot)
- Learners to hang a mass of 10g at 70cm mark and observe the motion of the metre rule

- Learners to transfer the same mass to 10cm mark of the metre rule and note the motion of the metre rule
- Repeat with other masses
- The teacher to guide the learners to identify the clockwise and anticlockwise moments
- Teacher to define moment and state the SI unit of moment

CONCLUSION (5 MINUTES)

Teacher summarizes the lesson

Teacher give assignment which the learners have to hand in later

Teacher marks the assignment before the next lesson. He/she reteaches the concepts which the learners did not understand.

LESSON 2&3

TOPIC: TURNING EFFECT OF A FORCE

Subtopic: Principle of moments

Objectives of the lesson: By the end of the lesson the learner should be able to:

i. State the principle of moments
ii. Convert the masses in grams to newton
iii. Apply the principles of moments to determine unknown weights

INTRODUCTION (10 MINUTES)

- The teacher introduces the lesson by reviewing the previous lesson by way of question and answer method.
- Teacher provides the objectives of the lesson
- Teacher discusses the procedure of the lesson
- Teacher encourages every learner to participate during the setting and performing of experiments
- Learners proceed to their respective groups

LESSON DEVELOPMENT(65MINUTES)

- Learners to hang 20g ,50g masses at 70cm and 90 cm marks respectively on the metre rule pivoted at its center.
- Learners to adjust the position of one 100g mass until it balances the other two masses on the metre rule
- Teacher to guide the learners in stating the principle of moments
- Teacher to guide the learners in converting the masses to newton
- Learners to identify the clockwise and anticlockwise forces on the metre rule
- Learners calculating the clockwise moments and anticlockwise moments
- Learners applying the principle of moments to determine the weight of unknown glass block.
- Teacher asking and answering questions
- The teacher harmonizes the results obtain by each group

CONCLUSION(5MINUTES)

Teacher summarizes the lesson

Teacher gives the assignments to be handed in later by the learners

Teacher marks the assignment and note the concepts which learners have not understood before the next lesson.

LESSON 4

TOPIC: TURNING EFFECT OF A FORCE

Subtopic: Equilibrium and Centre of gravity

Objectives of the lesson: By the end of the lesson the learners should be able to:

i. Define the term equilibrium
ii. Define c.o.g
iii. Determine the mass of a metre rule given the point of pivot and other forces.

INTRODUCTION (5MINUTES)

- The teacher reviewing the previous lesson by way of question and answer
- Teacher providing the objectives of the lesson
- Teacher giving the procedures of the lesson
- Learners proceed to their respective groups

LESSON DEVELOPMENT(30MINUTES)

- Learners performing experiments
- Teacher guiding learners to define equilibrium and c.o.g
- Learners determining the mass of the metre rule when pivoted at 40cm mark and a mass of 100g is hanged at 90cm mark

CONCLUSION (5MINUTES)

- Teacher summarizes the lesson
- Teacher gives the assignment to be handed in later
- Teacher projects the next lesson

TEACHER'S MANUAL (LESSON PLAN) FOR LECTURE METHOD OF TEACHING ON TOPIC MOMENTS IN PHYSICS

INSTRUCTIONS

- Use the above method in teaching the topic moments in Physics
- Provide the learners with the objectives of the lesson before the lesson
- Monitor students' work and provide corrective feedback as necessary.

LESSON 1

TOPIC: TURNING EFFECT OF A FORCE

Subtopic: clockwise and anticlockwise moments

Objectives: By the end of the lesson the learner should be able to:

iv. Recall the definition of a force

v. Define moment of a force and state its SI unit

vi. State the types of moment of a force

INTRODUCTION(5MINUTES)

Teacher preview the previous lesson and providing the objectives of the lesson.

LESSON DEVELOPMENT(30MINUTES)

- Teacher to begin the lesson by reviewing the definition of a force as taught in form one
- Learners to recall
- Teacher to draw a well labelled metre rule with a pivot on the chalk board to illustrate moment of a force as learners observe, listen and making short notes
- Teacher to define moment of a force and give its SI unit as he/she refer to drawing on the chalkboard

- Teacher to illustrate the types of moment of a force on the chalk board as learners observe and drawing.

CONCLUSION (5 MINUTES)

Teacher summarizes the lesson

Teacher give assignment which the learners have to hand in later

Teacher marks the assignment before the next lesson. He/she reteaches the concepts which the learners did not understand

LESSON 2&3

TOPIC: TURNING EFFECT OF A FORCE

Subtopic: Principle of moments

Objectives of the lesson: By the end of the lesson the learner should be able to:

iv. State the principle of moments

v. Convert the masses in grams to newton

vi. Apply the principles of moments to determine unknown weights

INTRODUCTION (10 MINUTES)

- The teacher introduces the lesson by reviewing the previous lesson by way of question and answer method.
- Teacher provides the objectives of the lesson

LESSON DEVELOPMENT(65MINUTES)

- Teacher to state the principle of moment as learners make notes
- Teacher to illustrate on the chalkboard the principle of moments
- Teacher to guide the learners on how to convert masses in grams to newton
- Teacher to give a problem in class which requires the application of the principle of moments
- Teacher to guide the learners in solving the problem as he/she monitors learners progress

CONCLUSION(5MINUTES)

- Teacher summarizes the lesson
- Teacher gives the assignments to be handed in later by the learners
- Teacher marks the assignment and note the concepts which learners have not understood before the next lesson.

LESSON 4

TOPIC: TURNING EFFECT OF A FORCE

Subtopic: Equilibrium and Centre of gravity

Objectives of the lesson: By the end of the lesson the learners should be able to:

iv. Define the term equilibrium

v. Define c.o.g

vi. Determine the mass of a metre rule given the point of pivot and other forces.

INTRODUCTION (5MINUTES)

- The teacher reviewing the previous lesson by way of question and answer
- Teacher providing the objectives of the lesson

LESSON DEVELOPMENT(30MINUTES)

- Teacher to illustrate the equilibrium on the chalkboard
- Teacher guiding learners to define equilibrium and c.o.g with the aid of well labelled diagrams on the chalkboard
- Learners to draw the diagrams and make notes
- Teacher to give a worked example involving equilibrium and c.o.g
- Learners to make notes

CONCLUSION (5MINUTES)

- Teacher summarizes the lesson
- Teacher gives the assignment to be handed in later
- Teacher projects the next lesson

Appendix VIII: Pre-test Items

INSTRUCTIONS TO STUDENTS

- Do not write your name or admission number anywhere in this paper
- The information obtained will purely be used for study purpose.
- Attempt all the questions
- The questions take 40 minutes
- Circle your answer if the question is multiple choices.
- Take g= $10^{N}/_{KG}$ where applicable.

1. What is a moment? (1mk)
   A. A turning effect of a force
   B. The mass of an object at a point.
   C. The distance of a mass from a pivot
   D. When a system is in equilibrium
2. What is the formula for the size of a moment? (1mk)
   A. M= Fxd
   B. F= Mxd
   C. M= $\frac{F}{d}$
   D. M= $\frac{1}{d}$
3. A see-saw is balanced on a pivot with two children on it. One child is sitting 1.5 m to the left of the pivot and has a mass of 50 kg. Another child of mass 30 kg is sitting on the right hand side of the pivot. What distance away from the pivot is the child on the right of the pivot? (3mks)

4. If the point of application of the force was moved further away from the pivot, what would be the effect on the moment? Explain (2mks).

……

……

……

5. Which of the following is an example of the principle of moments being utilized? (1mk)

A. Lifting a book

B. A rock falling

C. A crowbar being used to lift a drain cover

D. A USB stick

6. Reference to ability of an object to return to its original position after it has been tilted slightly is termed as

A. Stability

B. Equilibrium

C. Centre of gravity

D. Turning effect

7(i). Two types of moment of force are

A. Clockwise and Anti-clockwise

B. Stable and Unstable

C. Neutral and charged

D. Forward and backward

7(ii) The figure below shows a computer resting on a tabletop that is hanged at A.

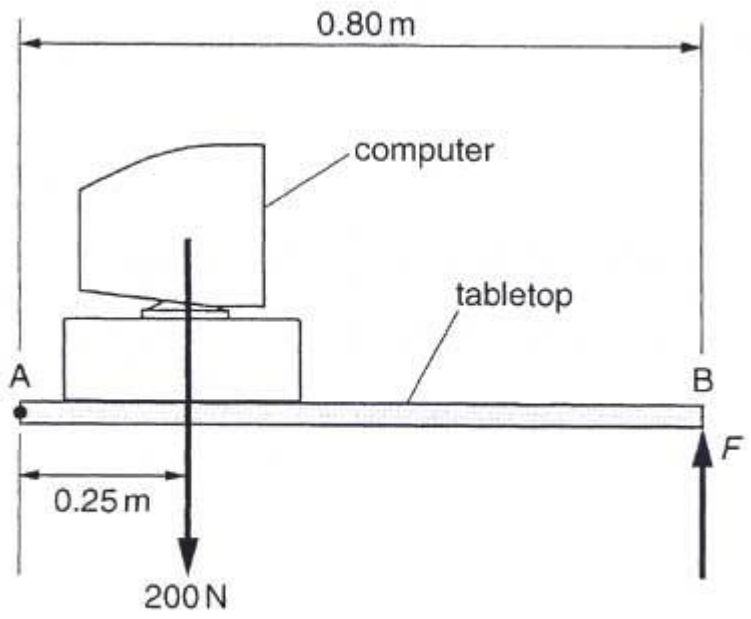


Fig. 2.1

The table top has a mass of 5.0kg and its centre of gravity is 0.40 m from the axis of the hinge at A. The computer has a weight of 200 N acting through a point 0.25m from the hinge at A. The table top is supported to maintain it in a horizontal position by a force of F acting vertically at B. The distance AB is 0.80 m.

(a) Calculate the weight of the tabletop. (2mks)

……

(b) Apply the principle of moments about the hinge at A to determine the vertical force F applied at B that is required to maintain the tabletop in equilibrium(3mks)

……

……

……

8. If we suspend lamina at different positions, its center of gravity will still lie along the

A. plumb line
B. line of force
C. line of weight
D. gravity line

Appendix IX: Pretest Marking Scheme

1. A

2. A

3 Cwm= Acwm=(300Nxd) =(500Nx50m), d = 83.33m

4. The moment would be greater. This is because moment is a product of force and distance.

5. C

6.A

7(i). A

7(ii)(a.) w = mg = 5KGx $10^{N}/_{KG}$ = 50 N.

(b) = (0.25x200) + (0.4x50) = (Fx0.8), F = 87.5N

8. C

Appendix X: Posttest Items

INSTRUCTIONS TO STUDENTS

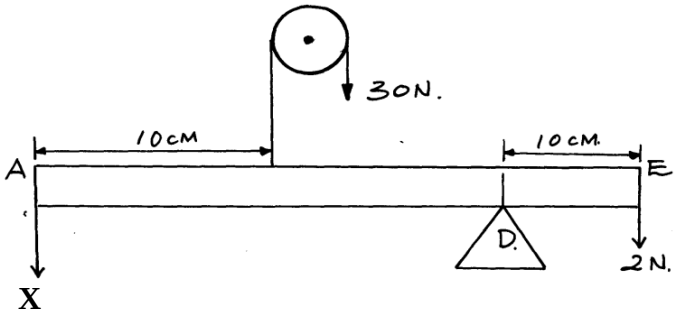
- Do not write your name or admission number anywhere in this paper
- The information obtained will purely be used for study purpose.
- Attempt all the questions
- The questions take 1 Hour
- Circle your answer if the question is multiple choices.
- Take g= $10^{N}/_{KG}$ where applicable.

1. (a) Write the SI unit of moments(1mk)

(b) State the principle of moments (1mk)

(c) Define Centre of Gravity of an object (2mks)

(d) Explain why it is easier to use a spanner with a long handle than the one with a shorter handle (2mks)



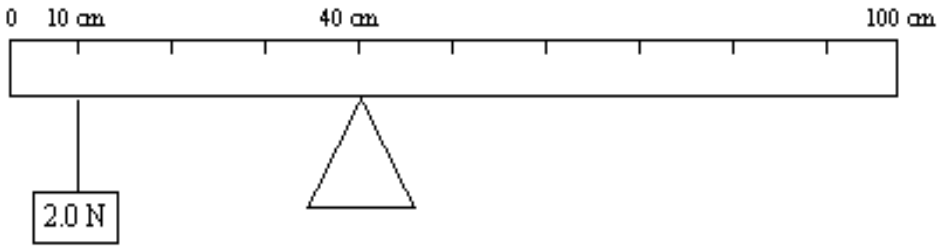
2. The figure below shows a uniform rod **AE** which is 40cm long. It has a mass of 2kg and pivoted at **D**. If 2N is acting at point **E**, and 30N force is passed through a frictionless pulley

(a) Identify clockwise forces (2mks)

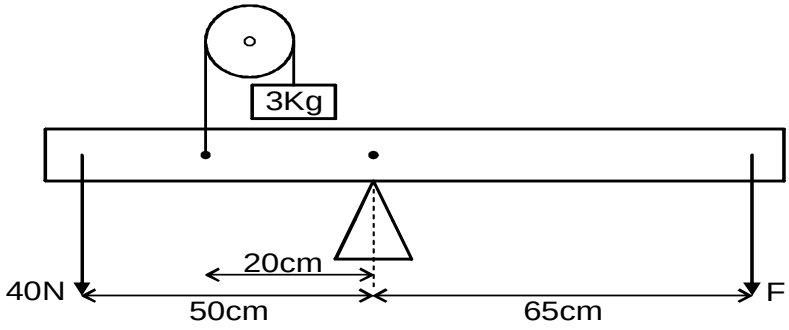
(b) Identify Anticlockwise forces (2mks)

(c) Find the force X acting at end A (3marks)

3. In the diagram below determine the weight of the metre rule shown below. (2 marks)

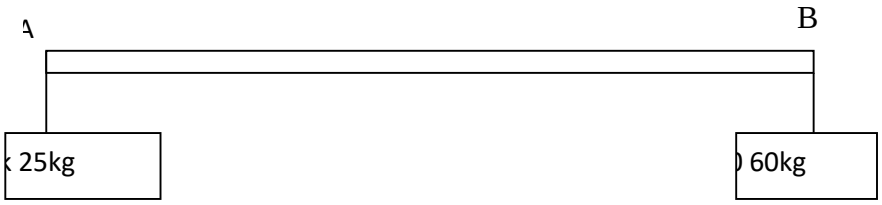


4. The figure below represents a system in equilibrium



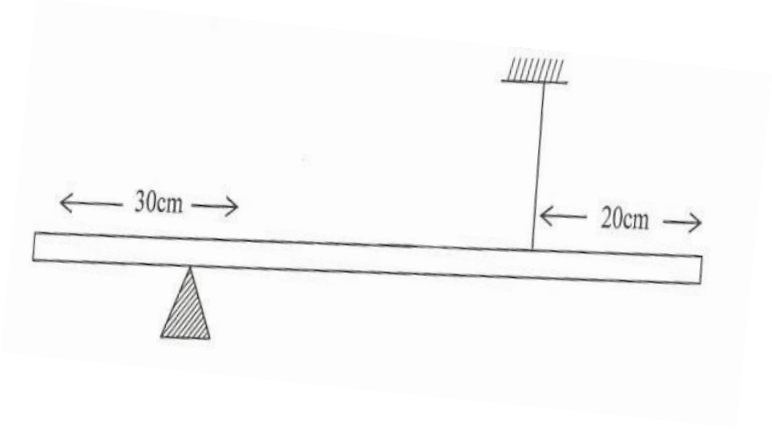
Determine the force F needed to maintain the equilibrium. (3 marks)

5. The figure below shows a uniform plank AB of length 10m weighing 500N. Two masses measuring 25kg and 60kg are loaded on its ends.



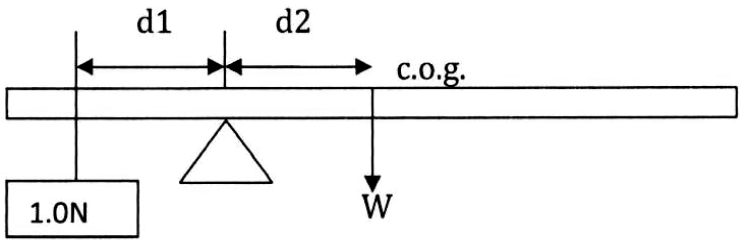
Determine the distance from point A where a support should be placed for the plank to balance horizontally. (3mks)

6. The figure below shows a uniform bar of length 1.4m pivoted near one end. The bar is kept in equilibrium by a string as shown.

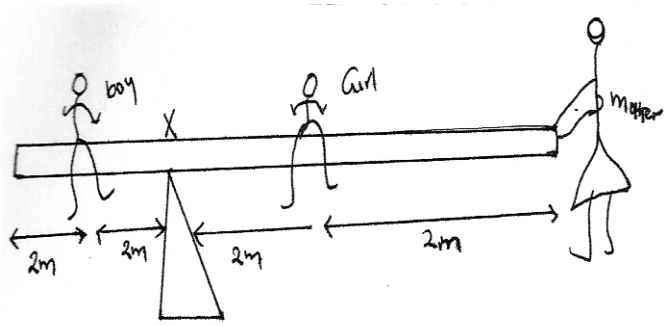


Given that the weight of the bar is 1.5N, determine the tension in the string. (3mks)

7. Determine the weight W of the metre rule given that d_1 =11.0 cm and d_2 =10.0 cm (2mks)



8. The figure below shows a boy and a girl on playground seesaw. The seesaw has a mass of 30kg and is pivoted at its centre. Their mother has to hold the girl's end in order to keep the seesaw level. The boy's mass is 50kg and the girl's mass is 30kg. All the distances are shown on the diagram.



Calculate:

(i) The turning effect of the boy's weight about point x.(1mk)

(ii) The turning effect of the girl's weight about x. (1mk)

(iii). The force their mother must apply on the end of the seesaw in order to keep it level. (2mks)

(iv). The total downward force in the central support of the seesaw. (2mks)

Appendix XI: Posttest Marking Scheme

2(a)

- Force 2N
- Force 30 N

2(b)

- Force X
- Weight of the rod 20N

2(c)

- M_1 to be awarded for correct sketch
- M_1 for substitution
- Answer 1mk

From the principle of moments, and taking moments about the pivot

∑CWM =∑ACWM

(2Nx0.1m) + (30N x 0.2m) = (X x 0.3m) + (20N x 0.1m) M_1

X= 14N A_1

3.

-1mk for correct substitution

-1mk for the answer

W x0.1m = 2.0N x 0.3m

W = 6N

4.

- Award 1mk for correct distances

- 1mk for substitution

-1mk for the correct answer

(F x 0.65m) +(30N x 0.2m) = (40N x 0.5m)

F = 21.5N

5.

- 1mk for correct labeled sketch

- 1mk for correct substitution

- 1mk for the answer

∑CWM = ∑ACWM

(600N x x) = 500N (5-x) + 2500N (10-x)

x= 3.7 m

Hence, the pivot distance from A is 6.3m

6.

- 1mk for correct sketch

- 1mk for substitution

- 1mk for the answer

(1.5N x 0.4m) = T x 0.9m

T = 0.67N

7.

- 1mk for correct substitution

- 1mk for the answer

W x 0.1m = 1.0N x 0.11m

W = 1.1N

Appendix XII: Overall KCSE Physics Performance Country wide 2013 to 2017

YEAR	PERCENTAGE MEAN	GRADE
2013	44.36	5.32 C-
2014	41.44	4.97 C-
2015	47.06	5.65 C
2016	40.55	4.87 C-
2017	38.38	4.61 C-

SOURCE: KNEC PHYSICS REPORT OF 2017

Appendix XIII: KCSE Physics Performance of Marakwet West 2013 to 2017

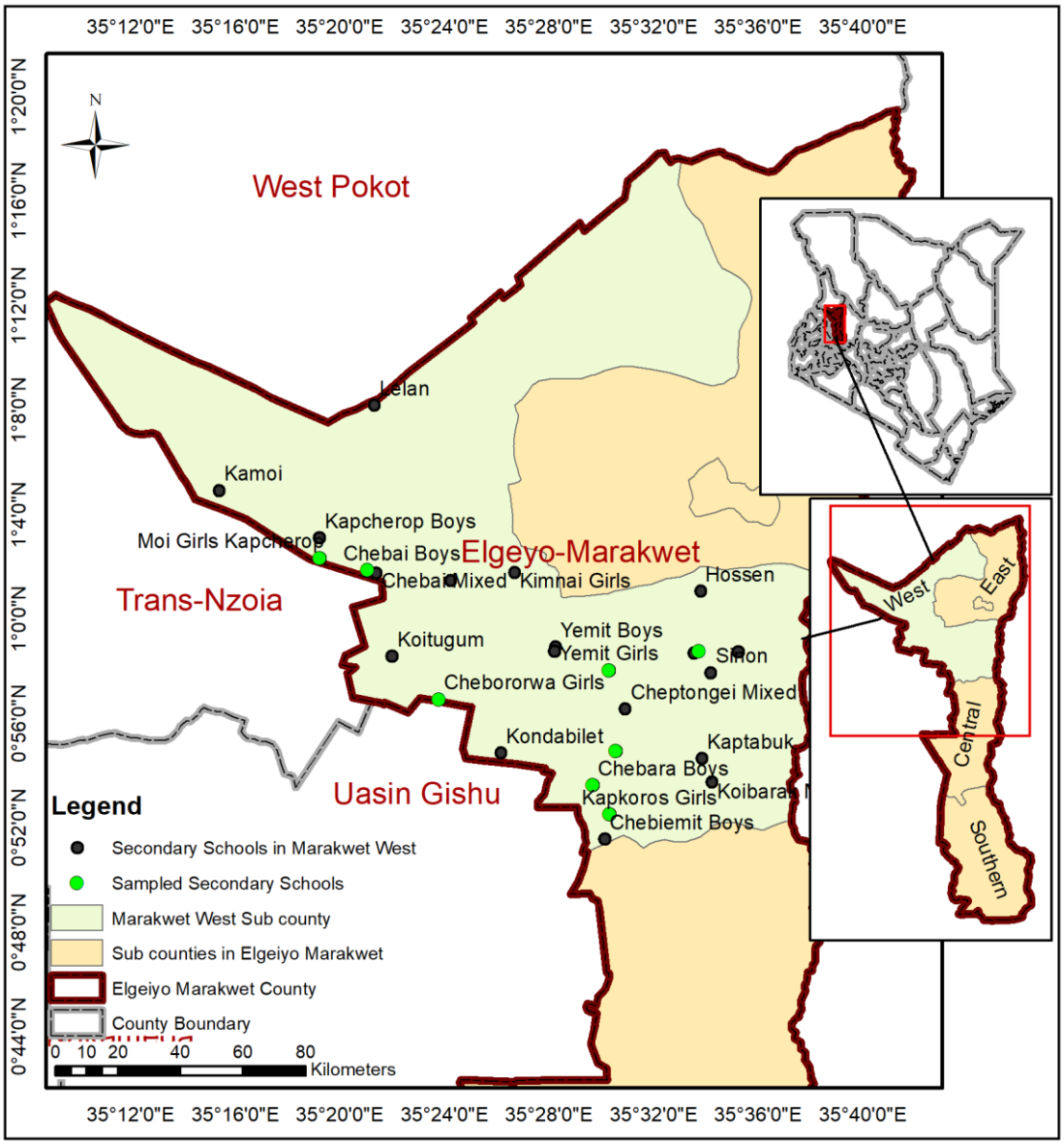
YEAR	PERCENTAGE MEAN	GRADE
2013	31.5	3.78 D+
2014	38.5	4.62 C-
2015	50.0	6.00 C
2016	40.6	4.87 C-
2017	33.7	4.04 D+

SOURCE: Sub-County Education Office, KCSE Analysis records of 2017

Appendix XIV: Categories of Schools in Marakwet West Sub- County

SCHOOL TYPE	**NUMBER OF SCHOOLS**
National	1
Extra- County	4
County	5
Sub-County	16
Total	**26**

Appendix XV: Marakwet West Map (Source: Author, 2019)



Appendix XVI: Research Permit

THIS IS TO CERTIFY THAT:
MR. SAMUEL KIPROP CHEPKWONY
of UNIVERSITY OF ELDORET, 0-30204 KAPCHEROP,has been permitted to conduct research in *Elgeyo-Marakwet County*

on the topic: *EFFECT OF EXPERIMENTAL METHOD ON RETENTION AND APPLICATION OF MOMENT CONCEPTS IN PHYSICS IN SECONDARY SCHOOLS OF MARAKWET WEST SUBCOUNTY*

for the period ending:
19th July,2019

.....
Applicant's Signature

Permit No : NACOSTI/P/18/27996/23722
Date Of Issue : 19th July,2018
Fee Recieved :Ksh 1000

.....
Director General
National Commission for Science, Technology & Innovation

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Appendix XVII: Similarity Report

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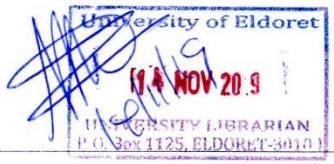

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