EFFECTS OF ADVANCE ORGANIZER CONCEPT MAPPING TEACHING STRATEGY ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND MOTIVATION TO LEARN PHYSICS IN RONGAI SUB-COUNTY, KENYA

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DECLARATION AND RECOMMENDATIONS

Declaration

This thesis is my original work and has not been presented in this or any other university for the award of a degree.

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Recommendations

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DEDICATION

This study is dedicated to my family, husband Evans and dear children Stella, Monica and Calvin for their prayers, patience and support.

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ABSTRACT

Physics is a science that forms an important element in the Kenyan education system. It provides essential knowledge required for technological advancement, achievement of vision 2030 and realisation of sustainable development goals (SDGs). In spite of its importance, students' achievement in physics in Kenyan secondary schools remains poor. Among the factors attributable to students' poor achievement include; use of teacher centred teaching methods and lack of motivation among students. This study investigated the effects of Advance Organizer Concept Mapping Teaching Strategy (AOCMTS), on secondary school students' achievement and motivation to learn physics. Solomon's Four Non-Equivalent Control Group Design was used. Two experimental groups received the AOCMTS as treatment while two control groups were taught using regular teaching methods. The study was conducted in Rongai Sub-County. Four co-educational secondary schools were purposively selected and randomly assigned to experimental and control groups respectively. The target population was all physics students in all co-educational secondary schools in the Sub-County, while the accessible population was form two physics students in the sampled schools. Data was collected from a sample of 192 form two students. Data was gathered using the Physics Achievement Test (PAT) and Student Motivation Questionnaire (SMQ). The instruments were validated by the supervisors and experienced physics teachers. The reliability of PAT and SMQ were estimated using respondents drawn from two secondary schools in Rongai Sub-County, which were not part of the study, but had similar characteristics with the sampled schools. PAT and SMQ had a reliability coefficient of 0.72 and 0.75 respectively, which was above the recommended value. Data was analysed with the aid of the Statistical package for Social Science. The t-test, one-way ANOVA and ANCOVA statistical techniques were used to analyse data. The hypotheses were tested at alpha level of 0.05. Findings of the study indicate statistically significant difference in achievement and motivation to learn physics between experimental and control groups in favour of experimental groups. Use of AOCMTS resulted in higher achievement and motivation to learn physics compared to the use of regular teaching methods. The study concluded that, AOCMTS may be an effective teaching strategy which physics teachers should be encouraged to use. Findings of the study may be useful to learners as they may benefit from improved teaching and learning which may lead to better performance. Findings of this study are also likely to be beneficial to teachers, curriculum developers and policy makers. This is because the findings provide an effective teaching strategy capable of improving students' achievement and quality of education.

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LIST OF ABBREVIATION AND ACRONYMS

ANCOVA	Analysis of Covariance.
ANOVA	Analysis of Variance.
AOCMTS	Advance Organiser Concept Mapping Teaching Strategy.
CBC	Competence based curriculum.
CEMASTEA	Centre for Mathematics Science and Technology Education in Africa.
DEO	District Education Officer.
ICT	Information Communication Technology.
KCSE	Kenya Certificate of Secondary Education.
KICD	Kenya Institute of Curriculum Development.
KIE	Kenya Institute of Education.
KNEC	Kenya National Examinations Council.
MOEST	Ministry of Education Science and Technology.
PAT	Physics Achievement Test.
RTM	Regular Teaching Method.
SMASSE	Strengthening of Mathematics and Science in Secondary Education.
SMQ	Student Motivation Questionnaire.
SPSS	Statistical Package for Social Sciences.
TNAR	Training Needs Assessment Report.
UNESCO	United Nations Educational Scientific and Cultural Organisation.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Science is of great importance internationally for technological innovation and socio-economic development. Science also plays a major role in health improvement, industrialisation, communication and wealth creation (Validya, 2003). Even more, wireless technologies, for example the use of satellite dishes and computers have reduced the world into a global village. In addition, the use of mobile phone is an example of telephone innovation that has greatly improved life in Sub-Saharan Africa and the world at large. Most African countries are making use of science and technology as a driver for development among them, Rwanda's rapid ICT growth and Kenya's vision 2030 (Chakravorti & Shankar, 2019; Republic of Kenya, 2007)

According to United Nations Conference (2015), Kenya is among the African countries required to achieve seventeen sustainable development goals (SDGs) by the year 2030. These are revised goals for social economic development, set at a world leaders' summit in New York in September 2015.The goals include achievement of; quality education, good health and well-being, industry and innovation among others. For this reason, there is need to embrace science and technology as it offers a major impetus towards achievement of sustainable development goals. It is against this background that science education is granted a prominent role in Kenya as well as globally.

Physics plays a central role in science education as it is the most utilized subject in scientific discoveries and technological innovations. Moreover, apart from equipping students with skills in collecting, analysing and interpreting data, physics offers fundamental knowledge in training of computer scientists, chemists and engineers. Therefore, the importance of quality teaching and learning of physics cannot be over emphasized because of its wide application and immense contribution towards economic and technological advancement (Sani, 2012).

Despite its importance, physics education in Kenya continues to face myriad of challenges. The challenges range from lack of personnel, inadequate teaching/learning resources as well as poor performance (Changeiywo, 2002; Okere, 2000).Poor performance for instance is manifested in candidates' scores in physics in the Kenya Certificate of Secondary Education (KCSE) Examination. This has made the government to continuously look for ways of addressing the challenge of poor performance. One of the governments' initiative to mitigate poor performance in physics is through Strengthening of Mathematics and Science in Secondary School Education (SMASSE) Project (Oirere, 2008; Oyaya & Njuguna, 2000). SMASSE project was piloted in 1998 and launched in 2002.This followed a baseline study on factors contributing to poor performance in mathematics and science. The factors identified included: lack of motivation among students, instructional methods used, and lack of teaching and learning resources among others (Waititu & Orado, 2009). SMASSE was mandated to conduct continuous in-service training of mathematics and science teachers which according to Mutisya (2013), resulted in slight improvement in performance in KCSE physics. This implies that much more needs to be done to improve students' achievement in physics in Kenyan secondary schools.

The instructional method employed by a teacher to teach physics, plays a vital role in content delivery. Student centred teaching strategies promote meaningful learning and better achievement of learning objectives. In Kenya for example, research has shown that, physics teachers in secondary schools use regular teaching methods during instruction (Toplis & Allen 2012). The dominant regular teaching method in secondary school physics classroom is the lecture method (Ministry of Education, 2001). Lecture method is ineffective since it makes students passive recipient of information. Lecture method is effective to self-driven students who can perform well without teacher's facilitation. Wasonga (2015), indicates that use of innovative teaching strategies may enhance content delivery in physics. This study therefore anticipates that success in teaching and learning of physics can be attained through the use of appropriate teaching strategies. It is from this perspective that the study intends to investigate the effect of Advance Organizer Concept Mapping Teaching Strategy on students' achievement and motivation to learn physics.

Besides low achievement, another challenge facing physics teachers is capturing and maintaining students' motivation to learn physics. Few students show interest in physics at form three, and even fewer students choose to pursue physics or physics related courses at tertiary levels due to lack of motivation. Athman and Monroe (2004) assert that there is a relationship between motivation and performance. They also indicate that lack of motivation in students' is among the major causes of poor performance. Similarly, Nelson (2000), argues that there exists an interrelation between motivation, mental cognition and conceptual change. Physics teachers therefore have a crucial role to play in designing learning environments that can enhance students' motivation. This may be achieved by use of Advance Organizer Concept Mapping Teaching Strategy (AOCMTS).

The Kenya Certificate for Secondary Education result for a particular subject is based on the grading system where grade E is the lowest and equivalent to 1 point while grade A is the highest Equivalent to 12 points. Kenya National Examinations Council (KNEC) yearly report indicates that students' poor performance in physics has persisted over the years (KNEC, 2019). For instance, candidates overall national performance has been poor and fluctuating between 2014 and 2018 as indicated in Table 1.

Table 1

Candidates' Overall National Performance in KCSE Physics Examination between 2014 and 2018 in Kenya

Year	Maximum Score	Candidature	Mean Score
2014	200	483,630	77.68
2015	200	522,870	87.03
2016	200	574,125	79.53
2017	200	611,952	70.09
2018	200	660,204	68.54

Source: Kenya National Examinations Council KNEC (2019).

As indicated in Table 1, the highest mean score recorded was 87.03 in 2015. The performance has been below the average score of 100%. Table 2 shows students' performance in Kenya Certificate of Secondary Education (KCSE) Physics in Nakuru County in the years 2014 to 2018.

Table 2

Students' Performance in KCSE Physics Examination in Nakuru County between 2014 and 2018

Year	**Mean score**
2014	4.96
2015	5.03
2016	4.51
2017	4.26
2018	5.37

Source: County Education Office, Nakuru

In the K.C.S.E grading system, the maximum score for all subjects is 12 points. The observation made from Table 2 is that County's mean scores have been lower than the average mean score of six points. Nakuru County has eleven Sub-counties. Rongai Sub-County is found within Nakuru County. Rongai Sub County is among the Sub-Counties in Nakuru County that has posted a low mean grade of D+ (4 points out of 12). Table 3 shows students' performance in Kenya Certificate of Secondary Education (KCSE) Physics in Sub-Counties within Nakuru County in the years 2014 to 2018.

Table 3

Students' Performance in KCSE Physics Examination in Sub-Counties within Nakuru County between 2016 and 2018

	Year		
sub	**2016**	**2017**	**2018**
Nakuru Town East	4.80	4.56	5.96
Nakuru Town West	4.89	4.33	5.91
Njoro	4.83	4.32	4.94
Molo	4.68	4.43	5.84
Gilgil	4.57	3.97	4.89
Naivasha	4.82	4.11	5.84
Kuresoi North	4.54	4.07	4.37
Kuresoi South	4.49	3.99	4.29
Rongai	4.68	3.23	3.07
Subukia	4.60	3.93	4.55
Bahati	4.91	4.57	6.04

Source: County Education Office, Nakuru

The observation made from Table 3 is that the average physics mean score for the year 2016, 2017 and 2018 in Nakuru County is less than the average mean score of six points. Rongai Sub-County recorded the lowest mean score in physics in 2017 and 2018.

In Rongai Sub-County, the experience of poor performance in physics is reflected in candidates' performance in Kenya Certificate of Secondary Education (KCSE) examination between the year 2014 and 2018. Table 4 shows students' performance in physics during the five years 2014-2018 K.C.S.E examination. Students' performance in physics is very poor as indicated in Table 3 and Table 4 which calls for urgent intervention such as the use of Advance Organizer Concept Mapping Teaching Strategy.

Table 4

Performance in KCSE Physics Examination in Rongai Sub-County between 2014 and 2018

Year	Mean score
2014	4.34
2015	4.52
2016	4.68
2017	3.23
2018	3.07

Source: Sub-County Education Office Rongai.

Use of inappropriate teaching methods has previously been mentioned as one of the major causes of students' poor performance in physics. For this reason, this study sought to find out whether the use of Advance Organizer Concept Mapping Teaching Strategy, could help curb this problem of low achievement.

An Advance Organizer is a teaching strategy used in introducing a lesson. It shows the relationship between what the students already know and the new information they are about to learn (Ausubel, 1963). It is usually presented during the beginning of the lesson and at a higher level of generality and inclusiveness than the content to be taught. Integration of new information into the existing mental structures is achieved when the new information interacts with Advance Organizers (Ausubel, 2000). According to Mayer (2003), an Advance Organizer is a device presented to the learner before learning, which can be used to organise learning and interpret new material. Novak and Canas (2008), define an Advance Organizer as a cognitive bridge which helps a learner to link new information to existing knowledge. It enables the learner to make use of relevant previous knowledge thus simplifying intricate tasks. It can be in form of metaphors, graphics or models (Ausubel, 1968).

A concept map is a graphical tool which displays relationships between concepts and ideas. Concepts are written in shapes such as circles, triangles and boxes and joined by use of arrows which split out in a descending hierarchical structure. Linking words, which are indicated in arrows, defines how concepts and ideas are related (Novak & Gowin, 1984). Complex ideas are placed at the highest level while successively simpler concepts placed at lower parts of the hierarchy. Novak and Gowin (1984), contend that concept mapping allows the learner to build on existing knowledge, by connecting new information to it, thus enhancing meaningful learning. Its effectiveness is attributed to the fact that encoding new information into existing knowledge framework requires retrieval of stored information, which reinforces knowledge retention, critical thinking and higher order thinking skills. According to Makoba (2012), Concept Mapping Teaching Strategy is among the Strategies advocated by CEMASTEA as one of the student-centred teaching strategy. Its advantage is based on the fact that meaningful learning occurs when learners integrate new information into the existing mental structures. Similarly, Novak and Gowin strongly advocates for the use of Advance Organizers in teaching and learning. They also noted that the advantage of Advance Organizers is associated with the fact that Advance Organizers promote mastery learning and meaningful learning (Novak & Gowin, 1984).Further, Eggen, Kauchak and Harder (2004), maintained that concept mapping teaching strategy should not be used in isolation. They recommended for integration of concept mapping with other instructional strategies, to make it more effective.

With regard to the immense contribution of Advance Organizers and Concept Mapping in learning, it is an area worth more research especially on the combination of two strategies. This work therefore sought to combine Advance Organizer with Concept Mapping to form one teaching strategy. This provides a superior teaching strategy compared to the use of one strategy, thus making it a more effective tool for physics instruction. Advance Organizers were used during the introduction of the lesson while Concept Mapping was used during lesson development. Combining the two strategies provided learners with a wide range of activities capable of stimulating attention consequently enhancing learning. Concept mapping activities for the learners involved; completion of partially completed maps and generation of concept maps using the provided terminologies. The strategy is therefore likely to improve achievement and motivation to learn physics by combining the benefits of advance organizers and concept mapping.

1.2 Statement of the Problem

Persistent poor performance in physics in KCSE in Kenya is disturbing and also an issue of national concern. This is because if the trend of poor performance goes on unchecked, it will hamper Kenya’s plan of achieving vision 2030. Among the factors identified as contributing to continued poor performance in physics include the use of inappropriate teaching methods. One of the governments’ initiatives to reverse the trend of poor performance of physics is through SMASSE. The SMASSE program was introduced in

Kenyan secondary schools in 2003 to conduct in-service training of science and mathematics teachers. Despite SMASSE being on for almost two decades, students' performance in physics has not shown any noticeable improvement as manifested by KCSE results. The use of Advance Organizers Concept Mapping teaching strategy (AOCMTS) may help curb this problem. AOCMTS is a strategy that combines two teaching strategies; Advance Organizers and Concept mapping, thus making it a more effective strategy in teaching physics. However, there is insufficient documented information on studies conducted in Kenya especially in Rongai Sub-County on AOCMTS. This study therefore attempts to fill this gap by investigating the effect Advance Organizer Concept Mapping Teaching Strategy on students' achievement and motivation to learn physics in Rongai Sub-County.

1.3 Purpose of the Study

The study sought to find out the effects of Advance Organizer Concept Mapping Teaching strategy on secondary school students' achievement and motivation to learn physics. This was achieved by comparing achievement and motivational gains between students taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using regular teaching methods.

1.4 Research Objectives

The following objectives guided the study:

i. To compare students' achievement in physics between students taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using Regular Teaching Methods.

ii. To compare secondary school students' motivation to learn physics between those taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using Regular Teaching Methods.

1.5 Hypotheses of the Study

The following null hypotheses were tested in the study:

Ho1: There is no statistically significant difference in students' achievement in physics between students taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using Regular Teaching Methods.

Ho2: There is no statistically significant difference in students' motivation to learn physics between students taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using Regular Teaching Methods.

1.6 Significance of the Study

The study may be of significance to students in that it may provide an improved teaching and learning strategy which may lead to better performance in physics. The AOCMTS promotes meaningful learning which may help students in using acquired skills later in life. Physics teachers may incorporate and adopt AOCMTS in teaching various topics in physics, which may lead to an improved performance in physics. The study may be beneficial to teacher educators as they may be informed of better teaching strategies that may be used in teacher training. Policy makers in the ministry of education and curriculum developers may benefit from the findings of the study in designing appropriate teaching strategies that may enhance students' achievement in physics. Findings of this study may add into existing literature on Advance Organizers Concept Mapping Teaching Strategy. This may be helpful to researchers as it may provide resourceful material for reference and address existing knowledge gap.

1.7 Scope of the Study

The study was conducted in Sub-County Public co-educational secondary schools of Rongai Sub-County. Public co-educational secondary schools were used because they had registered a mean score lower than the average score of fifty percent in the last five years. The study involved 192 form two students since 'Waves 1' is usually taught at this level. The topic of 'Waves 1' deals with oscillations accompanied by energy that travels through space. According to the Training Needs Assessment Survey Report (CEMASTEA TNA Report, 2015), the topic 'Waves' was rated by learners as the second most challenging topic after the topic of Electromagnetic Induction. Physics teachers also indicated that the topic was challenging to teach yet it is an important topic in scientific development in the field of medicine, engineering, and communication technology.

1.8 Limitations of the Study

The following were limitations of the study:

i) The use of Solomon four quasi experimental research design was a limitation because the design could not allow for Random assignment of study subjects into experimental and control groups is important because it minimises possible biases and ensures that the study groups are homogenous (De Rue, 2012). There also existed confounding and extraneous variables in the study, which the experiment did not have control over, creating the challenges of internal validity. This limited the ability of the study to conclude on the causal-effect relationship between the treatment and the outcome.

ii) Findings of the study can be generalised to other secondary schools with care. This is because the selected schools may differ from the rest of the schools because of other distinct features and factors that may impact on achievement apart from the identified variables.

1.9 Assumptions of the Study

In this study, the following assumptions were made:

i. Respondents gave independent, honest and impartial judgement and opinions.

ii. Teachers who participated in the experimental groups took the new strategy positively.

1.10 Operational Definition of Terms

Achievement: According to Allen and Delahunty (2002), achievement means to attain something especially by effort, courage or skill. In this study it refers to scores obtained by students in the physics achievement test.

Advance organizer: It is a device used to introduce a lesson and show the relationship between what the students already know and the new information they are about to learn (Ausubel, 1968). In this study, it refers to the images, pictures and information that was graphically represented.

Advance Organizer Concept Mapping Teaching Strategy: A composite strategy that involves the combination of advance organizers and concept mapping.

Concept mapping: Graphical representation of relationships between concepts and ideas hierarchically using linking words (Novak, 1998). In this study, it refers to learners' activity which includes hierarchical representation of relationships between minor and major concepts in Waves 1.

Effect: A change which is produced by an action (Hornby, 2000).In this study, the word effect refers to the change in students' achievement and motivation to learn physics after exposure to Advance Organizer Concept Mapping teaching strategy.

Gender: State of being male or female (Hornby, 2000).

Extraneous variables: These are variables which are not being studied but may influence the outcome of the study (Kothari, 2004). In this study, the extraneous variables are; teacher experience, school category and classroom environment.

Motivation: It is the force that initiates, directs and upholds goal-oriented behaviour (Hornby, 2000). In this study, it refers to motivation scores obtained by students in the students' motivation questionnaire.

Regular teaching methods: Conventional teaching methods commonly used in classroom instruction and are mainly teacher centred. Examples of conventional teaching methods include demonstration method, lecture method and class discussion method. In this study, regular teaching methods are the commonly used approaches in class. They include class discussion and lecture method.

Teacher experience: Knowledge or skills acquired over time in teaching profession after formal qualification (Allen & Delahunty, 2002). Physics teachers in the sampled schools had at least two years' experience in teaching form two physics.

Waves 1: In physics, a wave is an oscillation accompanied by transfer of energy, without transfer of matter in a medium (Hornby, 2000). The topic 'Waves' is taught in the Kenya secondary school Physics curriculum. It is a broad topic hence divided into two parts Waves I and Waves II. ‘Waves I’ is taught at form two level and it deals with electromagnetic waves, mechanical waves, progressive waves, pulses characteristics of wave motion, phase differences, speed, wavelength and frequency of waves.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on importance of physics in society, curriculum change in physics education, teaching methods used in physics, Students' achievement in physics globally, Students' achievement in physics in Kenya, motivation in teaching and learning of physics, use of Advance Organizer in physics instruction, use of Concept Mapping in physics instruction, and use of Advance Organizer Concept Mapping teaching strategy. It highlights researches that have been done on effect Advance Organizer and Concept Mapping on students' achievement and motivation to learn physics. Lastly it focuses on theoretical and conceptual framework.

2.2 Importance of Physics in the Society

Physics is a branch of science concerned with properties of matter, energy and their interactions (Chu & Lin, 2002). It attempts to describe the physical universe around us (Minishi et al., 2012). Physics is an important subject in the educational system since it is widely used in everyday life and it also generates foundational knowledge essential for technological transformations. The areas of application of physics knowledge include; communication, medical field, energy transformations among others. Earlier forms of communication such as rotary dial and the landline were developed using physics knowledge. Additionally, the much recent types of wireless communication such as mobile phones, and satellite communication are credited to physicists. Wireless communication has made communication across the globe take place very fast (Zhaoyao, 2002). Laws of optics have resulted in development of fibre optics which is widely used in optical fibre communication. It enables high speed data transmissions over longer distances and provide higher bandwidth than wire cables.

Application of physics in medicine and health care has led to improvement in the quality of life. This is attributed to invention of modern medical equipment and advancements in medical physics. For instance, machines such as x-rays, ventilators, defibrillators and incubators are among the many machines whose invention and operation is based on physics ideas (Kola, 2013). Similarly, the expertise required to execute medical procedures such as ultrasound imaging, resonance imaging, computer tomography, and laser eye surgery, requires an understanding based on physics ideas (Freeman, 2012; Liu et al., 2006). Availability of energy is vital for economic development and social progress of a nation. For example electricity. Electricity; whether geothermal, nuclear or hydroelectricity requires knowledge which is profoundly embedded in physics for transformation, transmission and dissemination (Muriithi & Ringeera, 2003). Physics therefore is an important subject in the education system. In this regard, the study of physics ought to be accorded great importance. This calls for provision of quality teaching in physics which this study maintains can be achieved by the use of AOCMTS. Advance Organize Concept Mapping Teaching Strategy helps in linking new information to previous knowledge thus aiding better understanding of concepts. It also promotes critical and creative thinking as well as enhancing high order thinking skills which is required for effective teaching and learning of physics.

2.3 Curriculum Change in Physics Education

Prior to attainment of independence, Kenya secondary schools taught the general science curriculum under the British system of education (7-4-2-3) (Ominde, 1964). The system provided seven years of primary school education, four years of lower secondary education, two years of upper secondary education and three years of university education. However, the curriculum was teacher centred and did not accommodate practical work. The main reason for teaching physics was to prepare students for higher education. In anticipation of independence, physical science syllabus was established. The syllabus laid emphasis on practical work and hence could only be implemented in schools with fully equipped laboratories. The rationale behind the introduction of physical science syllabus was preparation of skilled personnel needed to take charge of positions left by expatriates (Okere, 1996).

After Kenya acquired its independence (1963), it adopted the British system of education after making some reforms on it. Subsequently, the School Science Project (SSP) syllabus was introduced in 1966. The syllabus was practical in nature hence was implemented in schools with well-equipped laboratories. The school science project became difficult to maintain since it required expensive laboratory equipment. As a result, the syllabus was discontinued towards the end of 1970. The next science syllabus was the pure physics science syllabus which was established in early 1970s. The syllabus was also practical oriented and could only be introduced in schools with well-equipped laboratories. Pure physics syllabus, physical science syllabus, and school science project were offered simultaneously in Kenyan secondary schools between 1972 and 1984. During this period, the school science project was phased out.

The 8-4-4 system, a major structural and curricular overhaul, was launched in January 1985 following recommendations from Mackay report (Mackay, 1981). The curriculum provided eight years of primary education, four years of secondary education and four years of tertiary education. According to Amutabi (2001), the previous system of education (7-4-2-3) was, unsuitable mainly because it prepared learners for white collar jobs and could not meet the needs of the changing labour market. Thus, the 8-4-4 system was created to prepare learners for self-employment (Haan, 2001). This was done through placing emphasis on sciences, vocational and practical subjects, which would later aid self-employment in non-formal sector (Okere, 1996; Simiyu, 2001).The 8-4-4 curriculum offered both physical science and pure science syllabus. Pure science syllabus was broad, in-depth and more detailed whereas the physical science curriculum which was an option for students with less ambition for sciences, provided general knowledge.

A curriculum review on the 8-4-4 system conducted in 2000 led to the removal of physical science syllabus. Consequently, all secondary schools were required to offer pure science syllabus. The three science subjects were physics, chemistry and biology. They were compulsory in form one and two but elective in form three and four. A student could pursue at least two science subjects at form three and four. In 1999, the government conducted a needs assessment study on the 8-4-4 curriculum. The report of the study indicated that, the curriculum placed emphasis on theory work at the expense of practical skills. This necessitated the revision of the curriculum in 2002. Consequently, the curriculum revision brought changes in physics curriculum especially in teaching methods (Simiyu, 2001).

The competence based curriculum (CBC), is the latest system of education which was launched in 2017. The system brings a major paradigm shift from 8-4-4 curriculum. The CBC was formed after a critical review on 8-4-4 system indicated that the system had many shortcomings hence unsuitable. Some of the reasons that necessitated the overhaul of the 8-4-4 system included; great emphasis by 8-4-4 system on exams, and failure to cultivate creativity in students among others. The CBC structure 2-6-3-3-3 is modelled into; two years of pre-primary, six years of primary, six years of secondary and finally three years of tertiary education (Moest, 2012). Competence based curriculum is a skill-based curriculum that focusses on learner centred teaching strategies and promoting active learning through hands – on activities. Despite the change in curriculum, students' achievement in physics in KCSE remains poor. To solve this problem, it calls for the use of new pedagogical strategies such as AOCMTS.

2.4 Teaching Methods used in Physics

Effective instructional methods are necessary tools that can assist learners attain success in their studies. Among the factors that a teacher needs to consider before choosing a teaching method include:- accessibility of teaching/learning resources, nature of content, learners' previous knowledge, time and the teacher's preparedness to improvise (Bennet et al., 1996). Massey (1999), contends that use of inappropriate instructional methods is a major challenge facing science education today. Similarly, Tsuma (1998), observes that the use expository methods is predominant in Kenyan classrooms. Teaching is about cramming of concepts and reproducing them in an examination, which does not improve high order learning. This is compounded by the fact that most teachers were taught using traditional lecture method in secondary schools and they replicate the same in physics classroom (Greenfield, 2004). This often results in poor performance as the teacher often fails to meet learning objectives. The methods used to teach physics include:-lecture method, demonstration, discussion method, class experiment and project work among others.

2.4.1 Lecture Method

In lecture method, the teacher presents information verbally, visually or by use of graphics (Twoli, 2006). Lecture method assumes that the teacher is an expert and the sole source of information to the novice learner. It is a convenient method in large classes and enables a teacher to cover substantial amount of work within a short time. Newable and Cannon (2002), observes that lecture method used independently can neither foster creativity, nor stimulate the mind. One of the major constraint of lecture method as highlighted by Hansen and Stephens (2000), is that it makes learners passive listeners. Moreover, lecture method causes rote learning which does not promote development of high order thinking skills (Aikenhead & Kleeves, 1999). Similarly, the works of Bruner, Piaget and Bloom among others, fronts criticism on rote learning which is normally associated with lecture methods (Wellington, 1989). In spite of lecture method facing attack from eminent cognitive psychologists, it is still predominant in Kenyan classrooms (Hohn, 1995; Onyango, 2000).

2.4.2 Discussion Method

Teaching using discussion method involves exchange of ideas through a conversation or a debate. Discussion method promotes student participation, creates room for democratic reasoning, and improves self-reliance, cooperation and social interaction (Larson, 2000).Teamwork during discussions helps students solve problems and work out difficult tasks with ease. It also helps students to improve on problem solving abilities, communication skills and critical thinking (Okere, 1996). Discussions can either be teacher led discussions, class discussions or informal (non-directive) discussions. In teacher led discussions, the teacher provides directions to students. Teacher led discussions can be used to: introduce lesson objectives, aid in understanding of complex tasks and wind up a lesson. Just like lecture method, teacher led discussions make learners passive participants because only a few can participate at given time (Mukwa & Jowi, 1986). Class discussions are whole class instructional conversation between/among students and the teacher (Larson, 2000). They are applicable when the discussions are based on previous knowledge. In informal (non-directive) discussion, the teacher acts as a facilitator while students engage actively in generating ideas (Cheloti, 1996).The teacher can improve group discussions through: providing time limit, supervising the discussions, asking for presentations from learners and giving feedback. Despite having several benefits to the learning process, group discussions can be time consuming and learners may digress from lesson objectives if not well monitored.

2.4.3 Demonstration Method

Demonstration is a teaching method that involves the use of audio/visual illustration to communicate ideas in order to make them simpler. It is commonly used when experiments to be conducted are dangerous or complex (Okere, 1996). Cheloti (1996), notes that, teacher demonstration can be used in cases where there is inadequate teaching/learning resources or in ensuring that students follow the correct procedure. Demonstration method can be more effective if learners participate in recording observations, solving problems and predicting the outcome. A major advantage of demonstration method is that, it arouses students' interest and promotes active engagement of learners. Some of the disadvantages of demonstration method include learner's failure to follow correct procedure and passive learning especially in large classes (Shiundu & Omulando, 1992).

2.4.4 Class Experiment Method

Class experiments are activities which entail learners working together in groups on scientific process to disprove or validate a hypothesis (Etkina, 2002). Class experiments involve student's engagement through observing or manipulating real objects, collecting data, analysing data and making inferences (Rawer, 1993). During class experiments, the teacher is required to provide lesson objectives, clear instructions and time limit for each activity. After the experiments, the teacher needs to conduct discussions using the collected data. Experiments play a very important role in the cognitive development of learners. The use of experimental apparatus and equipment allow students to exercise their curiosity. Experiments also enhances scientific thinking, prevent rote learning and advance discovery of new ideas and concepts (Mang'eni et al., 2018).

2.4.5 Project Work

Project learning is the application of acquired knowledge and skills to create a scientific device/model using locally available materials (Okere, 1996). For effective use of this method, the teacher needs to provide guidance and facilitation by: designing the work plan, ensuring the project is in compliance with learning objectives, emphasizing collaboration and ensuring application of knowledge to project activities. Project learning promotes hands-on activities as well as active participation thus advancing student centred learning (Howell & Mordini, 2003). Moreover, it helps learners acquire problem solving skills, develop creativity, curiosity and self-guided learning.

2.5 Students' Achievement in Physics Globally

Underachievement in physics is not only a problem facing Kenyan education but is also a worldwide concern. For example, the United States of America (USA) is a global leader and also considered superior in several areas such as education, medical research, and entertainment. However, according to Trends in International Mathematics and Science Study (TIMSS, 2003) the USA students' achievement in physics is still below international standards. Similarly, Mupanduki (2009), indicates that students' achievement in science in the USA is declining. Further, the international studies of educational performance indicate that students' achievement in mathematics and science normally ranks near the bottom in USA (Rutherford & Ahlgren, 1991).This has forced the US government to focus on school reforms that will improve science education. In Africa, low achievement in physics is registered in Nigeria. For Instance, Research report by Adedayo (2008), revealed that, the students' achievement in physics is below the average mark of fifty percent. According to Mji and Makgato (2006), in South Africa, students' achievement in physical science in the Senior Certificate Examination has been below fifty percent. Ncube (2014), asserts that physical science is the most challenging and the worst performed subject in National Examinations of South Africa.

2.6 Differences between Teaching Methods and Teaching Strategies

A teaching method is a teaching approach used in presenting content while a teaching strategy is a well thought method used in teaching, in order to achieve the set objectives. Teaching methods can be classified into two categories that is teacher centred teaching methods and learner centred teaching methods. In teacher centred teaching methods, the teacher is the sole source of knowledge whereas learners are passive recipients of information. In learner centred teaching methods, the teacher acts as facilitator, as opposed to being the sole source of information, assisting learners in creating knowledge. Teaching strategies are well thought methods used in teaching in order to achieve the set objectives. Teaching strategies are learner centred and allow learners to be actively involved in the learning process. Teaching strategies promotes differentiated learning which caters for the diverse learner characteristics as well as fostering meaningful learning.

2.7 Students' Achievement in Physics in Kenya

Assessment of physics in Kenya is done by use of Kenya Certificate of Secondary Education (KCSE) examination, which is administered after a period of four years of study. A review of the yearly report by Kenya National Examinations council (KNEC) indicates recurrent below average achievement in KCSE physics. For instance, during the last five years, students' achievement in physics has been below average and at times physics is the worst performed among all subjects at KCSE (KNEC, 2013; KNEC, 2016).

The poor performance in physics is an issue of national concern since knowledge of physics is required for attainment of vision 2030 and achievement of Sustainable Development Goals (Republic of Kenya, 2007). Academic achievement in KCSE determines whether students will pursue college or university education. Consequently, poor performance in physics results in few students pursuing physics and courses related to physics at tertiary levels. This leads to fewer students graduating in physics leading to limited number of human resource in professions that require a background in physics. Numerous reasons have been attributed to poor performance in physics in Kenya secondary schools. For example, Meltzer (2002) observed that, laboratory inadequacy, negative attitude among students and poor instructional methods contribute profoundly to students' poor performance.

One of the government's main effort to curb the problem of poor performance in physics is through Strengthening Mathematics and Science in Secondary School Education (SMASSE). SMASSE project was introduced in 1998 and was organized by the Ministry of Education Science and Technology (MOEST) in collaboration with the Government of Japan International Co-operation Agency (JICA).The main objectives of SMASSE were to equip teachers with the capacity to adapt strategies that fosters meaningful learning and to help them upgrade their knowledge on subject content and instructional methods (SMASSE, 2004).As a result of SMASSE, there was a general improvement in physics performance in 2005 (KCSE) exam nationally. Despite the government's effort students' performance in physics has continued to fall below the average mean score of fifty percent.

Use of innovative teaching strategies can help solve the problem of low achievement in physics. An example of an innovative teaching strategy is the use of advance organizer concept mapping teaching strategy. It involves the combination of two strategies; Advance Organizer teaching strategy and Concept Mapping teaching strategy. Use of Advance Organizers enable learners to connect new information to existing knowledge. Meaningful learning takes place when learners seek to connect new information to existing knowledge. Concept mapping requires learners to be actively engaged in the learning process. This leads to knowledge construction and subsequent storage of information into the long-term memory. Combining the two teaching strategies creates a superior strategy that could cater for students' learning differences.

2.8 Teaching Methods and Students' Academic Achievement

Education Research study has indicated a strong relationship between students' academic achievement and the teaching method used by a teacher. Teaching methods can either be either be teacher-centred methods or learner-centred methods. In teacher-centred methods, the teacher is the sole source knowledge while learners are passive recipients of knowledge (Sahin, 2009). Minimal learning takes place when teacher-centred methods are used. An example of teacher-centred method is the lecture method. Some of the learner centred teaching methods include; Group discussion, Project work and experimental method.

Learner-centred teaching methods encourage long term learning and utilization of high order skills. These methods allow development of interactive skills and in-depth understanding of concepts. They also allow social interaction which enable learners to evaluate their understanding on new information. Students taught using learner centred teaching methods obtain better results compared to students taught using lecture methods (Sahin, 2009). Therefore, there is need for teachers to acquaint themselves with teaching methods that promote students' achievement. More so, teachers need to select student centred teaching methods as an alternative in teaching and learning of physics.

2.9 Motivation

The word motivation is obtained from the word motive. According to Nevid (2013), motive means desires or wants that drives an action. He further defines motivation as a force that stimulates, directs and maintains goal-directed behaviour. Motivation is also defined as description for persistent actions or a force that compels someone to work in an exceptional way (Elliot & Covington, 2001).In a classroom setup, learners motivation refers to the extent in which a learner puts effort into and directs attention to the learning process in order to achieve better results (Deci & Ryan, 2000).

2.9.1 Categories of Motivation

John Keller (1998) came up with an ARC'S model of motivational design. The model, which is made up of four categories, is used for promoting and maintaining motivation. The four categories are; Attention, Relevance, Confidence and Satisfaction (Wiener, 2010).

Attention

According to Keller (1998), attention refers to the interest exhibited by learners during the learning process. Learner's attention is achieved when the teacher manages to arouse and sustain learner's curiosity (Hattie, 2009). According to Wiener (2010), learner's attention should be captured at the beginning of the lesson. Keller (1998), also noted that for meaningful learning to take place, learners' attention must be captured and sustained throughout the lesson. He also pointed out that learners attention can be captured by use of three strategies. These three strategies are also referred to as sub-categories of attention. These are perceptual arousal, inquiry arousal and variability (Keller, 1998).

i. Perceptual arousal- it entails the use of surprise, dissonance and humour to stimulate interest and capture attention.

ii. Inquiry arousal-the teacher can nurture inquiry by allowing learners to be actively involved. The teacher can also present learners with challenging tasks and questions that generate brainstorming and critical thinking.

iii. Variability-It requires incorporation of a variety of instructional methods to retain interest (Keller, 1998).

In this study, learner's attention was captured by use of advance organizer teaching strategy during the introduction of the lesson. Advance Organizer enabled learners to relate new information with day to day experiences.

Relevance

Keller (1998), asserts that, relevance is achieved by use of examples that are well known to learners. Wiener (2010), maintains that for your learners to remain motivated throughout the lesson, they must be made to understand the relevance of the content being taught. Relevance is also created by explaining the application of learnt information in real life setting. According to Keller, the three major strategies for attaining relevance include; goal orientation, motive matching and familiarity.

i. Goal orientation- the teacher needs to explain to learners the present worth and the future usefulness of acquired knowledge.

ii. Motive matching- it calls for assessment of learners by the teacher to establish their motive for learning. This helps the teacher and to select the most suitable teaching method for the learners.

iii. Familiarity-the teacher can achieve familiarity by using examples that are related to the learners' previous knowledge and inviting role models to address learners.

Confidence

According to Hattie (2009), learners gain confidence from learning after they understand their probability of success. Motivation of learners tend to go down whenever they feel they cannot achieve the set objectives. Keller (1998), observes that confidence in learners can be built by:

i. Providing learners with learning standards and evaluation procedures.

ii. Providing varied challenging experiences that can give learners room for intellectual development.

iii. Providing learners with timely feedback on their learning progress and give advice on necessary adjustments.

iv. Allowing learners to exercise personal control over their learning process. This will make them attribute their success to personal efforts as opposed to external factors.

Concept Mapping process gave learners repeated opportunities to construct new concept maps, to fill gaps in already constructed maps and to logically organize words in constructed concept maps. Additionally, students demonstrated confidence in learning after they successfully tackled assignments and homework, given from the topic.

Satisfaction

Martin (2010), maintains that, satisfaction is achieved when learners are given opportunities to apply the acquired knowledge and skills to solve problems in day to day life. Satisfaction is also acquired when learners are provided with feedback and reinforcement on learning outcomes. According to Keller (1998), reinforcement can either be intrinsic or extrinsic;

i) Intrinsic motivation; is achieved when learners develop inbuilt enjoyment in learning without expecting any external rewards.

ii) Extrinsic motivation; requires appreciation of learners for example awarding prizes and certificates or commending learners with desired behaviour

In this study, satisfaction was achieved when the teacher provided feedback and reinforcement during learning process. The use of Concept Mapping Teaching Strategy enabled learners to work in pairs /groups which increased the degree of learner involvement. Learners also got an opportunity to discuss on learning challenges which led to a better understanding and satisfaction with the learning process.

The study will focus on intrinsic motivation because it is more sustainable and effective than extrinsic motivation (Pink, 2009). In addition Deci and Ryan (2000), indicates that, in contrast with extrinsic motivation, intrinsic motivation promotes creativity and enhances meaningful learning. They also observed that, students who are intrinsically motivated have lower anxiety levels, obtain higher achievement scores and attain higher competencies in learning than students who are not intrinsically motivated. Further, Deci and Ryan contends that teachers need to put more emphasis on intrinsic motivation since acquiring motivation from an external stimulus, can lead to a decline in motivation. Zelick (2007), outlined the four key components of intrinsic motivation. These are; curiosity, challenge, cooperation, recognition and control.

Curiosity

According to Zelick (2007), curiosity is the inherent desire for knowledge and that a curious student is interested in learning more about a subject. He also asserted that curiosity pushes students to learn for the sole pleasure of learning. Similarly Nevid (2013), asserted that students learn more efficiently and are more likely to remember the learnt content when they are curious about a subject. He added that curiosity can be enhanced by actively engaging students in the learning process. Therefore, curiosity is a key component in learning since it improves intrinsic motivation which in turn improves students learning and academic performance. In this study, curiosity was created by actively engaging students with the concept mapping process, asking students probing questions and allowing students to have autonomy over their own learning.

Challenge

According to Allen and Delahunty (2002), the word challenge means being faced with a situation that requires great mental or physical effort to be solved successfully. Zyngier (2008), asserted that learners become motivated and participate continually at optimal levels when exposed to teaching strategies that offer challenging learning experiences. He also added that challenging experiences can be created by use of diverse teaching strategies and by providing learning experiences that promote autonomy. Use AOCMTS enhanced students' autonomy by enabling students to make their own choices and take responsibility of their own learning. This was achieved by use of problem solving activities such as solving for missing links and words in provided concept maps. Learners also solved numerical problems on wave equations in pairs and in groups of three.

Cooperation

According to Hornby (2000), cooperation means the process of working together to achieve a common objective. According to Zelick (2007), student pair activities and student group activities increase the sense of belonging in students which increases their motivation to learn. The use Advance Organizer Concept Mapping Teaching Strategy provided learning experiences that required learners work together in pairs and in groups. These learning experiences were; Creation of concept maps, re-arranging parts of concept maps in a hierarchical order and filling in the missing links in already constructed concept maps.

Recognition

Martin (2010), asserts that recognition in teaching and learning involves acknowledgement and appreciation of students' efforts. The use of AOCMTS provided students with varied step by step activities that required the teacher's attention and facilitation. During the lesson, the teacher also moved around the class giving immediate feedback and recognition to learners who met the teacher's expectations. The use of AOCMTS also increased teacher-student interaction which enabled the teacher to encourage and correct misconceptions which consequently led to increased motivation.

Control

Zelick (2007), maintains that, for students to be motivated to learn, they need to be in charge of their own thinking and actions. Similarly, Zyngier (2008), noted that students can be given more control over their own learning through continuous evaluation. Advance Organizer Concept Mapping Teaching Strategy is a learner centred teaching strategy which maximised learners' opportunity to take control of their own learning. This was achieved through engaging students with learning activities. These activities included creating concept maps, filling blank spaces in constructed maps and group discussions among others.

2.9.2 The Role of the Teacher in Students' Motivation to Learn

The teaching method employed by teachers, largely affects students' motivation. For instance, Kithaka (2003), notes that, the teacher can raise students' motivation by use of interactive teaching strategies. Thus, the role of creating a motivating learning environment is entirely at the teacher's disposal.

Motivation to learn relates to the students' desire to participate in academic tasks during the learning process. It is a critical ingredient in a students' performance because it is believed to have a direct link to good achievement. Psychologists maintain that motivation is a requisite element for learning. They also believe that satisfactory students' learning cannot be realised without sufficient motivation (Biehier & Snowman, 1986). Similarly, Elliot and Dwerk (2005), maintains that motivation stands out as a fundamental contributor to great achievement in learning. They also observed that, motivation is connected to learners' tenacity and curiosity in learning. Zyngier (2008), maintains that, learners who are not motivated in academic tasks may acquire very little knowledge. This is because, motivated learners enjoy doing challenging class work and are usually ready take any risks. Thus, motivated learners are eager to apply effort and determination towards achieving their goals. Motivation in learning is necessary for learner's academic success and in the absence of motivation, learners may never apply any effort towards learning. This may adversely affect their achievement. Research study indicates that some of the classroom activities used by teachers are neither enjoyable nor interesting and that not all learners are motivated to learn. Therefore, there is need to employ more engaging strategies which will ensure that learners are highly motivated to learn. This can be achieved by embracing more effective teaching strategies that have potential to motivate learner.

The use of AOCMTS has potential to provide a structure in which a teacher can establish stimulating and motivating content. This is because the strategy is designed to capture the necessary conditions for motivation as stated by Keller; attention, relevance, confidence and satisfaction. For instance, AOCMTS can promote attention by allowing the teacher to use two various teaching strategies. Further, the strategy incorporates activities which give the learner immense opportunities for active involvement. According to Greenfield (2004), a teaching strategy can be intrinsically motivating if it presents challenging situations. This can be achieved by providing learners with new terminologies to use in generating concept maps. Similarly, learners can be presented with partially filled concept maps for them to complete.

2.10 Motivation and Students' academic Achievement

A study by Bakar (2014) noted that students learn best when they have the desire to learn. The study added that motivation increases retention and the rate of learning. Similarly, Brown (2000), observed that motivation increases the speed of learning since it provides the energy and effort required to complete a given task. Education research study has indicated that students who are motivated obtain higher achievement scores than students who are not motivated (Ryan & Deci, 2009). Similarly, Elliot and Murayama (2012), indicates that there is a positive correlation between learner's academic achievement and their levels of intrinsic motivation. This is because motivation directs learner's interest to important aspects of the lesson. Zyngier (2008), also indicates that motivated learners obtain better grades than unmotivated learners.

Motivation is a pertinent factor in teaching and learning and cannot be overlooked. This is because it influences the time and effort a student devotes to learning. Therefore, teachers need to provide learning tasks, learning environments and learning experiences that are challenging enough to motivate learners. This will improve teaching and learning and consequently improve achievement scores.

2.11 Use of Advance Organizer in Physics Instruction

Ausubel (1968), describes Advance Organizers as instructional devices used to begin a lesson and to show the relationship between incoming information and previous knowledge. This helps the students to relate what they already know to the new incoming information. This enhances retention and recollection of information. Ausubel indicates that advance organizers are used for three main functions. These are; to direct learners' attention to important aspects of the incoming lesson, to emphasize relationships among ideas to be taught and to help learners remember existing knowledge. In directing learners' attention to important aspects of the incoming lesson, advance organizer bring into working memory the existing information. The mental process of relating new information to existing knowledge requires active cognitive engagement. This enhances better understanding, retention and subsequent retrieval of learnt information.

Advance organizers emphasizes relationships among ideas by integrating visuals and texts. By using advance organizers in graphic form, students learn to visualize the main concept and ideas. Students also learn to analyse the relationship between concepts and ideas. Presenting advance organizers before introducing new knowledge builds a supportive mental framework for learning new ideas. The framework enables students to meaningfully link the new information into existing knowledge which helps the learner to remember the existing knowledge. According to Ausubel (1968), use of Advance Organizers also help students to eliminate information overload during learning. Information overload occurs when learners are presented with a large amount of information within a short time. It reduces learners' ability to process and understand information. Ausubel divided advance organizers into two main categories;

i. Comparative organizers
ii. Expository organizers

2.11.1 Comparative Organizers and Learning of Physics

Comparative organizers are learning tools used in activating prevailing schemas thus bringing into working memory relevant existing knowledge. They are presented when information to be taught is relatively familiar to the learner (Ausubel, 1968).

2.11.2 Expository Organizers and Learning of Physics

Expository organizers are used to dispense information required to comprehend new knowledge. They are used when information to be taught is new to learners thus making it more plausible (Ausubel, 1968).

2.12 Use of Concept Mapping in Physics Instruction

According to Novak (1998), a concept map is a conceptual diagram used to represent knowledge in two dimensions. Information is usually organised using circles and boxes connected by linking lines. The linking lines have wordings which specifies the relationship between concepts. Links between concepts and ideas can be linear, bilateral or directionless. Novak also indicated that concept mapping entails arrangement of concepts and ideas in a hierarchical manner starting with broad concept branching downwards to more specific concepts and ideas. Novak highlighted the four main components of a concept map. These are hierarchical structure, cross links, focus question and concepts.

Hierarchical Structure

Novak (1998), contends that the hierarchical structure is the main feature of a concept map. In a hierarchical structure, the most general concepts are located at the apex of the concept map while the less general and more specific concepts are hierarchically placed at the lower parts of the concept map. According to Novak and Canas (2008), a hierarchical structure contains labelled lines that show linkages between concepts and describe how concepts are related.

Cross Links

According to Novak (1998), Cross links are represented by lines or arrows. They often include linking words or phrases which describe the relationship between two concepts. Cross links enable learners to visualize how ideas within a domain are connected.

Focus question

According to Novak and Canas (2008), a focus question usually placed at the top most part of the map and serves the purpose of highlighting the problem or the issue to be addressed by the concept map. They also maintained that a focus question guides the learner during the mapping process and influences the type and quality of the concept map produced (Novak, 2008).

Concepts

According to Novak (1998), concepts are ideas or propositions which form the foundation of a concept map. They are usually presented in rectangular, triangular or circular shapes (Novak & Canas, 2008).Concept maps are formed when concepts are joined by cross links or linking words. Novak and Cansas (2008), went ahead to classify concept maps into three categories namely spoke graphical structure, chain graphical structure and network graphical structure.

Spoke Graphical Structure

According to Ausubel (2012), noted that spoke graphical structures are presented in circular shapes forming only one level. All minor concepts are related to the main concept which is located at the topmost part of the concept map. Novak and Canas (2008), observed that minor concepts can be added in a spoke concept map without disrupting the flow of the map. They also added that in a spoke structure there is no relationship between two or more minor concepts. Similarly, Novak (1998) described the spoke structure as a structure with the main concept placed at the centre. It is surrounded by other minor concepts related to the main concept. He added that deleting the minor concept from the map does affect the general structure of the concept map.

Chain Graphical Structure

In a chain structure, the main concept is linked to the minor concept in a sequential pattern. The structure forms a multiple listing of concepts as opposed to the hierarchical structure. Deleting one minor concept affects the subsequent minor concepts only. Addition of any concepts causes disruption in the sequence of the structure (Ausubel, 2012).

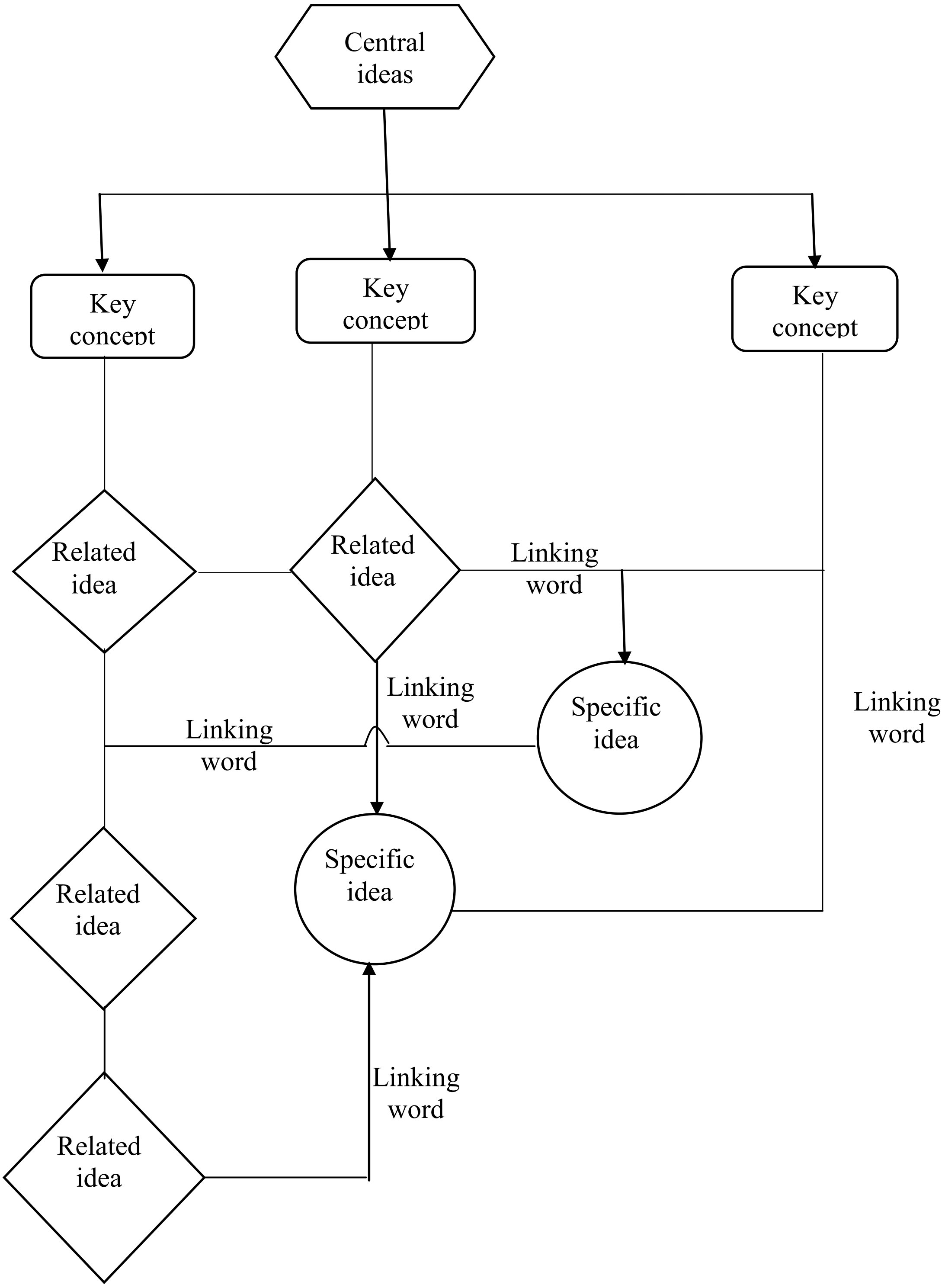
Network Graphical Structure

According to Novak and Canas (2008), it is a hierarchical structure which is highly complex and integrative. Minor concepts are not only related to the major concepts but also to other minor concepts. The minor and major concepts across different levels of the network are also structured with labelled crosslinks across the different levels. In this structure, any addition of more concepts causes minimal disruption of the map.

The idea of concept mapping can be represented by a diagram as indicated in Figure 1.

Figure 1

The idea of concept mapping



In this study network graphical structure was use in the concept mapping process. Learners were required to present learnt concepts hierarchically by use of boxes and circles.

2.13 Research on Effect of Advance Organizer Concept Mapping on Student Achievement

According to Ausubel (1968), advance organizer provides a link between new information to be learnt and the existing cognitive structure of the learner. Several studies have been conducted on Advance Organizers and Concept Mapping on student achievement. For instance, the study by Wasonga (2015), investigated the effect of concept mapping-based instruction on students' achievements in physics. Their study involved form three secondary school physics students in Nairobi County. Results of the study indicated that students in the concept mapping group participated more in class than the non-concept mapping group. In addition, students in the concept mapping group obtained a higher mean score than the group that was not exposed to concept mapping. A study by Czerniak and Haney (1998) was designed to test if the addition of concept mapping to instruction in a physical science course would improve achievement and reduce anxiety toward physical science, at the elementary school level. The results showed that concept mapping increased achievement, decreased general anxiety and decreased anxiety for learning physical science. Results did not indicate an increase in self-efficacy for teaching physical science.

Illa (2006), conducted an experimental research to find out the effects of concept mapping strategy on students' creativity in physics in Kenyan secondary school. The researcher evaluated the creativity level of form three students taught using concept mapping strategy. Findings of the study indicated that, students taught using concept mapping strategy obtained higher scores in physics creativity test than those taught using regular methods. On the basis of the findings, Illa recommended the use of concept mapping in teaching secondary school physics. This is because results of his study indicated remarkable improvement in the experimental group as compared to the control group.

Pankratius (1990), designed a study to find out the effect of concept mapping on students, achievement in physics. The study specifically set out to establish the quantity of concept mapping that would influence students' achievement in problem solving in physics. The first experimental group constructed concept maps at the inception of the unit and continued to build up on the concept maps during the subsequent lessons. The second experimental group constructed concept maps once, during the end of the unit while the control group did not construct any concept maps. Findings of the study indicated statistically significant differences in favour of experimental groups. In addition the periodic concept mapping group recorded superior performance over the group that made one concept map at the end of the unit.

Similarly, Mshenga (2013), conducted an experimental study on the effect of advance organizers on students' achievement, perception and attitude in narratives. The study involved form two secondary students of Kilifi district in Kenya. Results indicated statistically significant differences between experimental and control groups in favour of the experimental groups. Another study by Mayer (2003), on the effect of advance organizers on students' achievement involving 9th grade students established that, the group exposed to advance organizers, showed great improvement than the one that was not.

On the other hand, a study by Adlaon (2012), on effectiveness of a concept mapping instructional tool in high school biology on 10th grade students. The experimental group was taught using concept mapping while the control group was taught using traditional methods. The findings of the study indicated that, students exposed to concept mapping did not perform much better than the students in the traditional group.

Research findings by Novak and Canas (2008), indicates that concept mapping greatly facilitates comprehension of scientific knowledge. This was supported by Saouma and Attieh (2008), who demonstrated that the visual aspect of concept mapping help students recognise misconceptions, promote understanding and aids integration of new information. Similar conclusions were made by Schaal (2010), who indicated that the process of identifying relationships between bits of information aids problem based learning which in turn promote critical and creative thinking.

In this study, use AOCMTS involved the use of two strategies; advance organizers and concept maps. The researcher combined advance organizers with concept mapping thus providing a suitable and effective strategy for addressing learners' diverse learning styles along with creating a motivational learning environment. The strategy facilitated learning through visual medium hence promoting understanding of knowledge. The strategy was also designed to encourage interaction among learners by incorporating pair work, class discussions and small group activities.

2.14 Research on Effect of Advance Organizer Concept Mapping on Student Motivation to Learn

Learners' motivation is among the variables that have attracted a lot of interest in education research (Tella, 2007). Shihusa and Keraro (2009), conducted a study to investigate the effect of advance organizers on students' motivation to learn biology. Their study involved form three students of Bureti District in Kenya. Results of the study indicated that students taught using advance organizers attained a higher level of motivation than those taught using regular teaching methods. Similarly, Keraro et al. (2007), assessed the effects of co-operative concept mapping teaching strategy on secondary school students' motivation to learn biology in Gucha district. Findings of their study showed that co-operative concept mapping teaching approach increased students' motivation to learn biology.

2.15 Theoretical Framework

The study was guided by constructivist theory of learning, which advances learning by doing.

Constructivist learning focuses on student-centred form of learning where learners are actively engaged in the learning process as opposed to being passive recipients of information. (Amundson, 2003; Brott, 2005). According to constructivists, students learn best when they actively construct meaning from current/past knowledge.

Within the context of this study, learners participated actively during learning through co-creation of concept maps, building on previous information. In addition, the teacher provided learners with incomplete concept maps and guided them through filling the gaps and inserting connecting words. Learners were also actively engaged in; frequent logical organisation of concept maps, repeated construction of concept maps and identification of inter-relationships among concepts in the concept maps. The mind of learners was actively engaged through relating and organising incoming information into mental frameworks. Further, the teacher conducted lesson review using concept maps. This enabled learners to reflect on past experiences thus promoting integration of new information to existing knowledge.

According to Vygotsky (1978), learners do not understand information spontaneously but rather construct meaning from interactions between new experiences and their past knowledge. Constructivist epistemology contends that knowledge and understanding is based on learner's pre-conceived knowledge (Piaget, 1972). That is, knowledge is created from learners' past experiences. When an event takes place, learners reflect on past experiences and incorporate new information into the existing mental frameworks. Meaningful learning takes place when new ideas interact with past experiences. In this study, advance organizers enabled learners connect new knowledge to existing knowledge. This created a connection between what the learners know and the world. Frequent retrieval of existing knowledge and subsequent connection to new knowledge fostered recall and storage of information.

According to constructivists, during learning, the teacher acts as a facilitator and not as the source of knowledge. The teacher promotes self-directed learning and encourages students to be independent and autonomous (Sorden, 2005). The teacher also creates an environment that promotes knowledge creation. In this study, the teacher created an environment that allowed for group discussions. This enabled the learner to share ideas and promoted a better understanding of concepts.

The study was also based on Ausubel's theory of meaningful learning. According to Ausubel (1963), meaningful learning enables learners to relate new information to previous knowledge which serve as a framework for acquiring new knowledge. This promotes understanding and subsequent storage of information into long term memory. In view of this study, the teacher used familiar objects/devices for example the guitar, water bodies, the radio, the microwave among others to link the previous knowledge to incoming information. This assisted in the process of knowledge transformation and application to new environment thus promoting retention of knowledge and meaningful learning. In regard to motivation the study was guided by cognitive constructivism theory. According to proponents of cognitive learning theory, motivation to learn is largely intrinsic as opposed to extrinsic. This is because intrinsic motivation calls for significant re-organisation of the prevailing mental structures. They also emphasized that for learners to be motivated to learn, they need to know, understand and appreciate what is being taught (Perry, 1999).

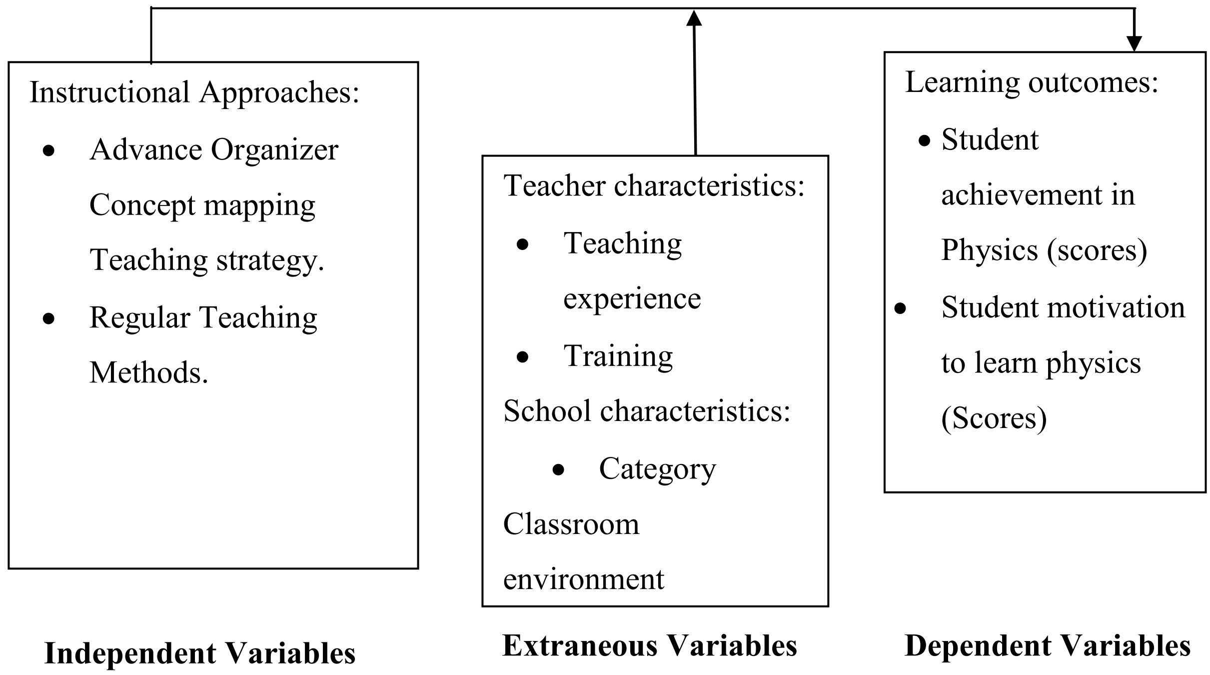
The study was also guided by self-determination theory of motivation. According to Deci and Ryan (2017), human beings have three psychological needs which must be met for them to be motivated. These psychological needs are autonomy, competence, and relatedness. Deci and Ryan (2017), defines autonomy as the ability to do something effectively. They also asserted that competence in teaching and learning is created by use of challenging learning experience. Within the context of this study, challenging learning experiences were created using open ended questions and using group discussions. With regard to relatedness, human beings possess a psychological need for connection with others. In respect to this study, learners held conversations during group discussions which helped them to connect and relate with one other.

2.16 Conceptual Framework

The conceptual framework for the study was derived from Ausubel's theory of meaningful learning. Advance organizers concept mapping was used as the intervention in teaching and learning process in the topic of Waves I. Independent variables are placed on the left, extraneous variables are placed at the centre while the dependent variables are placed on the right. Figure 1 is a diagrammatical representation of the conceptual framework for the study.

Figure 2

Interaction of variables in the Study.



The dependent variables for the study were students' achievement in physics and motivation to learn physics. The researcher tried to establish if the use of Advance Organizer Concept Mapping Teaching Strategy influenced students' achievement and motivation compared to regular teaching methods. The first extraneous variable was the teacher experience. Consequently, the researcher used teachers who had minimum experience of two years in teaching high school physics. The second extraneous variable was the teacher training. For this reason, the researcher used teachers who had bachelor's degree in secondary education. The third extraneous variable was school characteristics which was controlled by using Sub-County co-educational secondary schools with students who have comparable mean grades at point of entry. Classroom environment was also an extraneous variable. For this reason, the study was conducted in co-educational secondary schools where boys and girls learn in the same classroom.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology, location of the study, population of the study, sampling procedures and the sample size. It also gives an outline on instrumentation, data collection procedures and data analysis.

3.2 Research Design

The study used Quasi-Experimental Research using Solomon four non-equivalent control group design because it is the most rigorous design for experimental and quasi experimental research (Fraenkel & Wallen, 2000; Gall & Borg, 2006). The design was appropriate for this study because secondary school classes exist as intact groups and school authorities do not allow the classes to be reconstituted for research purposes (Shodish et al., 2002). Using the design, subjects were randomly assigned into four groups. Two of the groups were experimental groups and received the treatment while the other two groups were control groups which did not receive the treatment. One experimental and one control group received a pre-test. The post-test was administered to all the four groups. The pre-test was administrated to assess the plausibility of pre-test (sensitisation) effects, that is whether the pre-test itself had an influence on the post-test scores (Gall & Borg, 2006). The design adequately controls threats to external and internal validity, and allows the researcher to exert total control over the variables. The threats to internal validity are selection bias, history, instrumentation, maturation and regression to the mean. The research design was as shown in Figure 3.

Figure 3

Solomon Four Non-equivalent Control Group Design.

Group				
I	O_1	X	O_2	Experimental group
II	-	X	O_3	Experimental group
III	O_4	-	O_5	Control group
IV	-	-	O_6	Control group

Source: Gall and Borg (2006)

Key;

Pre-test: O_1 and O_4

Post-test: O_2, O_3, O_5 and O_6

Treatment: X

_______Dashed lines show that the experimental and the control groups have not been equated by randomisation hence non-equivalent groups.

Group I was the experimental group which received a pre-test, treatment and post-test.
Group II was not given a pre-test but received the treatment followed by post- test.
Group III was the control group which received a pre-test and post-test.
Group IV was the control group which received a post-test only.

3.3 Location of the Study

The study was conducted in Rongai Sub-County, Nakuru County, Kenya. The Sub-County was chosen due to the fact that it registers low performance in secondary school physics in KNEC examinations as already indicated in Tables 1 and 2.

3.4 Target Population and Accessible Population

There are forty five public co-educational secondary schools in Rongai Sub-County, with a population of nine thousand and seven students. Among these, four thousand six hundred and thirty nine are boys while four thousand three hundred and sixty eight are girls. The target population was all physics students in all co-educational secondary schools of Rongai Sub-county, Nakuru County, Kenya. The accessible population was form two physics students in co-educational schools within the sub-county. The population of form two students was chosen because the topic 'Waves I' is taught at this level in all Kenyan Secondary schools (Republic of Kenya, 2002).

3.5 Sampling Procedure and Sample Size

The sampling unit was co-educational secondary schools in Rongai Sub-County. The sample was drawn from forty public Sub-County co-educational secondary schools in Rongai Sub-County. Sub-County co-educational secondary schools were used because they have been performing poorly in physics. The Sub-County secondary schools attained an average mean score of D+ (4 points out of 12) in physics in the last five years. Purposive Sampling technique was used to obtain a sample of four schools. This is because the study required trained physics teachers with at least two years of experience in teaching physics, and classes with about 50 students. Form two physics classes from the four sampled schools had the following number of students; 45, 49, 50, 48 forming a sample size of 192 students. Selected schools were randomly assigned to experimental and control groups. In schools with more than one form two streams, all the streams were exposed to AOCMTS for the experimental schools. Simple random sampling was then used to pick one stream for data collection. The number of students per group was more than 30 which is suitable because experimental studies require at least 30 students per group (Mugenda & Mugenda, 2003). The sample size that participated in the study was as indicated in Table 5.

Table 5

Sample size of the Study

Group	Number students in each group
E_1	45
E_2	49
C_1	50
C_2	48
Total	192

3.6 Research Instruments

The researcher used two instruments in collecting data. These were the Physics Achievement Test (PAT) and Student Motivation Questionnaire (SMQ).PAT and SMQ were pilot-tested in two secondary schools in Rongai Sub-County, which were not part of the study but had similar characteristics to the sampled schools.

3.6.1 Physics Achievement Test

The Physics Achievement Test (PAT) items were adapted from past KNEC physics examinations questions. The items were modified in terms of the level of difficulty and length of the test items to suit form two physics students. The PAT had 18 structured questions having subsections, on the topic of 'Waves I' with a total score of 50 (See Appendix A). Each item was allocated one mark. PAT items were constructed using a table of specification consisting of the first three levels of learning; knowledge comprehension and application. This ensured that the items were proportionally distributed across the three levels of learning. The three cognitive domains of learning were obtained from Blooms Taxonomy of educational objectives (Bloom, 1985). The researcher was able to determine the effect of AOCMTS on students' achievement in physics by comparing the scores of experimental and control groups.

The PAT had 7 items testing on knowledge with a total score of 17. The Items testing on knowledge required learners to demonstrate ability to recall information and recall methods and processes. This was indicated by; questions that asked for definitions, questions that required naming and stating of examples and questions that required naming and stating of processes and methods. The items testing on comprehension were 6 which provided a total score of 15. Items testing on comprehension required learners to demonstrate the ability to grasp the meaning of content. It was indicated by questions that required the learner to translate content from one form to another, predict behaviour or patterns and explain the meaning of information. It was also indicated by questions that required description and explanation of relationships. In addition, questions that required learners to determine values through calculations also measured the comprehensive ability of learners. An example of a question in the PAT that measured the ability of learners to comprehend information was a question that required learners to predict the behaviour of waves under certain conditions. Items testing on application were 5 which had a total score of 15. Items testing on application required learners to use the learnt content in new and concrete situations. This was indicated by use of test items that required application for example questions on the working of hacksaw blade and questions on frequency modulation of a radio station.

3.6.2 Student Motivation Questionnaire

The Student Motivation Questionnaire (See Appendix E) was used to assess students' level of motivation to learn 'Waves 1'. The researcher adopted and modified the questionnaire developed by Glynn (2011). SMQ items were constructed on a five-point Likert scale. To obtain data from the Student Motivation Questionnaire, the responses to the items on the SMQ were coded as follows; strongly disagree (1), disagree (2), undecided (3), agree (4), strongly agree (5).Responses to negative items on the SMQ were reverse coded. The scores were as follows; strongly disagree (5), disagree (4), undecided (3), agree (2), strongly agree (1).For example a statement like "Sometimes I fail to concentrate during physics lessons" "strongly agree" would indicate a strong positive effect in learning of physics. The data obtained was used in assessing the learners' level of motivation when taught using Advance Organizer Concept Mapping Teaching Strategy and when taught using Regular Teaching Method.

3.6.1 Validity of the Instruments

According to Kothari (2004), validity refers to the degree to which an instrument measures what it is supposed to measure. Content and face validity of the items in the SMQ and PAT was determined by research experts from the Department of Curriculum Instruction and Educational Management, Egerton University and physics teachers who are examiners with KNEC. Comments from the experts were used to improve the instruments.

3.6.2 Reliability of the Instruments

According to Mugenda and Mugenda (1999), reliability is a measure of the degree to which an instrument yields consistent results or data after repeated trials. A pilot study was conducted in two schools from Rongai Sub-County, which were not part of the study but had similar characteristics to the sampled schools. The results from pilot testing were used to estimate the reliability of SMQ which was calculated using Cronbachs' alpha formula. The method was appropriate since the instrument was 5-Likert type items and was administered once (Mugenda & Mugenda, 2003).The Student Motivation questionnaire was adopted after the instrument yielded a reliability coefficient 0.73, which was above the required threshold of 0.70 (Mugenda & Mugenda, 2003).Reliability of the PAT was calculated using Kuder - Richardson formula (KR-21). The formula was appropriate because the questions had the same level of difficulty and each question had either a right or wrong answer. The Physics Achievement Test was adopted after the instrument yielded a reliability coefficient 0.72, which was above the required threshold of 0.70 (Mugenda & Mugenda, 2003).

3.7 Data Collection Procedures

The researcher obtained an introductory letter from graduate school of Egerton University which was used to obtain the research permit from National Commission for Science Technology and Innovation (NACOSTI). Permission was also obtained from the County Director of Education, Nakuru County and the Sub-county Director of Education, Rongai Sub-County. Thereafter, the researcher contacted principals of the selected schools and sought to be introduced to physics teachers of form two classes. Training of teachers on implementation of AOCMTS was done before the beginning of the study. The training took two days and was done using the teacher instructional manual. Group I and Group III were given a pre-test (PAT and SMQ) prior to implementation of AOCMTS. Treatment took four weeks during which the experimental groups were taught using AOCMTS, while the control groups were taught using regular teaching methods. At the end of the four weeks treatment period post-tests (PAT and SMQ) were administered to all the four groups (I, II, III and IV).

3.8 Data Analysis

Data was analysed by use of t-test, one-way ANOVA and Analysis of Covariance (ANCOVA).The t-test was used to determine if there was a significant difference between the means of students taught using AOCMTS and those taught using RTM. ANOVA was used to determine if there was a significant difference in the means of the four groups' post-test scores. Analysis of Covariance (ANCOVA) was used to cater for initial differences that may have existed among the groups. All significant tests of statistics were computed at $\alpha = 0.05$ level of significance. Data was analysed with the aid of Statistical Package for Social Sciences (SPSS). Table 6 shows a summary of statistical analyses used in the study.

Table 6

Summary of Data Analysis

Hypothesis	Independent Variable	Dependent Variable	Statistical Test
H_O: 1 There is no statistically significant difference in students' achievement in Physics between students taught using AOCMTS and those taught using RTM.	AOCMTS RTM	Achievement Scores in PAT	t-test, One-way ANOVA, ANCOVA.
H_O: 2 There is no statistically significant difference in students' motivation to learn Physics between students taught using AOCMTS and those taught using RTM.	AOCMTS RTM	Motivation Scores in SMQ	t-test, One-way ANOVA, ANCOVA.

3.9 Ethical Considerations

The researcher took full responsibility of collected data by ensuring it was kept safely and used only for research purposes. This helped in maintaining privacy and confidentiality of collected information (Mitchell & Jolley, 2007). Anonymity of the respondents was ensured by requesting the respondents to conceal their identities by writing their admission numbers on PAT and SMQ as opposed to their names. The researcher did not exaggerate, distort nor conceal research findings for individual or group gain.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter discusses and interprets analysed results of the study. The sections of discussions are organised in the following parts.

i. Pre-test analysis.
ii. Effects of AOCMTS on students' achievement physics.
iii. Effects of AOCMTS on students' motivation to learn physics.

The chapter also reviews discussions of other studies supporting or contradicting findings of this study.

4.2 Pre-test Analysis

The study employed quasi-experimental research using Solomon's four non-equivalent control group design. The design enabled the researcher to subject two groups; experimental group (E_1) and control group (C_1) to a pre-test. This was done to check the entry behaviour and establish whether the groups were similar before commencement of the study. Results are presented in Table 7.

Table 7

Independent Sample t-test on the Pre-test Score on PAT and SMQ

Test	Group	N	Mean Score	Std deviation	T-value	P-value
PAT	E_1	45	2.38	2.36	0.60	0.66
	C_1	50	2.62	2.16		0.66
SMQ	E_1	45	69.71	12.86	0.64	0.34
	C_1	50	68.48	12.46		0.34

The results in Table 7 indicate that the student mean score in PAT in E_1, (M=2.38, SD =2.36) was found to be lower than the mean score in C_1 (M=2.62, SD=2.16). Standard deviation in PAT for E_1 and C_1 were different. Students' SMQ mean scores and standard deviation for E_1 and C_1 were (M=69.71, SD=12.86) and (M=68.48, SD=12.46) respectively. Independent sample t-test was done to establish whether the differences in mean scores were statistically significant at the level of $\alpha = 0.05$.

Results in Table 7 also indicate that there was no statistically significant difference between the PAT means of experimental group (E_1) and control group (C_1);t (95) = 0.60 P>0.05. Similarly, the differences were not statistically significant when SMQ was used t (95) = 0.64 P>0.05. The data therefore shows that students in experimental and control groups had comparable abilities hence suitable for the study.

4.3 Effects of AOCMTS on Students Achievement in Physics

The first hypothesis (H_O1) sought to establish whether there was any significant difference in physics achievement between students taught using AOCMTS and those taught using RTM. An analysis of PAT post-test scores was carried out to determine the effect of AOCMTS on students' achievement in physics. The analysis compared achievement mean scores between students taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using Regular Teaching Methods. Table 8 shows a comparison of mean scores for PAT post-test scores obtained by students in the four groups.

Table 8

Post-test Scores on PAT for the four Groups

Group	N	Mean Score	Std deviation
E_1	45	21.42	5.92
E_2	49	22.57	4.74
C_1	50	17.66	5.87
C_2	48	15.33	4.18

Results in Table 8 indicate that group E_2 obtained the highest mean score of 22.57 in the PAT post-test followed by group E_1 with a mean score of 21.42. Groups C_1 and C_2, which were control groups, obtained a lower mean score of 17.66 and 15.33 respectively. Experimental groups E1 and E2 taught using AOCMTS obtained significantly higher scores than control groups C1 and C2, taught using RTM. The results indicate that the use of Advance Organizer Concept Mapping Teaching Strategy had significant effect on students' achievement in physics compared to the use of regular teaching methods.

One way ANOVA was carried out to test hypothesis (H_O1) which sought to establish whether there was any significant difference in physics achievement between students taught using AOCMTS and those taught using RTM. Results of ANOVA PAT post-test mean scores are shown in Table 9.

Table 9

ANOVA results for PAT Post-test Scores

	Sum of Squares	df	Mean Score	F	Sig
Between Groups	1410.34	3	470.11	17.21	.000
Within groups	5135.86	188	27.32		
Total	6546.20	191			

Table 9 reveals that there exists a statistically significant mean difference across the four groups, $F(3,191) = 17.21$ $P<0.05$. Thus, the null hypothesis was rejected. It was necessary to carry out a post hoc analysis using Least Significance Difference (LSD), to find out where the differences occurred within the groups. LSD was used because it is suitable for experimental research involving four groups and it also calculates the smallest significant differences between the groups (Arkkelin, 2014). Results of the LSD post hoc analysis of PAT post-test scores are presented in Table 10.

Table 10

Post -hoc Analysis of PAT Post-test Means for the Four Groups

I group	J Group	Mean differences(I-J)	p-Value
E_1	E_2	-1.15	0.28
	C_1	3.76*	0.00
	C_2	5.51*	0.00
E_2	E_1	1.15	0.28
	C_1	4.91*	0.00
	C_2	6.65*	0.00
C_1	E_1	-3.76*	0.00
	E_2	-4.91*	0.00
	C_2	1.74	0.10
C_2	E_1	-5.51*	0.00
	E_2	-6.65*	0.00
	C_1	-1.74	0.10

The results in Table 10 indicate that the differences in PAT mean scores for groups E_1 and C_1, E_1 and C_2, E_2 and C_1, and E_2 and C_2 are statistically significant at $P < 0.05$. The means for E_1

and E_2 were not statistically significant and neither were those for C_1 and C_2. On that account H_O1 was rejected, at α= 0.05 level of (significance). Findings of this study have shown that the use of AOCMTS resulted in a better achievement in physics than the use of regular teaching methods.

Further, analysis of covariance (ANCOVA) was carried out since the study was a quasi-experimental. KCPE results were used as covariates. Results on ANCOVA are presented in Table 11.

Table 11

Analysis of Covariance (ANCOVA) on PAT Post-test Scores with KCPE as Covariate

	Sum of squares	df	Mean Score	F	P-value
KCPE	762.13	1	762.13	32.59	0.00
Group	1068.66	3	356.22	15.23	0.00
Error	4373.74	187	23.39		

F=15.23 DF=3, $P<0.05$ Covariate KCPE marks=222.72

Analysis of covariance results in Table 11 indicate that there is a statistically significant difference in mean score between the control groups and the experimental groups $F(3,187) = 15.23$ $P<0.05$. It was necessary to carry out a post hoc pairwise comparisons to establish where differences occurred. Results on post hoc pairwise comparisons are presented in Table 12.

Table 12

Post-hoc Pairwise Comparison on PAT Post-test Scores

I group	J Group	Mean differences(I-J)	p-value
E_1	E_2	0.61	0.56
	C_1	4.52*	0.00
	C_2	5.50*	0.00
E_2	E_1	-0.61	0.56
	C_1	3.91*	0.00
	C_2	4.89*	0.00
C_1	E_1	-4.52*	0.00
	E_2	-3.91*	0.00
	C_2	0.99	0.32
C_2	E_1	-5.50*	0.00
	E_2	-4.89*	0.00
	C_1	-0.99	0.32

Post-hoc pairwise comparison results in Table 12 indicate that the differences in PAT mean scores for groups E_1 and C_1, E_1 and C_2, E_2 and C_1 and E_2 and C_2 are statistically significant at $P < 0.05$. However, the differences between E_1 and E_2 and C_1 and C_2 are not statistically significant. From ANOVA and ANCOVA results, the experimental groups (E_1 and E_2) performed better than the control groups (C_1 and C_2). The results revealed the following

i. There was no interaction between the PAT pre-test and the treatment. If there were any interaction, results from the pre-tested groups would have been significantly different from the non-pretested groups.

ii. The study involved two experimental groups E1 and E2 and two control groups C1 and C2. Experimental group E1 and control group C1 sat for the PAT pre-test. The difference in students' achievement in PAT between the experimental groups E1 and E2 was not statistically significant. Similarly, the difference in students' achievement in PAT between control groups C1 and C2 was not statistically significant. This implies that the pre-test did not affect the learning of physics.

iii. The use of AOCMTS in teaching the experimental groups (E1 and E2) resulted in students' high achievement in physics than the use of RTM which was used to teach the control groups (C1 and C2).This is because experimental groups E1 and E2 obtained significantly higher scores than the control groups (C1 and C2).

Therefore, the null hypothesis which stated that there is no statistically significant difference in students' achievement in physics between students taught using AOCMTS and those taught using RTM was rejected at $\alpha = 0.05$ level of significance.

Advance Organizer Concept Mapping Strategy allowed for student-centred learning which enabled learners to take active responsibility in their own learning. This took place when learners were engaged in answering questions, solving problems and group discussions. According to Zyngier (2008), learners who are engaged in learning activities are also dedicated and interested in the learning process. They also display good mastery of content and obtain higher scores than disengaged learners. Use of AOCMTS also enabled students to be engaged both physically and mentally through creation and assimilation of information, ideas and concepts. This may have resulted to the higher achievement in the experimental groups as compared to the control groups.

According to Patterson (2005) lesson review is an important aspect of learning since it results in better understanding and higher achievement in test scores. Use of AOCMTS involved expansion of previously constructed maps in every subsequent lesson. This required frequent review of previously learnt information thus giving learners opportunities to correct any misconceptions. This contributed to a better understanding of knowledge and also helped in the transfer of knowledge from short term memory to long term memory. Lesson review also helped students in remembering learnt information thus forming a concrete foundation for future learning.

The use of AOCMTS had a significant effect in learning of physics because it created an opportunity for learners to relate new information to what they already know. This enhanced the fitting of new information into larger mental frameworks and formation of new relations between already known concepts. This promoted higher order thinking skill and better understanding of concepts. This may have resulted into an improved achievement in the experimental group. Harris and Zha (2014) pointed out that when learners relate and integrate new concepts into existing knowledge it prompts retention of and storage of information into the long-term memory. This suggests that frequent mental activity of assimilating new ideas into existing knowledge could have led to a better understanding of concepts. Similarly, Novak (1998) indicates that the process of constructing and identifying interrelationships among concepts facilitates logical organisation of thoughts thus enhancing high order thinking. This promoted better performance in the experimental groups.

Improved achievement in physics portrayed by the experimental groups may also be credited to meaningful learning brought about by the use of AOCMTS teaching strategy. The

AOCMTS strategy provided learners with an opportunity to organise, connect, and relate ideas which facilitated storage of new information within their cognitive frameworks. Similarly, the increased thought process stimulated by frequent generation of concept maps may have led to better understanding of Waves I concepts. The better performance in favour of experimental groups may have also increased the level of independent and innovative thinking prompted by concept mapping. This was supported by Barchok and Ngeno (2013).

According to Novak (1998), concept mapping process promotes brain storming ability and high level thinking in learners. Therefore, the improved achievement in physics observed in the experimental groups may be attributed to the brainstorming ability brought about by use of Advance Organizes Concept mapping Teaching Strategy. Hoing (2001) postulate that brainstorming facilitates multiple thinking, creation of new linkages between concepts and ideas and expansion of knowledge. Similarly, Jarwan (2005) observed that brainstorming activities facilitates problem solving and creative thinking. It is apparent that, Advance Organizer Concept Mapping Teaching Strategy is superior to the regular teaching methods and should be used in physics teaching in secondary schools to reduce the problem of poor performance.

Findings of this study are in agreement with that of Wasonga (2015), on the Effects of Concept Mapping Based Instruction on Students' Achievement in Physics. The findings of his study showed that students taught using concept mapping performed better than those taught using regular teaching methods. Observations made from this study also concur with the findings of Kipkemoi (2019). His study was based on effect of collaborative concept mapping teaching strategy on students' attitudes towards mathematics in secondary schools in Bomet County, Kenya. In his study, the concept mapping involved group discussions. This facilitated exchange of ideas and experiences thus promoting a better understanding of concepts. This was comparable to the current study since the researcher incorporated the aspect of collaboration through group discussion. Learners worked in pairs/groups while generating and completing concept maps which facilitated sharing of information thus promoting meaningful learning. Working in pairs also enabled learners to easily identify and correct errors and misconceptions.

Results of the present study also concur with findings of the study conducted by Illa (2006), on Effects of Concept Mapping on Students' Creativity in Physics in Kenyan secondary schools. Results of his study indicated that students taught using Concept Mapping teaching strategy obtained higher scores in physics creativity test than those taught using regular teaching methods. Students were made to create their own knowledge by generating concept maps individually, in pairs and in groups of three. This may have sparked curiosity and creativity in learners thereby contributing to improved achievement in physics in the experimental groups.

Results of this study are also in agreement with findings of Schaal (2010).In his study, he investigated the cognitive and motivational effects of digital concept maps in pre-service science teacher training. Students were presented with slides of digital concepts of a specific topic. The frequency in which the students accessed the digital concept maps was noted. Results of his study indicated that the high intensity concept map users achieved significantly better than the low intensity users. Results of this study are consistent with findings of the study conducted by Omondi et al. (2018), on effects of advance organizers on students' achievement in biology in secondary schools in Kilifi County, Kenya. In their study, advance organizers presented prior to learning assisted learners in organizing and interpreting incoming information thus fostering retention of knowledge. The same applied in the present study since advance organizers presented at the beginning of the lesson helped students in connecting new information to existing knowledge. Frequent retrieval of pre-existing knowledge and connecting it to new knowledge fostered recall and storage of information into long-term memory.

Results of this study are in tandem with those of Wachanga et al. (2013). In their study, they addressed the Effects of Advance Organizer Teaching Approach on Secondary School Students' Achievement in Biology in Maara District, Kenya. Results of their study indicated that, students' who were taught using advance organizers obtained higher achievement scores in biology than those taught using traditional teaching methods. Results of this study are also in agreement with findings of Namasaka (2009), who researched on the effect of Concept and Vee Mapping Strategy (CVMTS) on Students' Achievement and Motivation to Learn Biology. His findings indicated that students' taught using CVMTS obtained higher scores in biology than those taught using traditional teaching methods. Findings of this study are also in agreement with findings of Omotade (2016), who sought to establish the effects of Advance Organizers on students' achievement in physics in secondary schools. Findings of his study indicated a statistically significant difference in achievement between experimental and control groups in favour of the control groups. Similarly, Muiruri (2016), conducted a study on the effects of Advance Organizers on secondary schools students' achievement in poetry in Nakuru North Sub-County. Results of his study indicated that Advance Organizers had positive effects on students' achievement in poetry. Findings of this study are also in harmony with those of Kapri (2017).In his findings, he established that students taught using

Advance Organizer model obtained higher scores in science achievement test than those taught using traditional methods. This shows that Advance organizer is a superior teaching strategy that enhances recall, understanding, retention and retrieval of information as well as meaningful learning.

4.4 Effects of AOCMTS on Students Motivation to Learn Physics

The second hypothesis (H_O2) sought to establish whether there was any significant difference in motivation to learn physics between students taught using AOCMTS and those taught using RTM. An analysis of SMQ post-test was carried out to determine the effect of AOCMTS on students' motivation to learn physics. The analysis compared motivational scores between students taught using Advance Organizer Concept Mapping Teaching Strategy and those taught using Regular Teaching Methods. The statements in the SMQ were quantified using a 5-point Likert scale. The values on the Likert scale were attached as follows. Strongly Agree (SA)=5, Agree(A)=4, Undecided(U)=3, Disagree(D)=2, Strongly Disagree (SD)=1. The negative statements were score in a reverse order. Table 13 shows a comparison of mean scores for SMQ post-test scores obtained by students in the four groups.

Table 13

SMQ Post-test Mean Scores for the Four Groups

Group	N	Mean Score	SD
E_1	45	106.84	14.87
E_2	49	103.61	11.87
C_1	50	72.30	8.78
C_2	48	76.19	8.01

Results in Table 13 indicate that the mean scores for SMQ in experimental groups in E_1 (106.84) and E_2 (103.61) were higher than those of control groups C_1 (72.30) and C_2 (76.19). Experimental groups E1 and E2 taught using AOCMTS obtained significantly higher scores in the SMQ than control groups C1 and C2, taught using RTM. The results indicate that the use of Advance Organizer Concept Mapping Teaching Strategy had a significant effect on students' motivation to learn physics compared to the use of regular teaching methods.

ANOVA test was carried out on SMQ mean scores to establish whether the differences were statically significant. ANOVA results on SMQ scores are presented in Table 14.

Table 14

Analysis of Variance (ANOVA) on SMQ Post-test Scores

	Sum of Squares	df	Mean Score	F	Sig
Between groups	46590.85	3	15530.28	125.38	.000
Within groups	23287.36	188	123.87		
Total	69878.20	191			

Results in Table 14 indicate that the differences in mean scores among the groups are statistically significant at $F(3,191) = 125.38$ $P<0.05$. There was need to conduct a post hoc analysis using the least significant difference (LSD) to establish where the differences occurred. Results of the LSD post hoc analysis of SMQ post-test scores are presented in Table 15.

Table 15

Post -hoc ANOVA of SMQ Post-test Means for the Four Groups

I group	J Group	Mean differences(I-J)	p-value
E_1	E_2	3.23	0.16
	C_1	34.54*	0.00
	C_2	30.66*	0.00
E_2	E_1	-3.23	0.16
	C_1	31.31*	0.00
	C_2	27.42*	0.00
C_1	E_1	-34.54*	0.00
	E_2	-31.31*	0.00
	C_2	-3.89	0.86
C_2	E_1	-30.66*	0.00
	E_2	-27.42*	0.00
	C_1	3.89	0.86

Results in Table 15 indicate that the differences in SMQ mean scores for groups E_1 and C_1, E_1 and C_2, E_2 and C_1, and E_2 and C_2 are statistically significant at $P < 0.05$. However, the mean differences for E_1 and E_2 were not statistically significant and neither were those for C_1 and C_2. Since the study involved the use of non-equivalent control group design, there was need to perform analysis of covariance (ANCOVA) to confirm the results. Kenya Certificate of Primary Education (KCPE) Science scores were used as covariates. Results on ANCOVA are presented in Table 16.

Table 16

Analysis of Covariance (ANCOVA) on SMQ Post-test Scores with KCPE Marks as Covariate

	Sum of squares	df	Mean Score	F	P-value
KCPE	4.46	1	4.46	0.04	0.85
Group	46268.99	3	15422.10	123.87	0.00
Error	23282.90	187	124.51		

F=123.87 DF=3, P<0.05 Covariate KCPE marks=222.72

Analysis of covariance (ANCOVA) results indicate that the differences in SMQ mean scores between the groups is statistically significant at $F (3, 187) = 123.87$ $P < 0.05$. Post hoc pairwise comparison was conducted to establish where the least significant differences occurred. Results of post-hoc pairwise comparison are presented in Table 17.

Table 17

Post-hoc Pairwise Comparison on SMQ Post-test Scores Based on ANCOVA

I group	J Group	Mean differences(I-J)	p-value
E_1	E_2	3.10	0.20
	C_1	34.49*	0.00
	C_2	30.66*	0.00
E_2	E_1	-3.10	0.20
	C_1	31.39*	0.00
	C_2	27.56*	0.00
C_1	E_1	-34.49*	0.00
	E_2	-31.39*	0.00
	C_2	-3.83	0.94
C_2	E_1	-30.66*	0.00
	E_2	-27.56*	0.00
	C_1	3.83	0.94

Post-hoc pairwise comparison based on ANCOVA in Table 17 indicate that there was a statistically significant difference in the following groups.

i. Group E_1 and C_1
ii. Group E_1 and C_2
iii. Group E_2 and C_1
iv. Group E_2 and C_2

However, there was no statistically significant difference between groups E_1 and E_2 and groups C_1 and C_2 ANOVA and ANCOVA results revealed the following

i. There was no interaction between the SMQ pre-test and the treatment, if there were any interaction, results from the pre-tested groups would have been significantly different from the non-pretested groups.

ii. The study involved two experimental groups E1 and E2 and two control groups C1 and C2 .Experimental group E1 and control group C1 were given the SMQ pre-test. The difference in students' motivational scores between the experimental groups E1 and E2 was not statistically significant. Similarly, the difference in students' motivational scores between control groups C1 and C2 was not statistically significant. This implies that the pre-test did not affect students' motivation to learn physics.
iii. The use of AOCMTS in teaching the experimental groups (E1 and E2) resulted in students' high achievement in physics than the use of RTM which was used to teach the control groups (C1 and C2).This is because experimental groups E1 and E2 obtained significantly higher scores than the control groups (C1 and C2).

Results from ANOVA and ANCOVA confirms that there was a statistically significant difference between SMQ means of experimental and control groups. ANOVA and ANCOVA results indicated a remarkable difference in motivational scores between control and experimental groups in favour of experimental groups. Thus, the null hypothesis which stated that there is no statistically significant difference in students' motivation to learn physics between students taught using Advance Organizer Concept Mapping Teaching Strategy (AOCMTS) and those taught using Regular Teaching Methods (RTM) was rejected at $\alpha = 0.05$ level of significance. This indicates that use of AOCMTS increased students' level of motivation to learn concepts in Waves 1 in physics. This could be attributed to the use of varying teaching strategies. Concept mapping allowed learners to use various activities which included completion of partially completed maps, generation of new concept maps and summarisation of a subtopic using developed concept maps.

According to D'souza and Masheswari (2010), the level of motivation in learners increases when the teacher is responsive and attentive to learners. The use AOCMTS provided teachers' activities that ensured increased teachers' attention and provision of immediate feedback to the students. This might have resulted in increased student motivation in the experimental group. These teachers' activities were;

i. Assisting learners in developing the concept maps, guiding them and providing feedback during the concept mapping process.
ii. Moving around the class from one group to another monitoring, supervising and marking learners' work and correcting any misconceptions.
iii. Providing opportunities for group discussion.

Results of this study concur with findings of Keraro et al. (2007). Their study investigated the effect of cooperative concept mapping teaching approach on secondary school students' motivation in biology. In their study, students were required to arrange concepts hierarchically beginning with general concepts while splitting them downwards into more specific concepts.

Identification of key concepts and establishing the interconnections amounted to active engagement which facilitated meaningful learning and increased students' motivation. The same applied in this study owing to the fact that concept mapping enabled students to make frequent meaningful connections between concepts which led to active mental engagement and consequently led to improved students' motivation in learning concepts in Waves. The engagement aspect of concept mapping helped students to persist in learning despite challenges and obstacles experienced. They also portrayed willingness to participate in the authentic learning activities thus promoting higher levels of achievement in the physics achievement test.

The results of this study are also consistent with findings by Wachanga et al. (2015). In their study on the effects of collaborative concept mapping teaching approach on secondary school students' motivation to learn biology, in Nakuru County, students taught using collaborative concept mapping teaching approach portrayed a higher level of motivation than those taught using regular teaching methods. Increased motivation in the experimental group was due to the interactive aspect of concept mapping. In the present study, AOCMTS provided an opportunity for students' to interact. This promoted motivation as it provided an environment for exchanging ideas and sharing of feedback amongst students.

Results of the present study also agrees with findings by Shihusa and Keraro (2009). In their study they assessed the effect of advance organizers on students' motivation to learn biology. Results of their study revealed that students taught using advance organizers attained a higher level of motivation than those taught using regular teaching methods. The increased level of motivation in the experimental group was due active cognitive engagement provided by advance organizers. In the present study, advance organizers facilitated active cognitive engagement through scaffolding of mental processes which enabled incorporation of more elaborate information. According to Ryan and Deci (2009), learners get motivated to learn when they engage in activities that are related to their real life experiences. Use of Advance Organizers raised learner's motivation to learn physics as it enabled them to engage in activities they could relate with their day to day experiences. These activities included production of water and sound waves using water and vibrating springs respectively.

Additionally the repeated activity of connecting concepts and establishing their relationships promoted better understanding of content in Waves 1 (physics). This is because concept mapping advanced students' thought process and stimulated reflective thinking which consequently led to increased motivation. Further, the visual aspect of concept mapping stimulated thinking and aroused interest in learning. This could have led to improved motivation in the experimental groups.

Similar work by Namasaka (2009) investigated the effect of concept and vee mapping on students' achievement and motivation to learn Biology. The study employed two different teaching strategies which were used separately during lessons. The same also applied to the present study. Two different strategies were employed during instruction i.e. advance organizers and concept mapping. However, contrary to the study mentioned above, advance organizers and concept mapping were used jointly in all lessons in the present study.

CHAPTER FIVE

SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of research findings, conclusions, implications made from the research, recommendations and suggestions on areas for further research.

5.2 Summary of Findings

Based on the objectives of the study, the following generalisations were made on physics students in Rongai Sub-County Co-educational secondary schools of Nakuru County, Kenya:

i. Students who were taught physics using Advance Organizer Concept Mapping Teaching Strategy obtained a higher achievement in physics than those taught using regular teaching methods.
ii. Students who were taught physics using Advance Organizer Concept Mapping Teaching Strategy developed a higher level of motivation to learn physics than those taught using regular teaching methods.

Therefore, Advance Organizer Concept Mapping Teaching Strategy is an effective strategy in teaching and learning of physics since it brought about a positive influence in students' achievement and motivation to learn physics.

5.3 Conclusion

Based on the findings of the study, it can be concluded that students taught using Advance Organizer Concept Mapping Teaching Strategy obtained higher achievement in physics than students taught using regular teaching methods. Students taught using Advance Organizer Concept Mapping Teaching Strategy developed higher motivation to learn physics than those taught using regular teaching methods.

5.4 Recommendations

The results of this study has indicated that the use of AOCMTS result in better performance and improved motivation to learn physics. Therefore, this study recommends that:

i. Teacher training colleges can incorporate learner centred teaching methods such as AOCMTS. This may equip teachers with effective teaching strategies capable of improving students' performance in physics.
ii. The Ministry of Education can in-service teachers on effective teaching methods for example the use of AOCMTS. This will enhance content delivery and consequently improve students' performance in physics.
iii. Physics curriculum developers and text book authors ought to consult with researchers in physics education to be informed on modern teaching strategies for instance AOCMTS. This may lead to incorporation of strategies such as AOCMTS in developing textbooks for teachers and learners which may help in curbing the current poor performance in physics.

5.4.1 Recommendations for Further Research

The study determined the effect of AOCMTS on the short term. This is because the teaching strategy was used for a period of one month and the post-test administered immediately after the intervention. There is need to determine the long-term effect of AOCMTS by conducting longitudinal study. The study focused on teaching and learning of physics. Thus, there is need to find the effect of AOCMTS on students' achievement in other subjects especially the humanities since they contribute to the learner's overall performance.

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APPENDICES

Appendix A: Physics Achievement Test (Pre-Test)

Adm. No............................... Gender…………

Time: 1 Hour 30 Minutes

Physics Form 2

Instructions

Write your admission number and your class gender in the spaces provided.

Answer all questions in the spaces provided.

1. a) Explain the meaning of the following terms

i) Progressive wave (1 mark)

ii) Frequency (1 mark)

iii) Wavelength (1 mark)

iv) Amplitude (1 mark)

b) Describe the meaning of the following terms

i) Pulse (1 mark)

ii) Oscillation (1 mark)

iii) Wave (1mark)

2 a) Define the following terms;

i) Longitudinal wave (1 mark)

ii) Transverse wave (1 mark)

b) Give one example of

i) Longitudinal wave (1 mark)

ii) Transverse wave (1 mark)

3) State one property of light which shows that light is a transverse wave. (1 mark)

4 a) Explain the meaning of the following terms

i) Electromagnetic wave (1 mark)

ii) Mechanical wave (1 mark)

b) State one example of:

i. Electromagnetic wave (1 mark)

ii. Mechanical wave (1 mark)

5) Calculate the wavelength of a wave which has a periodic time of 0.25 seconds and a velocity of 12m/s

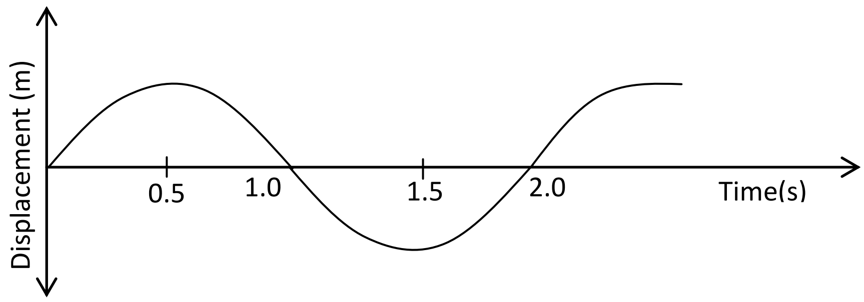
(1 mark)

6) A spring produces 30 wavelengths in every 5 seconds. Determine the;

i. Frequency (1 mark)

ii. Speed of the waves when the wavelength is 1cm. (1 mark)

7) The velocity of the wave in the diagram shown below is 0.50 m/s.



Determine the:

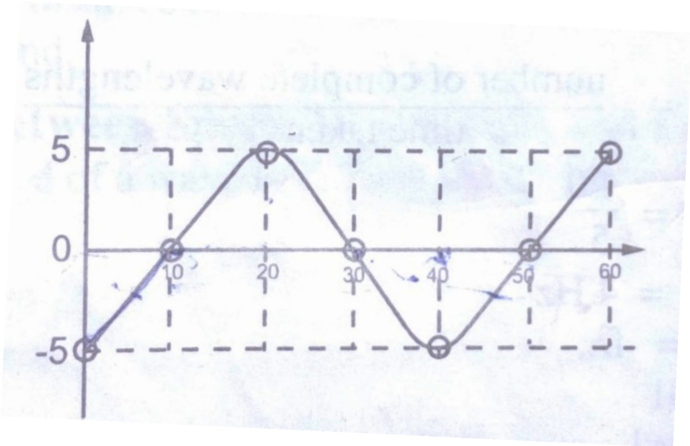
i. Periodic time (1 mark)

ii. Amplitude (1 mark)

iii. Frequency (1 mark)

iv. Wavelength (1 mark)

8) The diagram shows an illustration of a wave formed by a string. The velocity of the wave formed is 10m/s. If the scale of the drawing is in centimetres, determine the:



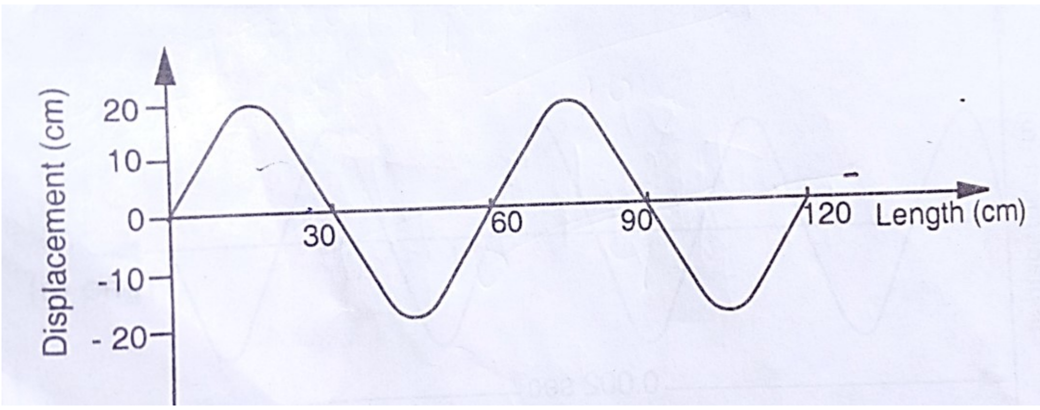
a) Amplitude (1 mark)

b) Frequency (1 mark)

c) Period of oscillation (1 mark)

9) A vibrator is casting out eight waves in one second. If the waves are 0.05m apart, determine the speed of the waves. (1 mark)

10) The figure below shows a graph of a wave formed by a slinky spring. The x-axis indicates the length in cm while the y-axis shows displacement in cm.



a) State the type of wave produced by the spring (1 mark)

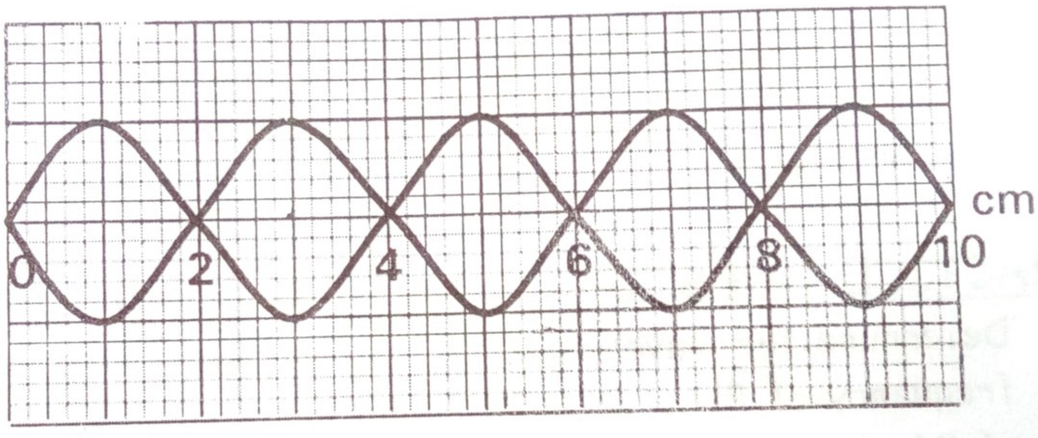
b) Determine the amplitude of the wave (1 mark)

c) Draw on the same figure a wave formed whenever:

i)The amplitude is reduced by half (1 mark)

ii) The frequency of vibration is doubled (1 mark)

11) The diagram shown below is an illustration of a wave on a string.



a) Calculate the wavelength (1 mark)

b) A radio wave has a frequency of 10Mz.If the speed of light is $3x10^8$, determine the wavelength of the wave. (1 mark)

12) A radio station broadcasts on a wavelength of 1000m and frequency of 250Khz.Find the;

i) Speed of radio waves (1 mark)

iii)The wavelength of a signal of another radio station whose frequency is 200Khz. (1 mark)

13) A straight vibrator produces water ripples on a water tank. The distance between successive troughs is 0.03m and the waves cover a distance of 0.252m in 1.25 seconds. Determine the:

a) Frequency (1 mark)

b) Wavelength (1 mark)

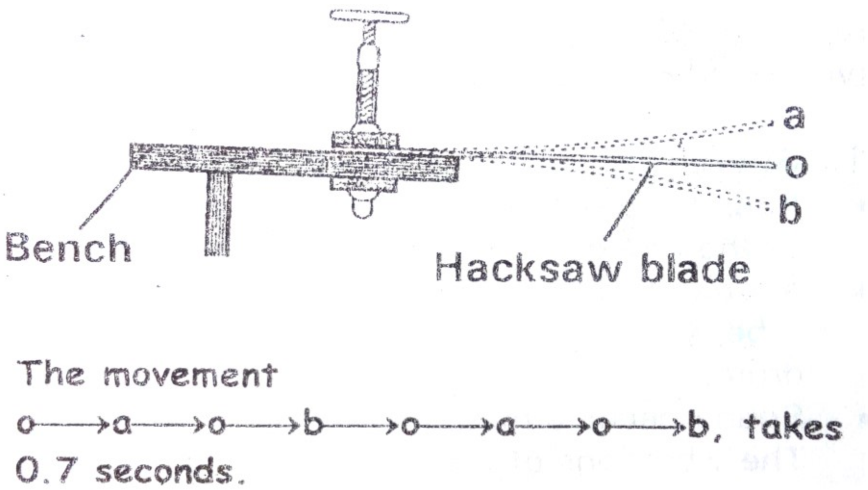
c) The wave of an earthquake moves in East-West direction while the rocks of the earths' surface vibrate in North-South direction. What type of a wave is formed? (1 mark)

14) 40 crests of a wave enters a boatyard in one minute. If one crest of the wave passes two buoys which are 12m apart in two seconds, calculate the:

a)Wavelength (1mark)

b) Frequency of the wave motion (1 mark)

15) The diagram below shows a blade of a hacksaw which is free to vibrate about the mean position.



a) Calculate the frequency of the vibration (1mark)

b) If the speed of sound in air is 330m/s determine;

i)The wavelength formed by the blade if the frequency changes to 240Hz (1mark)

ii)The frequency of the wave when the wavelength changes to 0.7m (1mark)

16). a) Write the equation relating velocity, frequency and the wavelength of a wave (1mark)

17).a) Calculate the frequency of a pendulum which makes one oscillation every two seconds (1mark)

18).a) State the difference between sound waves and light waves (1 mark)

b) The wavelength of a signal of a radio station is 1400m.If the frequency of the signal is 280 kHz, calculate;

i)The speed of the radio waves (1 mark)

ii) The frequency of another radio station broadcasting at a wavelength of 1500m.

Appendix B: Physics Achievement Test (Post-Test)

Adm. No................................ Class.................. Gender…………….

Time: 1 Hour 30 Minutes

Physics Form 2

Instructions

Write your admission number, your class and your gender in the spaces provided

Answer all questions in the spaces provided

1a) Explain the meaning of the following terms

i. Progressive wave (1 mark)

ii. Frequency (1 mark)

iii. Wavelength (1 mark)

iv. Amplitude (1 mark)

b) Describe the meaning of the following terms

i. Pulse (1 mark)

ii. Oscillation (1 mark)

iii. Wave (1mark)

2a) Define the following terms;

i. Longitudinal wave (1 mark)

ii. Transverse wave (1 mark)

b) Give an example of

i. Longitudinal wave (1 mark)

ii. Transverse wave (1 mark)

3) State one property of light which shows that light is a transverse wave. (1 mark)

4a) Explain the meaning of following terms

i. Electromagnetic wave (1 mark)

ii. Mechanical wave (1 mark)

b) Give one example of;

i. Electromagnetic wave (1 mark)

ii. Mechanical wave (1 mark)

5) Sketch a wave motion indicating two complete oscillations. (1 mark)

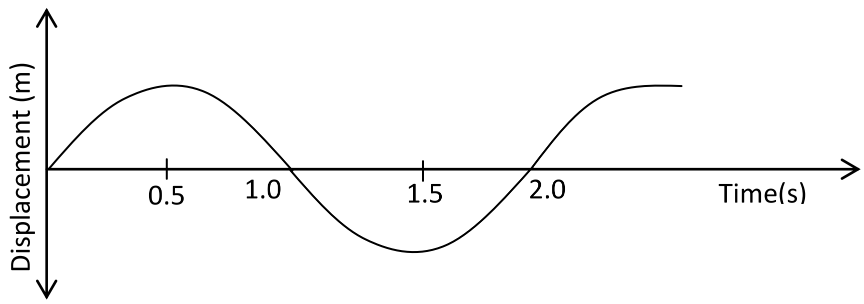
6a) Write the equation of the wave equation. (1 mark)

b) A spring produces 40 wavelengths after five seconds. Calculate;

i. The frequency (1 mark)

ii. The speed of the waves when the wavelength is 2cm (1 mark)

7) The velocity of the wave in the diagram shown below is 0.40m/s



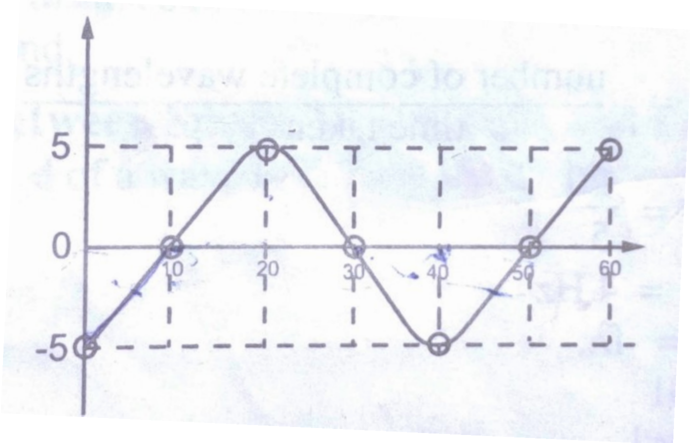
Determine the;

i. Periodic time (1 mark)

ii. Frequency (1 mark)

iii. Wavelength (1 mark)

8) The diagram shows an illustration of a wave formed by a string. The velocity of the wave formed is 10m/s. If the scale of the drawing is in centimetres, determine the:



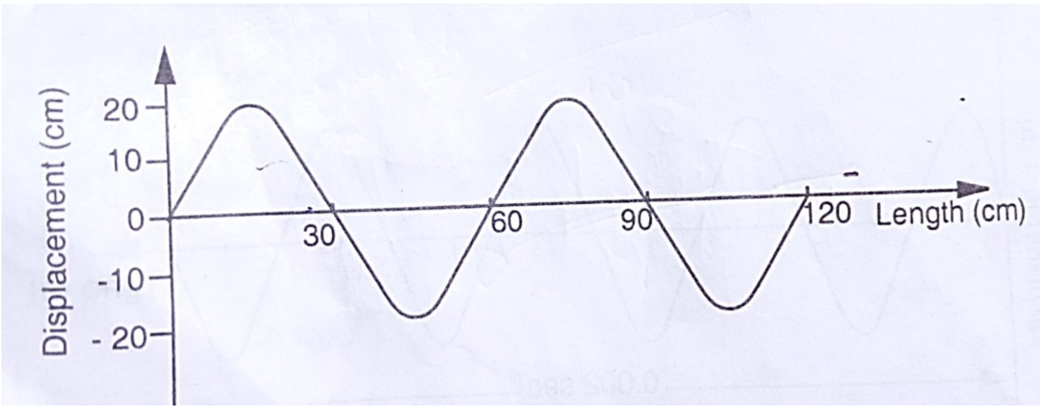
a) Amplitude (1 mark)

b) Frequency (1 mark)

c) Period of oscillation (1 mark)

9) A vibrator is casting out eight waves in one second. If the waves are 0.05m apart, determine the speed of the waves. (1 mark)

10) The figure below shows a graph of a wave formed by a slinky spring. The x-axis indicates the length in cm while the y-axis shows displacement in cm.



a) State the type of wave produced by the spring (1 mark)

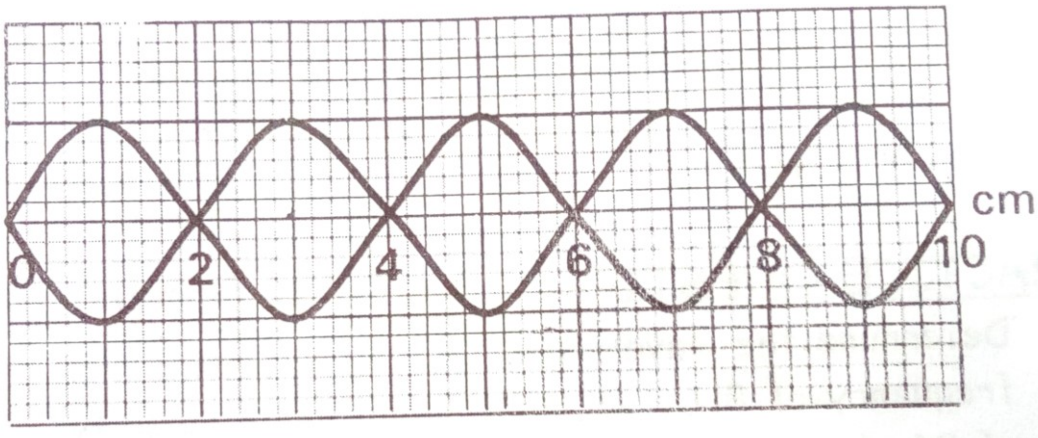
b) Determine the amplitude of the wave (1 mark)

c) Draw on the same figure a wave formed whenever:

i)The amplitude is reduced by half (1 mark)

ii) The frequency of vibration is doubled (1 mark)

11) The diagram shown below is an illustration of a wave on a string.



a) Calculate the wavelength (1 mark)

b) A radio wave has a frequency of 10Mz.If the speed of light is $3x10^8$, determine the wavelength of the wave. (1 mark)

12).A straight vibrator causes water ripples to travel across a water tank. If the waves travels 40cm in 4 seconds and the distance between successive troughs is 10cm, calculate the;

i. Velocity (1 mark)
ii. Frequency (1 mark)
iii. Wavelength of the wave (1 mark)

13).Water ripples 8cm apart are produced by a vibrator. Find;

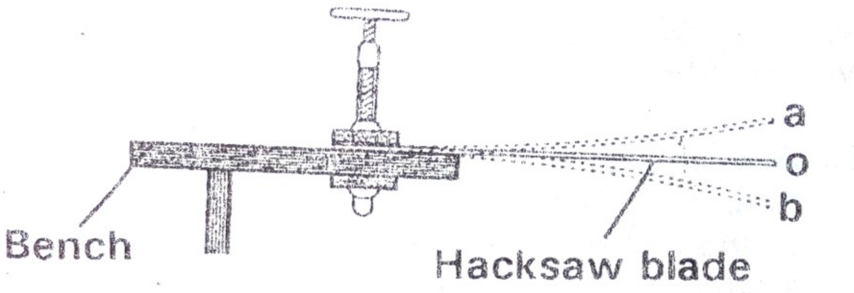
i. The velocity (1 mark)
ii. The frequency (1 mark)
iii. The wavelength of the wave (1 mark)

14).The frequency of water waves that travels 4m in 10 seconds is 20Hz.Determine;

i. The wavelength (1 mark)

ii. The speed of the water waves (1 mark)

15) The diagram below shows a blade of a hacksaw which is free to vibrate about the mean position.



The movement
o⟶a⟶o⟶b⟶o⟶a⟶o⟶b, takes 0.7 seconds.

a) Calculate the frequency of the vibration (1mark)

b) If the speed of sound in air is 330m/s determine;

i)The wavelength formed by the blade if the frequency changes to 280Hz (1mark)

ii)The frequency of the wave when the wavelength changes to 0.9m (1mark)

16) A source of frequency 300Hz is set to into vibrations. If the speed of sound in air is 330m/s calculate the wavelength of the waves produced. (1 mark)

17).a) Calculate the frequency of a pendulum which makes one oscillation every two seconds (1mark)

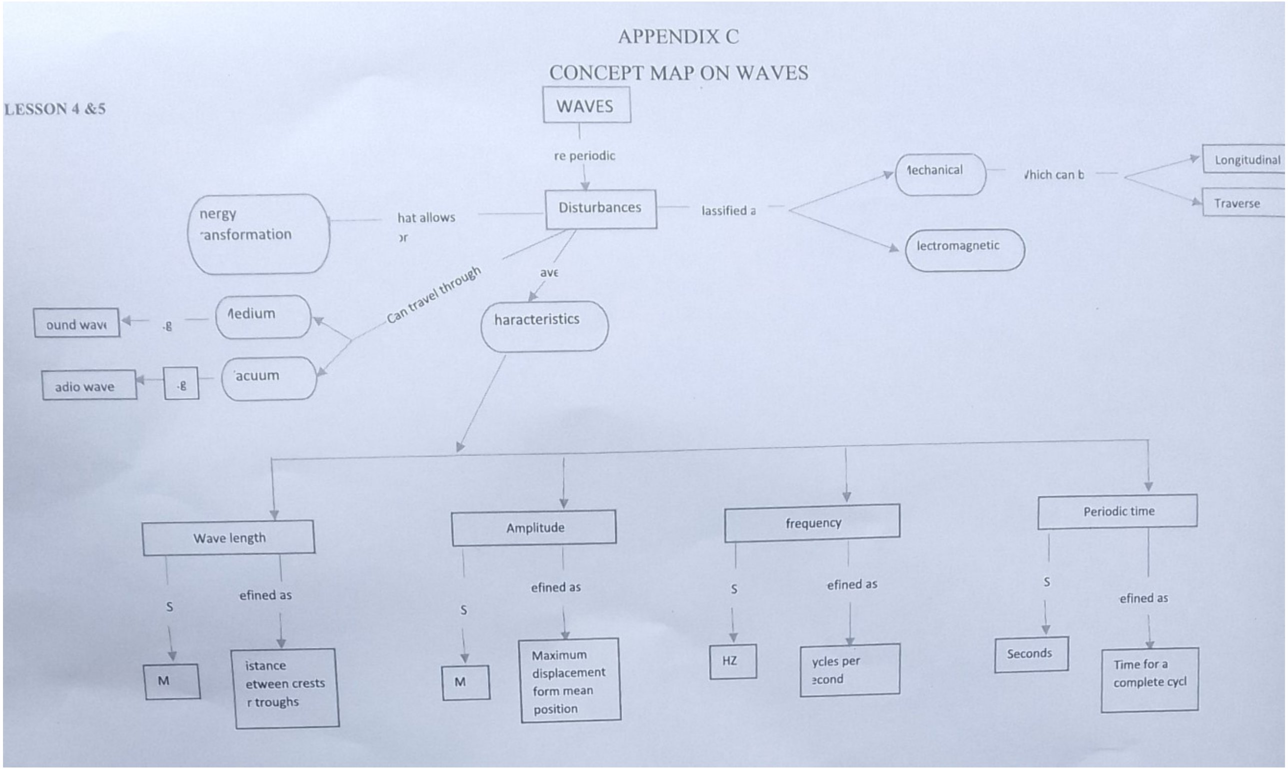
18).a) State the difference between sound waves and light waves (1 mark)

b) The wavelength of a signal of a radio station is 1400m.If the frequency of the signal is 280 Khz, calculate;

i)The speed of the radio waves (1 mark)

ii) The frequency of another radio station broadcasting at a wavelength of 1500m.

Appendix C: Concept Maps on Waves



Appendix D: Teachers' Instructional Manual

Lesson 1

Class Discussion

Topic: Waves I

Subtopic: Pulses and Waves

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

i) Define the term wave.
ii) Define mechanical wave.
iii) Define electromagnetic wave
iv) Describe the formation of waves and pulses.

Resources; stones, piece of wood bucket/basin, string/ropes and water, hand-outs.

Introduction (5 minutes)

The teacher introduces the topic using an advance organizer ***(figure1 i.e. Waves and wave*** **properties)**

- The teacher briefly describes waves and pulses.
- *The teacher sets a demonstration of waves using advance organizers (tossing a stone* in water).
- The learner states what he/she observes.
- The teacher introduces different types of waves.

Lesson Development (30 minutes)

- The teacher describes concepts on waves.
- The teacher conducts a class discussion on: -
    i. Waves
    ii. Pulses
    iii. Mechanical waves
    iv. Electromagnetic waves
- Learners take brief notes
- The teacher introduces a concept mapping.

CONCLUSION (5 minutes)

i. Teacher summarizes the lesson.
ii. The teacher issues an assignment to the learners.

LESSON 2 & 3

TOPIC: WAVES I

Subtopic: Transverse and Longitudinal Waves

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

i) Describe transverse and longitudinal waves and pulses.
ii) State examples of transverse and longitudinal waves and pulses.

Resources; slinky spring and Ropes.

Introduction (10 minutes)

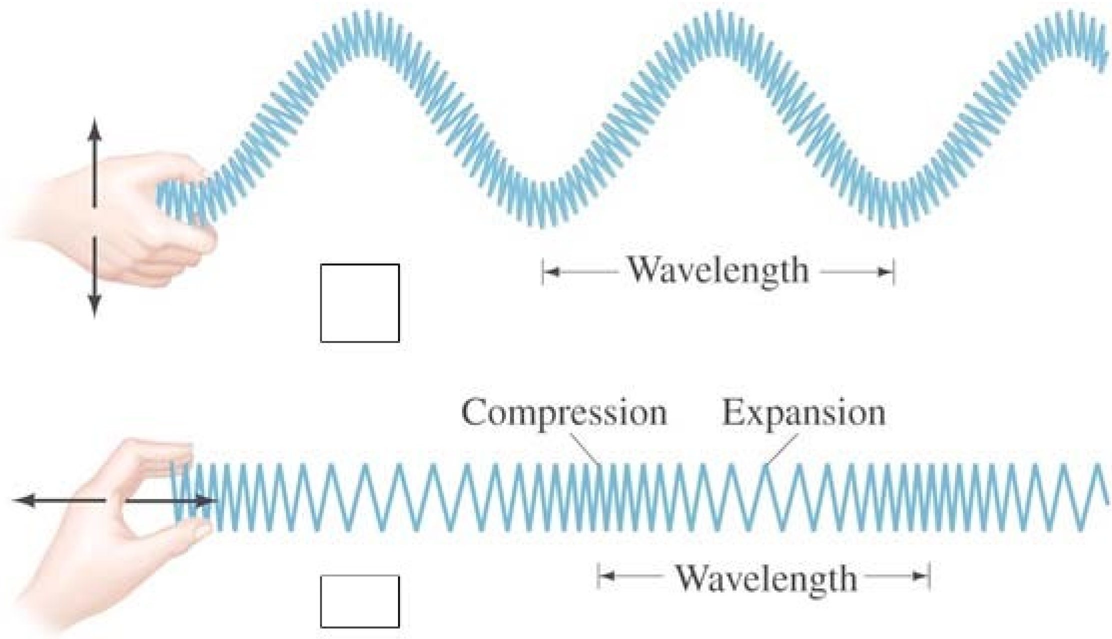
- The teacher demonstrates transverse and longitudinal waves by use of an advance organizer (slinky spring).

  Transverse wave

  To obtain a transverse wave, the teacher attaches a slinky spring between two supports on each end. The teacher stretches the spring between the supports and asks one student to pull a portion of the spring near the end upwards. Learners observes what happens.

  Longitudinal wave

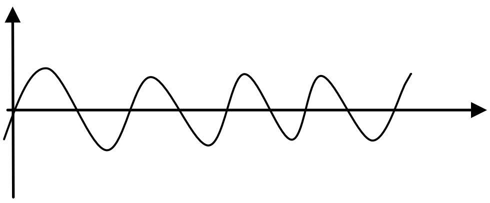
  To obtain a longitudinal wave, the teacher compresses one part of the spring. Thereafter, the spring is released to spread out. Learners notes the observation.



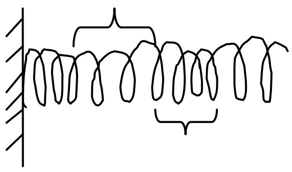
- The teacher presents figure 2 on production of waves to learners.
- The teacher asks the learners to observe the figures keenly and identify the type of wave produced.

Lesson Development (75 minutes)

- Teacher led discussion on transverse and longitudinal waves.
- The teacher draws examples of transverse and longitudinal wave.
- The teacher gives detailed explanation on transverse and longitudinal wave.



Transverse wave



Longitudinal wave

- Learners take down brief notes.

- The teacher assists the learners in developing the concept map using the additional concepts.
- Teacher gives learners the summary.

Conclusion (5 minutes)

- The teacher summarizes the sub-topic and issues an assignment.
- Teacher marks assignments before the next lesson.

LESSON 4

CLASS DISCUSSION

TOPIC: WAVES I

Subtopic: Characteristics of Waves

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

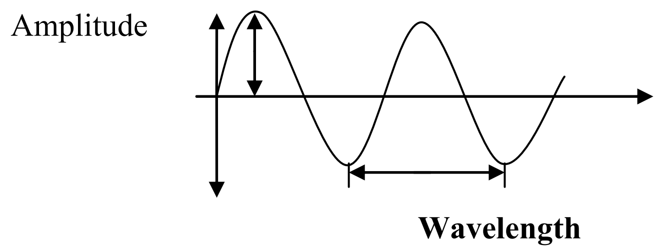
i) Define progressive wave.
ii) Define the terms: wavelength, amplitude, frequency and periodic time.
iii) State the SI units of the above terms.

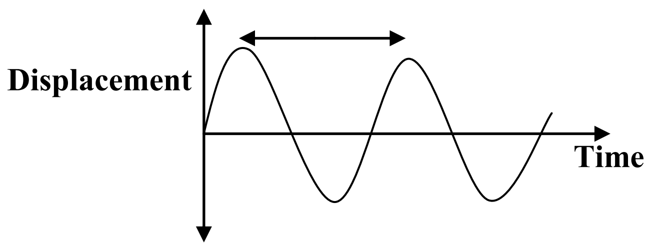
Introduction (5 minutes)

- The teacher introduces the lesson by use of an advance organizer **(hand-outs on wave characteristics i.e. figure 3).**
- The teacher provides additional terminologies to be used in expansion of the concept map.

Lesson Development (30 minutes)

- Learners are instructed to sit in pairs.
- The teacher issues one hand-outs to each pair.
- The teacher discusses the meaning of progressive waves.
- The teacher discusses the meaning of wavelength, amplitude frequency and period.





- Students constructs concept maps in pairs.

Conclusion (5 minutes)

- The teacher discusses the constructed concept map.

LESSON 5

CLASS DISCUSSION

TOPIC: WAVES I

Subtopic: Characteristics of Waves

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

i. Identify a wave of the same amplitude but different frequency.
ii. Identify a wave of the same frequency but different amplitude.

Introduction (5 minutes)

- The teacher introduces the lesson by use of an advance organizer **(hand-outs on wave characteristics ie figure 4 and 5**

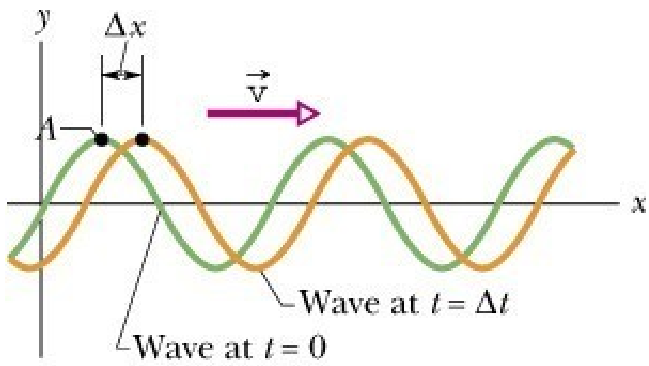
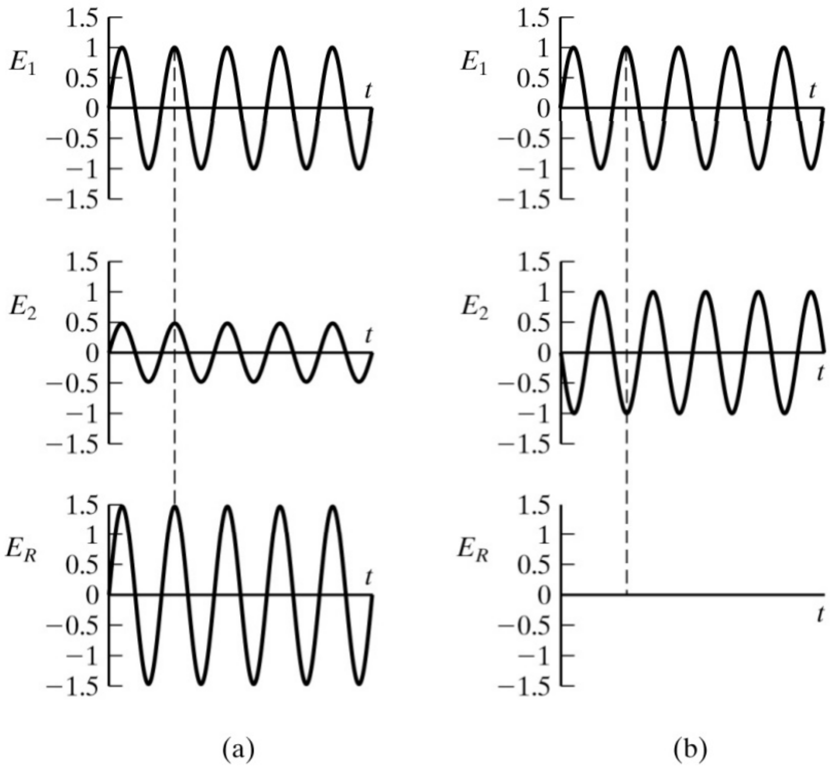


Figure 4: Waves of the same amplitude but with different frequencies



Lesson Development (25 minutes)

- The teacher instructs learners to sit in pairs.
- The teacher issues one hand-out to each pair.
- The teacher discusses the following:
    1. Waves of the same amplitude but different frequencies.
    2. Waves of the same frequency but different amplitudes.
- In the already created pairs learners develops the existing concept maps.

Conclusion (10 minutes)

- The teacher reviews the concept map developed so far.
- The teacher summarizes the sub-topic using a question.

LESSON 6 & 7

CLASS EXPERIMENT

- **TOPIC: WAVES I**

Subtopic: Characteristics of Waves

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

i. Explain the characteristics of waves

ii. Describe the characteristics of a wave motion.

iii. Draw a displacement time graph for a mass in oscillating.

Resources; 1kg mass, string retort stand.

Introduction (10minutes)

- The teacher introduces the lesson using an advance organizer.
- The teacher organizes the students in groups of four and issues the apparatus to be used in the experiment.

  Experiment to determine the characteristic of a wave motion

  Procedure
- One kilogram mass is attached to one end of the string.
- The one kilogram mass is displaced into motion by releasing it from the farthest end.

- Learners observe how the oscillations are formed.

Lesson Development (60 minutes)

- The teacher supervises students' work while moving around from group to group. The teacher also guides and provide feedback to students.

  Class Discussion

  Teacher led class discussion is conducted on the following;

  i. Characteristics of waves.

  ii. Characteristics of a wave motion.

  iii. Displacement time graph for an oscillating mass.

The teacher takes the learner through the expansion of the existing concept map

CONCLUSION (10minutes)

i. Teacher summarizes the lesson using the concept map.
ii. The teacher issues an assignment to learners

LESSON 8

CLASS DISCUSSION

TOPIC: WAVES 1

Sub Topic: Characteristics of Waves

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

- Describe a displacement time graph of a given wave.
- Describe the relationship Velocity=Frequency x Wavelength.

Introduction (5minutes)

- The teacher introduces the lesson by use of an advance organizer **(hand-outs on wave characteristics i.e. figure 6 and 7**
- The teacher states the lesson objectives to the learners.

Lesson development (30minutes)

- The teacher displays illustrations of displacement-time graph curves to learners.

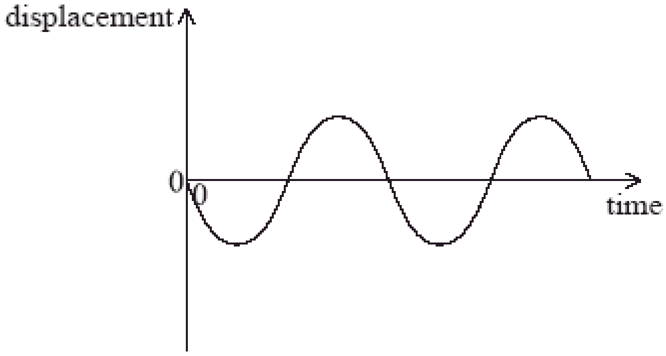
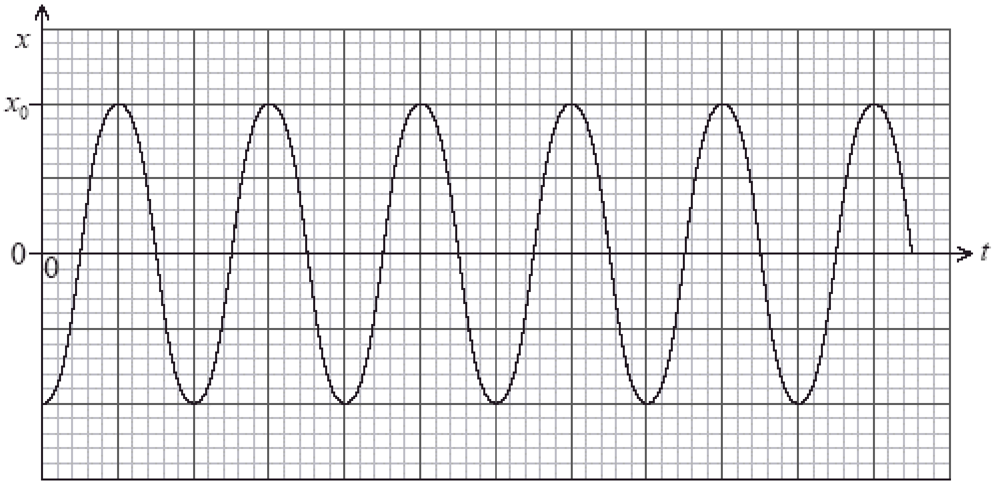


Figure 6: displacement-time graph curves

Displacement



Time

Figure 7: displacement-time graph curves

- The teacher explains the relationship between velocity frequency and wavelength
- The teacher gives examples of numerical problems on velocity, frequency and wavelength.
- The teacher issues numerical problems which learners solve in groups of three.
- The teacher leads a discussion on velocity=frequency x wavelength
- Learners expand their concept maps in the already formed groups.

Conclusion (5 minutes)

- The teacher reviews wave equation velocity=frequency x wavelength
- The teacher summarizes the lesson by commenting on the expanded concept map.

LESSON 9

CLASS DISCUSSION

TOPIC: WAVES

Sub Topic: *Relationship between speed, wavelength and frequency.*

Objective*: By the end of the lesson the learner should be able to;*

Derive he wave equation Velocity=Frequency x Wavelength.

Introduction (5minutes)

- *The teacher introduces the lesson by use of an advance organizer.*

Lesson Development (25minutes)

- *The teacher explains the concepts frequency, speed and wavelength.*
- *Leaners expands the concept maps in groups of three using new terms learnt during the lesson.*

Conclusion

- The teacher discusses the concept map and makes corrections where necessary.
- The teacher asks learners questions on velocity, frequency and wavelength.

LESSON 10 and 11

CLASS DISCUSSION

TOPIC: WAVES 1

Subtopic: Numerical Problems on V=Frequency x Wavelength

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

i. Solve numerical problems on frequency, velocity and wavelength.

Lesson Development (50minutes)

- The teacher organizes learners in groups of three.
- The teachers assigns each group three numerical questions on wave equation.

- The teacher moves around the class, marking leaners' work and assisting them in areas of difficulty.
- The teacher and reviews the developed concept map

Conclusion

- The teacher summarizes the lesson using the concept map.
- The teacher gives an assignment on numerical problems.

LESSON 12-14

CLASS DISCUSSION

TOPIC: WAVES 1

Sub topic: Physics Achievement Test and Student Motivation Questionnaire

Objectives: By the end of the lesson the learner should be able to answer all question in physics achievement test and the student motivation questionnaire.

The teacher gives learners the physics achievement test on content covered and student motivation questionnaire.

Appendix E: Student Motivation Questionnaire (Pre-Test)

Gender.............................. Adm No................Class…………….

Instructions

Students should note that this is not working test. Hence, there are no correct or wrong answers.

i. Do not indicate your name anywhere on the questionnaire.
ii. It is important that you give your honest view
iii. Read the items with care in order to understand before making your choice.
iv. Respond to all questions by putting a tick (√) inside the appropriate box.

Use the key provided below:

Key

□ **SA** - Strongly Agree.

□ **A** - Agree.

□ **D** - Disagree.

□ **SD** - Strongly Disagree.

□ **U**- Undecided.

1. I am always attentive during all physics lessons.

   □**SA** □**A** □**D** □**SD** □**U**

2. Sometimes I fail to concentrate during physics lessons.

   □**SA** □**A** □**D** □**SD** □**U**

3. Physics lessons are interesting and captivating.

   □**SA** □**A** □**D** □**SD** □**U**

4. I enjoy learning physics.

   □**SA** □**A** □**D** □**SD** □**U**

5. Physics lessons are always boring to me.

   □**SA** □**A** □**D** □**SD** □**U**

6. I am not always inspired to attend Physics lessons.

   □**SA** □**A** □**D** □**SD** □**U**

7. Physics concepts like force, heat, etc. are convincing to me.

□**SA** □**A** □**D** □**SD** □**U**

8. The concepts I learn during physics lessons are useful in answering examination questions.

□**SA** □**A** □**D** □**SD** □**U**

9. The knowledge I get in physics lessons helps me understand other physics topics.

□**SA** □**A** □**D** □**SD** □**U**

10. The progress during physics lessons is interesting to me.

□**SA** □**A** □**D** □**SD** □**U**

11. The knowledge I get during physics lessons does not help me to understand the world around me.

□**SA** □**A** □**D** □**SD** □**U**

12. The knowledge I get during physics lessons does not help me to solve problems in day to day life.

□**SA** □**A** □**D** □**SD** □**U**

13. Learning of physics concepts like force and heat is usually difficult to me.

□**SA** □**A** □**D** □**SD** □**U**

14. Learning of physics is not always useful to me.

□**SA** □**A** □**D** □**SD** □**U**

15. Sometimes I find physics knowledge to be non-educative.

□**SA** □**A** □**D** □**SD** □**U**

16. The progress during physics lessons helps me to answer teachers' questions in the physics classroom.

□**SA** □**A** □**D** □**SD** □**U**

17. I participate actively during physics lessons.

□**SA** □**A** □**D** □**SD** □**U**

18. Learning physics concepts like force and heat increases my desire to learn physics.

□**SA** □**A** □**D** □**SD** □**U**

19. In most cases, I am not able to apply physics knowledge in learning other subjects.

□**SA** □**A** □**D** □**SD** □**U**

20. I am sure that I will perform well in physics.

□**SA** □**A** □**D** □**SD** □**U**

21. I am not confident in my ability to perform well in Physics.

□**SA** □**A** □**D** □**SD** □**U**

22. The physics lessons I have attended so far have made me believe that physics is an easy subject.

□SA □A □D □SD □U

23. The physics lessons I have attended so far have made me believe that physics is a difficult subject.

□SA □A □D □SD □U

24. Activities during physics lessons are usually meaningful.

□SA □A □D □SD □U

25. I am comfortable with the way physics lessons are carried out.

□SA □A □D □SD □U

26. I am always eager to participate in class activities during physics lessons.

□SA □A □D □SD □U

27. I find most physics lessons to be boring.

□SA □A □D □SD □U

28. Physics activities always make me frustrated and unhappy.

□SA □A □D □SD □U

Appendix F: Student Motivation Questionnaire (Post-Test)

Gender............................... Adm No.................Class…………….

Instructions

Students should note that this is not working test. Hence, there are no correct or wrong answers.

i. Do not indicate your name anywhere on the questionnaire.
ii. It is important that you give your honest view
iii. Read the items with care in order to understand before making your choice.
iv. Respond to all questions by putting a tick (√) inside the appropriate box.

Use the key provided below:

Key

□ **SA** - Strongly Agree.

□ **A** - Agree.

□ **D** - Disagree.

□ **SD** - Strongly Disagree.

□ **U**- Undecided.

1. I was more alert during lessons in the topic of 'Waves' compared to lessons in other topics in physics

□SA □A □D □SD □U

2. I kept getting lost during the course of the lessons in the topic of 'Waves'.

□SA □A □D □SD □U

3. The lessons in the topic of 'Waves 'were boring to a large extent

□SA □A □D □SD □U

4. I found the lessons in the topic of 'Waves' quite interesting and exciting.

□SA □A □D □SD □U

5. It was more fun going through the lessons in the topic of 'Waves' in comparison to lessons in other topics in physics.

□SA □A □D □SD □U

6. I was quite convinced about the 'Wave' concepts I learnt during the physics Lessons.

□SA □A □D □SD □U

7. It was not really exciting to learn about the 'Waves' concepts during the course of the lessons. □**SA** □**A** □**D** □**SD** □**U**

8. I was more eager to attend the lessons in 'Waves' topic in comparison to lessons in other topics in physics

□**SA** □**A** □**D** □**SD** □**U**

9. I acquired adequate information that will help me answer questions on the concept of 'Waves'

□**SA** □**A** □**D** □**SD** □**U**

10. The knowledge I have acquired has no basis as a foundation for future learning of 'Waves' concepts

□**SA** □**A** □**D** □**SD** □**U**

11. I developed considerable doubts about the concepts of 'Waves' during the lessons.

□**SA** □**A** □**D** □**SD** □**U**

12. The procedure of the lessons in the topic 'Waves' was not captivating.

□**SA** □**A** □**D** □**SD** □**U**

13. The knowledge I have acquired during the lessons in 'Waves' topic has helped me answer many questions about nature

□**SA** □**A** □**D** □**SD** □**U**

14. The knowledge I have gained will help me solve life problems related to the concept of 'Waves' □**SA** □**A** □**D** □**SD** □**U**

15. On the whole I can confidently say that the activities during the lessons were useful to me.

□**SA** □**A** □**D** □**SD** □**U**

16. I am not quite sure I will be able to answer examination questions using the knowledge I gained during the lessons in the topic of 'Waves'.

□**SA** □**A** □**D** □**SD** □**U**

17. The knowledge I have gained during the lessons in the topic of 'Waves' has not positively influenced my attitude towards learning physics.

□**SA** □**A** □**D** □**SD** □**U**

18. I am confident I can answer a good percentage of questions based on the concept of 'Waves' in the Form 1I syllabus.

□**SA** □**A** □**D** □**SD** □**U**

19. The knowledge I have gained may not help me answer a good proportion of questions in 'Waves' in the Physics syllabus.

□**SA** □**A** □**D** □**SD** □**U**

20. The knowledge I have acquired during the lessons has positively influenced my decision to consider physics as a career subject.

□**SA** □**A** □**D** □**SD** □**U**

21. I highly doubt my ability to learn physics concepts after going through the lessons.

□**SA** □**A** □**D** □**SD** □**U**

22. Going through the lessons has made me realize that learning physics concepts is not all that difficult

□**SA** □**A** □**D** □**SD** □**U**

23. Going through the lessons has enhanced my view that physics is not a hard subject to learn.

□**SA** □**A** □**D** □**SD** □**U**

24. I was quite encouraged during the lessons to learn about the 'Waves' concepts.

□**SA** □**A** □**D** □**SD** □**U**

25. The knowledge I acquired during the lessons will have no input on my success in physics subject. □**SA** □**A** □**D** □**SD** □**U**

26. I am not satisfied with the way the lessons in the topic of 'Waves' were taught.

□**SA** □**A** □**D** □**SD** □**U**

27. I was demoralized during the progress of the lessons of 'Waves'.

□**SA** □**A** □**D** □**SD** □**U**

28. It was a wastage of time doing the activities during the lessons in the topic of 'Waves'.

□**SA** □**A** □**D** □**SD** □**U**

Appendix G: Research Permit

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
3. The Licensee shall inform the County Governor before commencement of the research.
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
5. The License does not give authority to transfer research materials.
6. NACOSTI may monitor and evaluate the licensed research project.
7. The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.
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REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH LICENSE

Serial No.A 24965

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MS. JACQUELINE NANJALA WANJALA
of EGERTON UNIVERSITY, 536-20107 NJORO,has been permitted to conduct research in *Nakuru County*

on the topic: *EFFECTS OF ADVANCE ORGANIZER CONCEPT MAPPING TEACHING STRATEGY ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND MOTIVATION TO LEARN PHYSICS IN RONGAI SUB-COUNTY, KENYA*

for the period ending:
27th May,2020

Permit No : NACOSTI/P/19/42988/29752
Date Of Issue : 28th May,2019
Fee Recieved :Ksh 1000

....
Applicant's Signature

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

Appendix H: Snapshot of Abstract of Published Paper.

Journal of Education and Practices
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EFFECTS OF ADVANCE ORGANIZER CONCEPT MAPPING TEACHING STRATEGY ON SECONDARY SCHOOL STUDENTS' MOTIVATION TO LEARN PHYSICS IN RONGAI SUB-COUNTY, KENYA

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Abstract

Physics is a science that forms an important element in the Kenyan education system. It provides essential knowledge required for technological advancement, achievement of vision 2030 and realisation of sustainable development goals (SDGs). In spite of its importance, students' motivation to learn physics in Kenyan secondary schools remains low. Among the factors attributable to students' low motivation to learn physics include; use of teacher centred teaching methods and lack of teaching/learning resources. This study sought to find out the effects of Advance Organizer Concept Mapping Teaching Strategy (AOCMTS), on secondary school students' motivation to learn physics. Solomon's Four Non-Equivalent Control Group Design was used. Two experimental groups received the AOCMTS as treatment while two control groups were taught using regular teaching methods. The study was conducted in Rongai Sub-County. Four co-educational secondary schools were purposively selected and randomly assigned to experimental and control groups respectively. Data was collected from a sample of 192 form two students. It was gathered using Student Motivation Questionnaire (SMQ) and analysed with the aid of the Statistical package for Social Science. The t-test, one-way ANOVA and ANCOVA statistical techniques were used to analyse data. The hypotheses were tested at alpha level of 0.05. Findings of the study indicate statistically significant difference in motivation to learn physics between experimental and control groups in favour of experimental groups. Use of AOCMTS resulted in higher motivation to learn physics compared to the use of regular teaching methods. The study concluded that, Advance Organizer Concept Mapping Teaching Strategy may be effective in raising students' motivation to learn physics and hence physics teachers should be encouraged to use AOCMTS.

Key words: *Advance Organizer, Concept Mapping, Motivation, Physics Education, Teaching Strategy*