UNIVERSITY OF EDUCATION, WINNEBA

EFFECTS OF ANALOGY INSTRUCTIONAL STRATEGY ON STUDENTS' PERFORMANCE IN WAVE CONCEPT

AYIWAH MARK WESONO

(7130130013)

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DECLARATION

I, Mark Wesono Ayiwah declare that **Effect of Analogy Instructional Strategy on Students' Performance on Wave Concept In Physics: A Study,** is my work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

Mark Wesono Ayiwah

Signature .... Date ....

SUPERVISORS' DECLARATION

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on the supervision of thesis as laid down by the University of Education, Winneba.

Name of Supervisor: Dr. Ishmael K. Anderson

Signature .... Date...................................

DEDICATION

I dedicate this work to my parents Mr and Mrs Ayiwah and my siblings Prudence, Irene, Patience and Jnr. Lawrence.

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I am forever grateful to the Almighty God for His abundant Grace, Favour, Mercy and Strength. I could not have completed this work without You.

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ABSTRACT

The study investigated effect of analogy instructional strategy on SHS students' performance on wave concept. The study involved one class of form two physics students in Navrongo Senior High School, selected through purposive and convenience sampling technique, totalling 52 students (12 female and 40 males). The individual teacher research strategy was adopted for the study in which the 52 students were taken through analogies. Data was collected using both qualitative and quantitative methods through pre intervention test and post intervention test items and unstructured interview. The students wrote a pre intervention test after which the analogies were used to teach the lesson. The students then wrote a similar test as a post intervention test. A change or otherwise in their performance was ascertained through gain analysis adopted from Richard Hake (1998). Responses obtained from the questionnaire and notes recorded during the observation schedule were also compiled and analysed. The findings from the average normalised gain of the post and pre intervention test scores showed a gain of 0.66, indicating that an effectiveness of the analogy lessons in enhancing performance. A dependent sample t-test conducted showed that there was a significant difference in the pre intervention test and post intervention test score, $p = 0.000$ ($\alpha = 0.05$). The findings further revealed that the students perceive the analogy instructional strategy to be very effective since it enhanced their performance. The study recommends the use of analogy instructional strategy in physics lessons at the SHS level.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background of the study, statement of the problem and purpose of the study. The structure of the chapter also includes the objectives, research questions and significance of the study as well as the delimitation that was identified. This chapter ends with the organization of the study.

1.1 Background of the Study

Physics is a fundamental science which is concerned with the basic principles of the universe and therefore its objective is limited to a number of fundamental laws that govern natural phenomena (Serway & Jewett, 2004). According to Serway and Jewett (2004), physics use these laws to develop theories that can predict the results of future experiments and that these laws are expressed in the language of mathematics. However, Physics is considered to be in crisis not only Ghana but globally. The cause of this is identified as the fall in number of students taking Physical sciences especially Physics and Chemistry, because while the numbers taking Physics and or Chemistry are falling at higher levels of education, numbers taking Biology are much higher and fairly steady (Taale, 2010). Physics is widely recognized to be the most fundamental of all the sciences and has also been recognized as the foundation of our society (Pravica, 2005), and indispensable in many professions and for economic development (Stokking, 2000). Taale (2011) also emphasized that, of all the sciences, physics is at the heart of the technology driving the world economy and is present in almost every facet of modern life. Physics as one of the core science subjects is peculiar having been identified by experts as abstract or difficult in nature and demanding high quantitative aptitude in explicating most of its principles and concepts (Bassock, 1990; Franz, 1983; NERDC, 1994; Ogunsola-Bandele, 2001; Okoronka, 2004; Toews, 1988). According to Ogunsola-Bandele (2001) and Toews (1988), most high school and college students recoil from physics because they feel it contains too many facts or technical terms to learn, the textbooks are too difficult to read and has the reputation as an applied mathematics course. These might have resulted in decreased enrolments in physics at a time when our society desperately needs scientifically literate citizens.

According to Dean (1980), the concept of wave is one of fundamental and important topics in physics however students appear to lack the understanding of the fundamental ideas because it has more conceptual contents than it is usually accorded in teaching schemes. Okoronka (2004) also emphasized that, any instructional intervention must be directed to address this trend and should help the learner in making meaning and creating understanding of the various 'tagged' difficult concepts. One of such instructional intervention is the use of analogies as instructional strategy to address the trend of students' difficulties in understanding of wave concept.

Analogies use are common in science teaching, and more so in physics. This is because of the many abstract concepts that physics embodies. Analogies are teaching tools that compare structures of two domains by indicating the similarities of the parts of the structures (Duit, 1991). Everyday use of the term analogy includes metaphors, models and to some extent examples, though there are important differences between these terms.

Many studies have been done on the use of analogies in teaching science concepts worldwide however, only a few of these studies are done in Africa, most of which are in the area of biology (Lagoke, Jegede & Oyebanji, 1997).

According to a study conducted by US Embassy in 2012 suggested that the current high school curriculum in Ghana puts emphasis on science subjects and yet students' performance in the science subjects in national examinations has been consistently poor over the years (United States Embassy, 2012). Students, parents and other stakeholders in education yearn for good grades in physics as a subject for further education and other physics related occupation. Entry into science related courses in the higher institutions require a grade of C6 or better. This is likely to put pressure on the students as well as the teachers to produce such results. It is perceived that a successful teacher in Ghana is one who produces better results by having many students do well in WASSCE and one who has many students joining higher institutions. This teacher is even more recognized and respected by having many of his/her students join the "best" courses at the universities. At present, the "best courses" are science related. This is because with qualification in any of these courses, one is almost certain of getting a job.

Selection of subjects to take for WASSCE is done in SHS two. The Ghanaian system requires a student to have passes in at least three elective subjects of any combination of biology, physics, chemistry and or mathematics. This makes the selection of any of the subjects to be based on a student's high chances of making the required grade for tertiary level. This therefore invites to explore best teaching strategies in physics that can help raise the understanding and performance of wave concept so as to influence the choice of selection of physics as a first option for students. However, how the subject is taught and learned may inform a student's choice of selecting it or otherwise for their final examination, hence, a need for a detailed study of one of the important teaching strategies in physics; use of analogy on the grounds that better teaching will attract many students to select the subject.

1.2 The Problem Statement

Students turn to perceive physics as a difficult subject due to some abstract nature of some topics, in particular the concept of waves. This perception must be eliminated through the introduction of some better teaching strategies. The focus of this study is the use of analogy instructional strategy to help students have better knowledge of concept of wave.

1.3 Purpose of the Study

The purpose of the study was to explore modern instructional strategies in physics that can help raise the academic performance of students in physics. The purpose of the study was to determine the effects of analogy instructional strategy on students' performance of wave concepts.

1.4 Objectives

The objectives of the study were to determine

1. The knowledge students have about concept of wave before the instructional strategy.
2. The knowledge students have about concept of wave after the instructional strategy.
3. The perception of students about the use of analogy instructional strategy.

1.5 Significance of the Study

The findings of the analogies instructional strategy are hoped to contribute to the study and learning of physics in Senior High Schools if used in the following ways;

1. High school teachers will enhance the teaching of wave concept by making teaching more practicable as possible by relating to the study to students environment.

2. The research will create a source of awareness for physics teachers in High schools and the ministry of education on the use of analogy instructional strategy to enhance the teaching and learning of physics. This will ensure that there are enough physics talents in the society to provide solutions for improvement.

1.6 Research Questions

In order to ascertain the effect of analogy instructional strategy on students' performance of wave concept in the selected Senior High School, the following questions were addressed in the study:

1. What is the knowledge students have about the concept of wave before the use of analogy instructional strategy?

2. What is the knowledge students have about the concept of wave after the use of analogy instructional strategy?

3. What is the perception of students about the use of analogy instructional strategy?

1.7 Scope

There are several factors that impede student's academic performance in physics but the study was confined to the analogy instructional strategy to enhance wave concepts in senior high schools. The conditions in the school including teacher qualification and the availability of teaching and learning materials, conditions such as student motivation which include social support, pressuring students to study hard, monitoring their progress in school, giving them that sense of belongings and socio-economic status of parents, the structure of the family were not part of the study.

1.8 Delimitation

The study was delimited to Navrongo Senior High School in Upper East Region because the researcher happens to be the subject teacher for the class and he used the intact class for the study. The research could not be extended beyond the confines of the school and for consideration of suitable sample only form two classes was used for the study.

1.9 Limitations

A broader survey of the study would have clarified to a large extent the effectiveness of Analogy Instructional Strategy on students' performance of wave concepts. Time and cost constraints prevented the extension of the study to other institutions. Therefore, the results of the study would be strictly applicable to the elective science students in Navrongo Senior High school.

1.10 Organization of the Study

The research work is organized in five chapters; the first chapter is the introductory chapter which gives an account of the background of the study, the statement of the problem and purpose of the study. The chapter also includes the research hypothesis raised, delimitation and limitations.

The second chapter is made up of review of literature on the topic under study while chapter three describes the methods and techniques used to collect and analyze data. The forth chapter is about presentation and discussions about findings. Chapter five which is the final chapter is made up of summary, conclusions and recommendations to use analogies instructional strategies to enhance wave concepts in senior high schools

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter reviews relevant literature on students' performance in wave concept using traditional and analogy strategies of instructions. It highlights the effects of analogies instructional strategy on students' understanding of wave concepts. It also considers some methods of instructions especially for the delivery of physics lessons. The review explores analogical learning and problems teachers and students face during the teaching and learning of wave concept in physics and initiatives to improve the study of wave concept in physics.

2.1 Meaningful Science Learning

Anderson and Thompson (1989) described meaningful learning as the process of integrating new knowledge with existing knowledge. They observed that the process is complex and results from the interaction of key cognitive processes, such as forming images, organizing, and drawing analogies. According to them, the interaction of these processes leads to the construction of conceptual relations.

According to Glynn, Yeany and Britton (1991), students learn concepts meaningfully when they learn concepts relationally, not by rote. Therefore, students are expected to learn science concepts as organized networks of related information and not as lists of facts. Science teachers often realize this, but are not sure how to facilitate relational learning in their students, particularly when the number of students in a class is large and the concepts are complex (Glynn, Yeany & Britton, 1991). Glynn and colleagues were of the view that many of these concepts are introduced to children in the elementary school years and that by high school, all students are expected to be scientifically literate in order to understand these complex concepts. Therefore, science teachers at all levels play a critical role in ensuring that students have a meaningful and a relational understanding of fundamental science concepts. Teachers need powerful instructional strategies to be successful in this role.

2.2 Students' Difficulties in the Study of Wave Physics

From Wittman (1995) investigation, it was found that many students have profound and meaningful difficulties with fundamental ideas and concepts. This is found not just of wave physics but of the general ideas and approaches of physics, often taken for granted in physics instruction yet students must learn in the classrooms. For example, many students might not be able to have fundamental ideas about the meaning of a disturbance to the equilibrium state of a system. According to Hults (1980), many students are unable to adequately describe the concept of linear superposition, having great difficulty in considering many different points at once and also the mathematics which describes wave propagation causes trouble for students. This implies that students use misinterpretations of mathematics to guide their reasoning about the physics. The results of Physics Education Research Group (PERG) and University of Maryland (UMd) are specific to the investigation of wave physics, but the manner in which students are unable to build a coherent and functional understanding of the physics may cause problems for their study of physics in many other subjects (Wittman, 1995).

2.3 Students Perception of Physics

According to Taale (2011), one of the most continual problems in learning physics is the perceived difficulty encountered by students when solving physics problems which persists due to students' lack of proper and effective methods to tackle these problems. Most topics in physics such as mechanics, optics, electricity and several others involve problems which can be solved simply and effectively using proper problem solving methods. The Competent Problems' Solver and Understanding Basic Mechanics are examples of proper problem solving methods (Taale, 2011).

According to Chief Examiners' Report on West African School Certificate Examination (WASSCE) Physics Examination (2012-2014) conducted by West Africa Examination council (WAEC), physics is gradually phasing out and if care is not taken, it will be very difficult to get adequate and competent teachers to effectively handle the subject. It appears there is a high negative impression that physics is too difficult and as such few students are pursuing it at various levels of academic discipline.

Taale (2011) further observed that the perception of Physics to be difficult is due to lack of proper problem solving strategies. Specifically, most of the candidates who took WASSCE physics Exams for that period had problems in data analysis in terms of drawing graphs to illustrate given physical phenomena; definitions and explanations of physics concepts; not being able to distinguish between the 'situation' in which certain physical phenomena occur and the 'uses' of such phenomena; and weak mathematical background.

2.4 Students' performance in Physics

Performance of students in physics, for example in Ghana has generally and consistently been poor over the years. Relevant data collected on SHS students' achievement in biology, chemistry, physics and mathematics from 1993 to 2007 for PRACTICAL project showed an abysmal performance in physics (Anamuah-Mensah, 2007). More so, performance statistics by West Africa Examination Council (WAEC) from 2007 to 2014 show that majority of the physics candidates did perform poorly and could not qualify for admission to tertiary education.

The WAEC (2014) reported that quite a number of candidates could not solve mathematical-related problems accurately. The WAEC (2014) also painted a very gloomy picture of students' performance in physics: One was even tempted to conclude that the standard of the paper was lower than the previous. However the performance of candidates did not lend to support this assertion. The performance could be described as woefully marginal. Only few candidates could show a good knowledge of the subject and could also apply the principles. Candidates' answers showed lack of understanding of the principles of the subject. (p. 104). The WAEC (2013) report stated that poor knowledge of subject matter, inadequate preparation and poor labelling of schematic diagrams were some of the weaknesses that adversely affected candidates' performance.

Buabeng, Ossei-Anto and Ampiah (2014) also observed that over the years, students' achievement in physics has prompted educational researchers to continuously make relentless efforts at identifying mitigating factors that might account for the observed poor performance. Some research studies suggest that factors inside and outside the classroom affect students' achievement and interest. (Orleans, 2007 ; Buabeng, Ossei-Anto & Ampiah, 2014)

Wambugu and Changeiywo (2008) states that teaching methods are crucial factors that affect the academic achievement of students, and no matter how well-developed and comprehensive a curriculum is, its success is dependent on the quality of the teachers implementing it (Ajaja, 2009; Ughamadu, 2005). In the attempt to help improve upon the teaching and learning of the sciences, the Ghanaian government in 1987, implemented an educational reform nationwide with the aim of providing a system of education that will serve the needs of the individual, the community and the country as a whole (Tuffour, 1989). Tuffour (1989) reported that though there were some challenges after almost a period of time, Ministry of Education (MOE) and Ghana Education Service (GES) made a considerable success in recruiting teachers for all the schools, the supply of inputs namely science syllabi, textbooks and laboratory kits, the effect of orientation for teachers and the general interest of teachers in the programme.

Similarly, the government of Ghana in 1995, through the Ministry of Education (MOE) and Ghana Education Service (GES) further established Science Resource Centres (SRCs) in 110 SHS spread throughout the country to help bridge the gap between schools with well resourced science laboratories both human and material resources. This project was initiated to ensure equity in students' learning across the rural-urban divide (Ministry of Education, 2012). The SRCs were equipped with basic science equipment including modern electronic devices and computers to be used in the teaching and learning of science, including physics, and thereby improving students' performance (Ampiah, 2004). Despite these projects and implementations, WAEC (2014) report shows that the performance of students in the science with physics in particularly, has not been any better as indicated earlier. It is not clear where the responsibility lies as little is known about physics teaching in the SHS. It would be interesting, therefore, to investigate whether some effective teaching strategies such as Analogy could affect positive performance of students in physics of SHS.

2.5 The Meaning of Analogy

Nashon (2000) described the meaning of analogy as explaining new concepts using similar known and familiar concepts constitutes an analogy. The new concepts are the unfamiliar topics or ideas and the known concepts are the familiar topics or ideas (Nashon, 2000). Therefore, the use of familiar ideas, models, situations and maps to explain the unfamiliar constitutes an analogy as well (Duit, 1991; Treagust & Duit, 1992). The familiar concepts are called analogues or bases and the unfamiliar concepts are called targets or topics (Lagoke *et al*, 1997).

The actual analogy involves comparison of features of both the analogue and the target and these features are sometimes referred to as attributes (Glynn, 1994). Harrison and Treagust (1994) also stated that, analogy is complete if attributes in the analogue match those in the corresponding target. Such attributes are said to be similar and these similarities give the analogy its power. However, in practice not all the attributes in the two domains of the analogy match or are similar (Harrison & Treagust, 1994).

Stretching further, Brown and Clement (1989) range characteristics of an analogy which includes relating abstract ideas to the real world and in some cases involves opening new points of view or perspectives. According to Treagust *et al*. (1992), analogies promote visualization of the abstract and the unfamiliar concepts. In other words, analogies make the invisible and abstract appear visible and real. For example, the familiar water circuit analogy assists mental visualisation of the behaviour of electric current in a circuit by using the behaviour of water in a water circuit where water represents current. Zeitoun (1984) sums up the meaning of an analogy by saying that when an analogy is used as a teaching strategy, it provides a comparison, which can explain something difficult to understand by pointing out its similarities to something easy. This view has also been expressed by Akinbobola (2006) who says, helpful analogies tend to be less complex than the phenomena they are meant to depict. In other words, analogies have to be simple and meaningful.

According to Lagoke *et al.* cited in Ornek (2012), in a teaching situation, some analogies are planned in advance of instruction while others are spontaneously generated during instruction. Ornek (2012) explained that some of these analogies are universal while others are local. For the purpose of this study, universal analogies would refer to those found in textbooks and widely understood across different social and cultural contexts, while local analogies would apply to those analogies drawn from students' immediate environment. Lagoke *et al.* (1997) further refer to such analogues as "environmental", in the sense that they are analogues drawn from the socio-cultural environment of the learner.

According to Gunstone, (1994) and Kelly (2005), whether planned or spontaneously generated, universal or local, analogies that teachers use tend to work well. However, there are times when analogies convey to students wrong meanings of the new concepts or targets, as revealed during their contribution to classroom or group discussions, or their responses to test questions on analogous concepts. Therefore, it is important to have good research data on the effective use of analogies and to identify any commonly used analogies that do not action well. This is because the repertoire of good analogies that teachers and textbooks possess is inadequate (Black & Solomon, 1987; Webb, 1985).

2.6 Traditional Teaching Strategy

According to King (2005), traditionally it was thought that students learn physics in small incremental steps and that each step builds logically, one upon the next. King

(2005) emphasized that during the teaching of Science in English course, most students could admit that it is the easiest way to teach in our Senior High Schools. King (2005) continued to elaborate that in traditional teaching, it is easy to control the context and processing of learning because it is logical and sequential. In fact, this approach is a typical example of teacher-centered teaching. However, we all realize that there are some weaknesses in the traditional teaching approach. This approach to teaching often leads to surface learning as much of the content is too abstract and students find it hard to relate to real life (Stelzer *et al*, 2009; Joyce & Weil, 1992)

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2.7 Some Effective Teaching Strategies

Ronsini (2000) states that, cooperative learning is a successful teaching strategy in which small teams, each with students of different levels of ability use a variety of learning activities to improve their understanding of a subject. Each member of a team is responsible not only for learning what is taught but also for helping team mates to learn, thus creating an atmosphere of achievement (Ronsini, 2000). Cooperative learning is a mode of learning in which students work in small groups to achieve a purpose. Here there is an emphasis on the importance of group work, students in a group help each other in learning the content, but achievement is judged individually.

Odili (1990) states that the class in cooperative learning is divided into groups, and each group has specific work to do in which group rewards and individual accountability within the group are essential.

According to Slavin (1987), the two major theoretical perspectives related to cooperative learning are motivational and cognitive. Slavin (1987) further noticed that the motivational theories of cooperative learning emphasize the student's incentive to do academic work, while the cognitive theories emphasize the effects of working together. Motivational theories related to cooperative learning focus on reward and goals structures (Slavin, 1987). One of the elements of cooperative learning is positive interdependence, where students perceive that their success or failure lies within their working together as a group (Johnson, Johnson & Holubec, 1986). From a motivational perspective, cooperative goal structure creates a situation in which the only way group members can attain their personals goals is when the group is successful (Slavin, 1990). Therefore, in order to attain their personal goals, students are likely to encourage members within the group to do whatever will help the group to succeed and to help one another with a group task.

Johnson, Johnson and Holubec's (1986) theory identified the three types of cooperative learning groups as formal, informal and base. According to them, the formal group ensures that students are actively involved in the intellectual work of organizing materials, explaining it, summarizing it, and integrating it into existing conceptual structures. Informal cooperative learning group task from a few minutes to a whole class period .and the teachers uses them during direct teaching to focus student's attention on the materials to be learnt. A base cooperative learning group task extends for at least a year. It provides students with long-term committed relationship. The formal cooperative learning group as used in this study.

According to Johnson and Johnson (1999), competitive learning is one in which students' work against each other to achieve a good grade. They further state that it exits when one students' goal is achieved and all other students fail to reach the goal. They further state that competitive learning can be between individuals or between groups (Johnson & Johnson, 1999). Competitive learning is most appropriate when students need to view learned materials (Johnson, Johnson & Holubec, 1986).

Akinbobola (2006) emphasized that, the mode of delivery for physics lessons at senior secondary school in Ghana is by expository. The expository method is teacher-centered, student-peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials. However, the modern expository method involves more that talking and reading about science for it allows some interaction between the teacher and the students in terms of asking and being asked questions on the topic of discussion. Also, the current educational system in Ghana is based upon competition among the schools. According to Akinbobola (2004), in Ghana and with the present educational system, competition is valued over cooperative learning strategies.

Hence, cooperative learning being a new strategy for physics teaching in Ghana has not been frequently used by teachers (Akinbobola, 2004).

2.8 Learning through Analogies

Mautner (1997) noticed that schema theories constitute paradigms that can explain certain aspects of learning through analogies. A paradigm is the thinking or framework that guides observation, interpretation and explanation of phenomena or data (Klemke et ai., 1998; Mautner, 1997; Zeitoun, 1984). However, Kuhn (1970) interpretation of data is central to understanding of a paradigm which becomes a domain in an analogy. An analogy therefore consists of a comparison of two different paradigms or 'worlds' (Kuhn, 1970).

According to Zeitoun (1984), analogical learning is effective when the subject transfers the analogous attributes from the analogue schema to that of the target.

On how effective teaching of science should proceed, Hodson and Reid (1988) advocate the teaching of some theory before providing the students with the practical experiences. Hodson and Reid (1984) observed that teaching theory provides the learners and the teacher with opportunities to theorize and explore students' already existing ideas. In other words, practical investigations should be theory driven in the sense that practical investigations are used to explore, test and develop students' ideas or the ideas teachers are trying to persuade the students to adopt. Furthermore, according to Hodson and Reid (1988), it is not that students frequently do not have the necessary and appropriate theoretical framework, but they have a different one. So they may look in the wrong place, way and make wrong interpretations. As a consequence they may go through the entire lesson without ever appreciating the point of the experiment, the procedure or the findings (Hodson & Reid, 1988)

This quotation may be taken to suggest that students have ideas that may be different from the scientifically correct or accepted concepts. Perhaps, the aim of teaching is to help students appreciate the correct view of science and probably make a shift from the wrong ideas or misconceptions to the correct ideas. The two sets of ideas are based on two different paradigms: the individual students' paradigms and the teacher's paradigm. According to Hewson and Thorley (1989), in an attempt to assist these students to undergo a paradigm shift, the new ideas and the methods of developing the new ideas must be plausible, intelligible and hatful. Posner *et al*. (1982) also emphasized that, once the ideas of the students already hold have changed to acceptable ones, the students can use them to explain new concepts. They stressed that these new ideas become a student's preconceptions from which analogues for analogies can be selected. According to Posner *et al* (1982), a paradigm shift can be brought about by faulty preconceptions and misconception in the analogue which will be transferred to the target leading to wrong paradigm shift. However, an analogue with no errors ensures transfer of correct ideas from the analogue paradigm to the target paradigm therefore the analogue should contain correct science in order to explain the target correctly (Posner *et al*, 1982).

Duit (1991) states that analogical learning is also effective when the subject isolates the irrelevant attributes of the analogue schema from that of the target schema. Kelly (2005) exemplifies this point by saying that, learning is but a process of actively employing the already familiar to understand the unfamiliar. Learning, therefore, fundamentally has to do with constructing similarities between new and already known. It is precisely this aspect that ernphasises the significance of analogies in a constructivist learning approach. (p. 652)

2.8.1 Constructivism and Learning

Advocates of constructivism argue that knowledge is constructed as the learner interacts with experiences (Driver, 1983; Driver & Enckson, 1983; Driver, 1989; Kelly, 2005). Understanding and interpretation of new experiences is dependent on the knowledge the learner already has (Ausubel, 1963; Driver, 1983; Hewson & Thorley, 1989; Hodson, 1998; Mathews, 1994; Posner *et al.*, 1982).

Through analogical experience, learners are expected to assimilate or accommodate target information Piagetian terms that as different modes of learning. The process of assimilation takes place when the new concept or information does not conflict with what the learner already has (Posner, *et al.*, 1982). They elaborated that such information is accepted easily however, this is not always the case.

Sometimes the student's current concepts are inadequate to enable him or her to grasp the new information successfully. Other times, the new information conflicts with the student's current concepts. The student is then forced to reorganize or replace his or her central concepts (Posner *et al.*, 1982). This is called accommodation (Hewson &

Thorley, 1989; Posner *et al*., 1982). According to Posner *et al*. (1982), the conceptual change model of learning is about the relative status of the existing and the incoming new information. For a concept to be accepted by the learner its status must be raised and the old idea about the target is lowered in status. In this situation, the new idea is accommodated: the old is replaced by the new, the new idea or concept is modified consistent with the old to embrace the new. But, if the old is as good as the new, such that the learner finds both useful, then the new idea gets assimilated. In these two scenarios, the learner undergoes conceptual change (Hewson & Thorley, 1989; Posner, *et al*, 1982). What this means is that the learner has added new information to what he or she already had or has changed his or her original viewpoint. In other words, the learner now sees things differently, hence the idea of conceptual change.

2.8.2 Conditions for Accommodation

According to Hewson and Thorley (1989), accommodation of target information may take place if the learner is dissatisfied with the existing conceptions or there is a conflict between what the learner already knows and the new information; the new concept is more intelligible which makes more sense than what the learner already knows; the new concept is plausible consistent with some aspects of the learner's existing understanding or preconceptions. Hodson (1999) and Posner *et al*. (1982) stressed that; accommodation of target information may take place if the new concept has the potential of being fruitful or useful.

2.8.3 The Process of Conceptual Change

Dale (1975) states learning or conceptual change is brought about from a state of dissatisfaction when an external experience is disturbed or conflicted between the existing ideas and the incoming ideas. Thus, the student sees the environment from the point of view of higher existing knowledge and mental thought patterns. Cobern (1996) explained that any individual is constantly assimilating new information that agrees with higher existing ideas. Nevertheless, when a disturbance or conflict between what the learners already know and the new information occurs, the new information may be rejected or modified before being accepted (Cobern, 1996). In other cases the old idea might be replaced or reorganized. According to Dale (1975), this process is called accommodation. It is the case when discrepant events or 'kounteo experiences" are used with the hope that the student will undergo a conceptual change or otherwise the conflict may remain unresolved (Gunstone, 1994). Accommodation in this case is brought about by equilibration and achieving a state of balance by either replacing the old idea with the new, or modifying the new idea for acceptance. Equilibration, which is a Piagetian term, means a compensation for an external disturbance (Dale, 1975). The compensation is by having a changed of viewpoint due to alterations to existing knowledge and modification of existing mental structures to incorporate the new aspects (Dale, 1975).

However, not al1 that is presented to learners is accepted. Some students are resistant to conceptual change because of their various psychological or socio-cultural beliefs. Hodson (1999) have interpreted this resistance by viewing such events from a Vygotskian perspective. This is an outlook that sees the group or social class as having a major role in shaping what its members learn or accept as user information.

Among the factors influencing learning or acceptance of a new concept is social pressure. This may come from other peers who hold a particular view. The peers could be those who occupy a special place in the student’s personal life with respect to what Hodson (1998) calls the "student power" hierarchy. They create immense social pressure to conform, leading to a development and legitimization of a change of view. Sometimes the learner may hold membership of several social groups each of which has to follow and exerts social pressures to conform. In Hodson's view, the personal framework of understanding view of learning allows for the proliferation of meaning in response to entry into additional social groups.

Social and cultural group identities, such as gender, ethnicity, religion and politics also impact heavily on learning (Hodson, 1998). Aikenhead (1996) revealed in his study that each of these cultures or subcultures provides the learner with different "lenses" through which experiences are interpreted and understood. These different ways of seeing things can develop into what Claxton (1993) calls "stances" which tend to direct or guide individual students and their group activities or actions. In other words, stances constitute the ethics, the code of practice of the individual members of a group and the group as a whole subscribe to. These stances become the frameworks that guide students' leaning behaviour. Sticking to these stances is like ensuring allegiance to the norms and practices that constitute them. It is because of this that students always work to hold together all the social groups they associate with. They do this by implicitly or sometimes explicitly swearing allegiance to the social groups. Some of the learners have been found to "act out" by supplying responses that depend on the prevailing circumstances (Hodson, 1998; Matthews, 1994). In addition, Bloom (1995) argued that, analogies, which are embraced favourably by proponents of constructivism, may be major sources of misconceptions.

The constructivist approach has recently come under serious scrutiny. It is charged by some people with being simplistic, especially in its account of how misconceptions can be eliminated (Hodson & Hodson, 1998; Matthews, 1998). These authors seem to concur on the point that the process of meaning making or construction is context bound and includes emotions, values, aesthetics, interpretive frameworks and personal experiences. It is precisely this perspective that Lagoke *et al*. (1997) have attempted to address by exploring the potential of environmental analogues in enhancing science concept learning among gender groups in Nigerian schools. In other words, they recognize the importance of social factors in analogical learning. This way, analogical learning is of a social constructivist nature. If learners already hold misconceptions in the analogue domain then it follows that the same or hybrid misconceptions will be transferred to the target domain. In other words, analogies do not necessarily eliminate misconceptions.

Clearly, a construct resulting from analogies should be in line with students' correct preconceptions. Kelly (1955) defines a construct as simply a way in which some things are construed as being alike and yet different from others. Essentially, this is how an analogy works; presenting things or concepts that are different as though they are the same. The analogue and target concepts in an analogy are different and yet matching of attributes in these two domains or paradigms works as though the matched attributes are alike.

2.9 Analogical Learning

According to Zeitoun (1984), analogical learning, which also embraces constructivist views of learning, takes place when the learners exhibit the following characteristics: Familiarity with the analogue, no prior knowledge of the target, analogical reasoning ability, appropriate Piagetian cognitive levels especially formal reasoning, visual imagery and cognitive complexity.

It is important that the learners be familiar and comfortable with the analogue. Unfamiliar analogues may distract students' attention from studying the target, and may also add a new load to the learning situation (Zeitoun, 1984). This is because the learner will be forced to understand both the analogue and the target at the same time. The use of familiar analogues may even drive some learners into looking for alternative, more familiar analogues, which can be a recipe for chaos or confusion in conceptual learning, which according to Willner (1964), is one reason for the usefulness of the principle of analogy in constructing new scientific hypotheses such that, a relationship envied from a well understood realm may be extrapolated to a dimly understood one, and provide a key for understanding. (p. 479)

The familiar will only facilitate learning to the extent that it is analogous to the topic or target. When familiar analogues are not available and easy to understand, unfamiliar material can be introduced to explain the target somewhat in the style of an advance organiser (Ausubel, 1963, 1968). Advance organisers are typically written at the same level of abstraction, general and inclusiveness as the learning material or targets, and achieve their effect largely through repetition, cornpressing material or summarizing, selective emphasis on central concepts and pre-familiarization of the learner with certain key words. (Ausubel, 1963, p-214). Zeitoun (1984) continues to Clarify that, what matters is the link between the analogue and target attributes and other conceptions that the student has. Having no prior knowledge of the target captures students' interest and desire to learn the new material. In other words, "analogies would produce best results when the learning material is unfamiliar, thus, the student has not yet developed a schema for this material" (Zeitoun, 1984).

According to Duit (1991), providing students with an analogy when they already possess relevant background knowledge about the target may interfere with their attention to learning target material. Furthermore, it may unnecessarily complicate the learning process and lead to confusion and resentment.

Zeitoun (1984) further states that, analogical reasoning ability has to do with a learner's ability to extract relationships in one domain, construct a closely equivalent relationship in a different domain and make careful inspection of both relationships to ensure that they match. In other words, the learner should have the ability to understand and comprehend analogous arguments or comparisons and not to take them literally. For example, "airplane is to air as ship is to water" kind of reasoning. This way the learners become responsible for their own learning and the learning tools that facilitate this learning (Gunstone, 1994). It has, in this context, to do with the fact that learners are aware of analogies as learning devices. Not only do the learners need analogical reasoning skills, they are assisted by being conscious of having them. The awareness and consciousness of having analogical reasoning skills and abilities give analogy use a prominent place among the tools of teaching science.

Learners at the Piagetian concrete operations stage (Dale, 1975) would require a bridging device to transit into the abstract. Analogies are just the right kind of devices to provide that bridge. In other words, analogies have a concretising function. They render the unobservable (abstract) attributes perceptible by comparing them with the concrete imaginable analogues (Zeitoun, 1984). It is therefore expected that learners at the concrete operational stage can benefit from the use of analogies in studying abstract concepts or material.

Analogical leaning is also enhanced by a student's ability to visualise the match between similar attributes of the analogue and target. Creating the image of the match or mismatch between the analogue and target attributes is a prerequisite to understanding the new (target) material. This is a high level coronation referred to as cognitive complexity, one of the structural characteristics that define individual differences. It is based on the belief that learners (people as distinct from other species, such as animals, birds, etc.) possess cognitive structures that involves students' ability to examine what they are thinking about, to make distinctions and comparisons, to see errors in what they are thinking about and how they are thinking about it, and to make self corrections (Onistein & Lasley, 2000). It is noted that Meta signifies "aboutness" and is used to form new terms which show a discourse, the theory or field of inquiry one level above its object which is also a discourse or field (Mautner, 1997) are responsible for data processing. This structure has two components: discriminating structure which refers to partitioning of stimulation; and integrating structure which also refers to how partitioned parts are related, combined, added, etc (Zeitoun, 1984). Zeitoun states that those people classified as cognitively complex are high on the discriminative structure and or the integrative structure. They are said to be cognitively simple if they are low on these two structural indices. The significance of cognitive analogical learning is expressed by Zeitoun (1984), as follows: The integrative structure might be utilized when the students relate the analogous attributes of the analogue to that of the topic or target, the discriminative structure functions when the students isolate the irrelevant attributes between the analogue and the topic or target J. (p.113)

However, analogical learning, according to Zeitoun (1984), is related to nonstructural variables as well as the complexity of the analogy, which refers to the number of conjoint (analogous) attributes that can be interpreted from an analogy statement, the degree of concreteness of the analogy, the number of analogues included in the analogy and the format of presenting the analogy, which comprises two categories: mixed and separate. Mixed format involves a situation where both the analogue and the target are presented together and compared in the lesson - matched and unmatched attributes are pointed out carefully and systematically, for example, the blind spot and the optic nerve are compared with the photovoltaic cell. Glynn (1991) therefore suggested separate format which involves a situation to;

1. Assess the prior knowledge of the students about the topic.
2. Analyse the learning material of the topic.
3. Judge the appropriateness of the analogy to be used.
4. Determine the characteristics of the analogy to be used.
5. Select the strategy of teaching and the medium of presenting the analogy.
6. Present the analogy to the students.
7. Evaluate the outcomes of using the analogy in teaching.
8. Revise the stages of the model.

Whereas on the surface this model looks appealing, it has certain weaknesses. For example, assessing the prior knowledge of the student does not specify which characteristics or how they can be measured. Characteristics such as analogical reasoning ability, Piagetian cognitive levels, visual imagery and cognitive complexity are not easy to measure moments before preparing a lesson. For analogical learning to be successful, teachers need a simple model that they can use without too much hassle.

Glynn (1991) claims that his Teaching With Analogies (TWA) model can be used quickly in analyzing any analogy for suitability or can be used to guide the construction of a suitable analogy. Of course, the value of an analogy is the ability to achieve its intended purpose. An analogy is good if it expresses new ' ideas in terms of what the students are already familiar with; it is bad if it is difficult to identify and map the important features that are similar (Glynn, 1991).

It serves an explanatory purpose if several features are compared, most of the features compared are similar, and the features compared are of conceptual significance.

According to Glynn (1991), Teaching with Analogies (TWA) model is developed by utilizing these qualities (among others) and comprises six stages:

1. Introduce the target.

2. Cue retrieval of analogue.

3. Identify relevant features of target and analogue.

4. Map similarities.

5. Draw conclusions about target-

6. Indicate where the analogy breaks down.

This model is simple, clear and useful. However, like the Zeitoun's (1984) General Model for Analogical Teaching (GMAT), it has weaknesses, though not of the same magnitude. They are relatively easy to fix.

For example, introducing the target is too general. It could be elaborated by incorporating some of the ideas from GMAT, such as assessing students' prior knowledge of the target to determine whether the students already have the schemata or not. As stated earlier, analogies appear not to work well when the learners already have the schemata for the new concepts (targets). Duit (1991) reiterates the necessity of ensuring that students understand the analogy in the way the teacher thinks they should and that students see the similarities the teacher has in mind. Arguing for the case of learners having multiple meanings, Hodson (1998) says: If meaning is, in part, socially constructed, it follows that different social groups can negotiate and construct different meanings. Moreover, since individuals have membership of more than one social group, they need to be familiar with more than one framework of understanding and to be able to access the knowledge, language and codes of behavior appropriate to each group quickly and reliably, as the social situation changes.

In this context of analogy use, it follows that it is important for teachers to establish common keywords that are clear to the students. Otherwise, if the teachers and the students operate in different works, the teachers' intended meanings may not necessarily be the students' constructs.

Learners' frameworks constitute their cultural universe. Moreover, as a parallel to Freire (1973) extension agents, teachers have to enter students' cultural universe of thinking and meaning making. This can only happen when the teacher appreciates the students' position. Failure will result to construction of misconceptions. Webber (1979) has voiced similar support for learner centeredness in this matter by asserting that: "There is considerable evidence that the constructs, which are elicited from the subjects individually, are more personally meaningful to these subjects than are constructs applied to them from other sources". Learners make sense of new information or experiences using their already existing knowledge (Brown & Clement, 1989). When this is not the case, there is the possibility that the analogue becomes confused with the theory it is serving, and when improperly used, it may serve as an obstruction to the learning process. It makes sense to point out where the analogy does not work before making conclusions about the target. Then it indicates where the analogy breaks down in TWA before the conclusions are drawn about target and vice versa (Hamson & Treagust, 1994). By combining elements of GMAT and Teaching with Analogies (TWA), it is proposed to use a simpler model, Working with Analogies (WWA) mode1 (Nashon, 2000). It comprises six steps which includes; assessing students' knowledge of analogue, assessing students' prior knowledge of target identifying analogue and target attributes, map similar attributes, point out unmapped attributes and draw conclusions about target.

This model closely matches what Zeitoun (1984) has described as the way of presenting an analogy: The objective of the presentation is stated first, this is done as a way of directing students' focus and attention to the topic or target. The analogue is then introduced quickly if it is familiar to the students. The suggested model Working with Analogies (WWA) is explicitly assessing the students' knowledge of the analogue. Previous research has showed that analogues can often be misconceived and can lead to the propagation of misconception into the learning of new material or target. The unfamiliar analogue might require some in-depth teaching until it becomes familiar to the learners. A statement that initially connects the analogue to the topic or target is presented, so that the students are cognitively prepared. Analogous attributes are presented one at a time, a transfer statement is presented, and irrelevant attributes are presented.

In WWA model, before pointing out unmapped attributes, a conclusion is drawn instead, on the grounds that it makes sense to identify and present unmatched attributes.

2.10 Some Factors Influencing the Understanding and Performance of Wave Physics

Following the low understanding rates of wave concept in Physics at SHS level there must be factors hindering students from understanding and pursuing the subject up to form three and may be take courses related to Physics at the tertiary colleges and universities. This will explore the factors related to students, teachers and school environment.

2.10.1 Students' Influence on Performance of Wave Physics

Perceived and actual level of difficulty of the topic by the students has been shown to influence the choice of Physics. According to Nicholls and Miller (1984) students' judgment about the difficulty level of school tasks clearly affect their achievement related cognitions. Tasks perceived by the student as difficult in his or her skill level engender lower expectations for success, perceptions of control and perceptions of self efficacy than easy tasks.

Most learners admit that they consider mathematics and science a difficulty subject. A study by Jones and Mooney (1981) revealed that students felt that sciences have calculations associated with mathematics that was traditionally thought to be difficulty and was equated to failure.

Eboda (1974) agrees with Jones and Mooney Ibid for he observed that generally some students from the western state of Nigeria did not understand Physics in secondary school. When these students were interviewed, they gave the reason as there are mathematical calculations associated with Physics at the school leaving examination, inadequate teaching resources and learning resources, poor teaching methodologies among others. Musyoka (2000) found that a majority of students who were not taking physics for instance were scared of its quantitative nature and the conception that physics is too abstract especially when taught theoretically.

Difficulty and prior achievement are strongly linked to course uptake and there is a relationship between them. Sharp, Hutchison and Keys (1996) in their survey teachers perceived difficulty as the highest factor that discouraged take up of science followed by negative subject image. There is evidence that past or previous performance of Physics influence its choice. According to Weiner (1992) attributions for past performance influence future performance. Real academic performance is influenced by the importance that students attach to good performance. According to Aduda (2003) students shun physics when given an option and this especially applies to girls. That is given a choice a student would rather drop physics in favour of other science subjects. For a long time physics has been mystified as difficult and hence some schools do not offer it. Cheng, Payne and Witherspoon (1996) as cited by Smyth and Hannan (2006) say that prior success within science in terms of performance is associated with subsequent take up of scientific subjects.

Further Smyth and Hannan (2006) found out that students are more likely to take science subjects if they find them interesting and useful and if they do well in science, and are less likely to take the subjects if they find science difficult. Wikeley and Stable (1999) as cited by Owoyele and Toyobo (2008) found that performance of students in junior school examination determine students placement in the senior school level. It is noted that students took account of their previous experiences academically in making option choices.

2.10.2 Attitudes of students towards Physics have been found to influence its choice.

According to Adesina and Akinbobola (2005) attitudes are acquired through learning and can be changed through persuasion using a variety of techniques. Attitudes once established help to shape experiences the individual has with object, subject or person. Although attitudes can change gradually, people constantly form new attitudes and modify old ones when they are exposed to new information and experiences. Gagne (1979) define attitudes as an internal state that influences the personal actions of an individual, he recognized attitude as a major factor in subject choice.

According to Hoofman (2002) as cited by Semela (2010) the choice of Physics as a major field of study or taking higher Physics courses is shaped by student's interest, motivation and prior achievement. Existing literature show that interest in Physics is strongly related to Physics self concept.

Bloom (1976) found that twenty five percent (25%) of the variance in achievement could be attributed to students' attitude towards science. Kempa and Dude (1974) reported that student's interest in science is associated with their achievement in science. Olatonye (2002) agrees with the two that student's attitudes towards science have significant direct effect on student achievement.

Students' enjoyment and liking for the subject might be important in course choice by students and teachers alike. Reid and Skryabina (2002) noted that in Scotland in contrast with the rest of the United Kingdom and other countries, Physics is the fourth most popular subject at senior higher school students take at age 18.

Literature shows that career goals might influence the students' choice of Physics.

Perceived strategic usefulness of Physics is a significant predictor of the choice. It is observed that, teachers and students rate career intentions as an important influence on school student course choice. Students report that they choose Biology for interest but tend not to choose the physical sciences for this reason.

Tinto (2007) as cited by Ogunkola and Fayombo (2009) asserted that well defined career plans or goals positively influence decisions of students to remain in college. In addition Hull-Blanks et. al (2005) found that students with a well defined job related career goal were more likely to decide to persist in college than students without such a career goal. Further, Ting (1997) found that setting long term career goals predicted positive academic achievement.

Study habits have also been found to contribute significantly to students' physics achievement. Studies like Olatonye and Ogunkola (2008) as cited by Ogunkola and Fayombo (2009) indicated that study habits makes significant contribution to the prediction of physics achievement. This implies that if a physics student exhibits negative study habits like lacks concentration, feels bored, tired and sleepy while studying physics, spends little time on physics and does not map out immediate goals to attain, it is likely that the student may lack the impetus to engage adequately in productive physics learning during allocated school time and during his or her personal study time.

Nouhi, Shakoori and Nakhei (2008) added that mastering skills by students makes study more enjoyable and effective which in turn strengthen the students‟ interest so that he or she spends more time studying.

According to a study by Owoyele and Toyobo (2008) students‟ choice of subjects at school is influenced by jointly peer pressure, parental will and academic ability but it is influenced more by peer pressure and parental will than their academic ability. A study by Tella et.al (2007) as cited by Owoyele and Toyobo (2008) indicated that peer pressure has a positive effect on students‟ subject selection and achievement growth. Further results of a study by Ablard (1997) reported that adolescents enjoy peer support on choice of school subjects and vocational aspirations. Owoyele (2007) found out that peer support has also been found to be positively related to adolescents‟ academic achievement and choice of school subjects.

According to Dryler as cited by Smyth and Hannan (2006) peer groups have also been found to be influential, with boys' and girls' choices correlating with the choices of their same sex classmates, but not with those of opposite sex classmates.

Gender differences emerge when other factors come into play which can compromise self concept of performance in physics. A study by Balogun (1985) showed that more boys than girls tend to opt for all the basic sciences at school certificate level examination because boys are more generally disposed to science and mathematics than girls.

Parents have great influence on their children especially when they are young. A study by Labudde et. al (2000) as cited by Tuaundu (2009) revealed that there should be a strong bond between Physics contents and students everyday experiences. This implies that students who are exposed to technological toys and games which in most cases are boys will have greater interest in mathematics and science because of the existing knowledge that they have. This knowledge plays an important role in the understanding of mathematics and science. Gilbert and Calvert (2003) as cited by Tuaundu (2009) found out that most young women do not see themselves as being capable of studying and succeeding in mathematics and science, therefore they are not interested in it.

The myths and realities of women progressing in mathematics and science field were studied in Tuaundu (2009) concluded that the attitudes adopted by girls from parents, teachers, friends, and society have a significant influence on the girls choice and performance in science and mathematics.

2.10.3 Teachers' Influence on Students' Performance of Wave Physics

Hargreaves (1989) says that what the teacher believes, what the teacher thinks, what the teacher assumes, all these things have powerful implications for the change process.

According to Hewson (1989) as cited by Freitas,Jimenex and Mellado (2004) science teachers are considered as having conceptions about the nature of science, about scientific concepts and about how to learn and teach them.

These are usually deeply rooted conceptions and a teachers' first step in his or her education and professional development is to reflect on these conceptions critically and analytically.

Teachers do not change their conceptions easily, however and even less so their teaching practices. In some cases this is because their conceptions are the fruit of many years they themselves spend at school.

Teacher preparation and mastery of subject could also influence effectiveness of teaching.

According to Huibregtse and Wubbels (1994), many teachers use pedagogical methods that are similar to those they preferred in their own teachers when they were students or simply teach in the same way they themselves were taught.

Further Freitas, Jimenez and Mellado (2004) say that teachers feel satisfied with certain teaching models that have been consolidated by professional experience or because they do not have any teaching strategies readily available that they find better for real daily work of teaching their specific subjects and for the students learning.

The teacher is the mediator who transforms content into depictions that are comprehensive to the students. Teachers" educational strategies depend very much on the material being taught, and their classroom practice and activities relating to the subject matter.

A study by Kiboss (2000) showed that students conceptions about science might be negatively affected by the way the teacher presents the subject.

For example the use of such techniques as lecturing, giving notes and drilling students on past examination papers, which most teachers find as useful strategies, may make pupils perceive science subjects as the mastery of some formulas and or as a way of receiving and storing information. According to Linder (1992) and Simpson and Oliver (1990) as cited by Kiboss (2002) this eventually makes them lose interest in the subjects.

A study by Kumar and Altschuld (2002) showed that video-based science methods influenced the knowledge and understanding of effective ways of teaching science. The video –based science methods enabled teachers to plan and teach science with confidence, in addition to relating science with other disciplines and societal issues in classrooms.

UNICEF (2009) asserts that in many developing countries, a higher percentage of teachers lack the prerequisite levels of education and training needed to rise from challenges of school reforms geared for improved performance. Further Torongey (1986) established that science teachers especially Physics teachers characteristics such as pace of content delivery, comments made in class, frequency of missing lessons among others contributes to negative attitudes by students towards science.

According to Rono (1985) some teachers even go ahead to use very difficulty terms that students could not easily understand as an excuse to hide their ignorance. A 1988 report on science achievement (international association for the evaluation of educational achievement, 1988) stated that elementary and secondary schools were not laying a satisfactory foundation for advanced science and engineering education and this was due to poor preparation in mathematics and science. The way in which physics is taught within the school at junior cycle also influences students" attitudes and orientations to the subject and thus their likelihood of continuing to take physics.

Further, teacher student relationship affects the performance of Physics. A study by Brekelmans *et al*. (1990) found that student perceptions of the teacher influence are related to cognitive outcomes. The higher a teacher was perceived on the influence dimension, the higher the outcomes of students were on a Physics test.

2.10.4 Effect of the School Environment on Students' Understanding of Physics

Whether or not a subject is provided in a school is clearly a matter of policy for that particular school. School organization may facilitate or constrain the choice of physics.

According to Oakes, Selvin, Karoly and Guiton (1992) as cited by Smyth and Hannan (2006) schools are found to make assumptions about the abilities and needs of their student intake, assumptions which guide their decisions about which courses to offer.

Roger and Duffield (2000) found that schools can influence the course understanding indirectly through subject packaging for optional subjects and more subtle encouragement of the understanding of particular types of subjects. Aduda (2003) asserts that despite the fact that physics is an important subject in economic, scientific and technological development most schools have made it optional in form three and others do not offer it at all.

According to Smyth and Hannan (2006) schools vary in the way in which scientific subjects are made available within the school; they may allow certain ability groups to take particular subjects or they may set prerequisite for taking certain subjects (e.g., a student may need to achieve a certain grade in order to be allowed to take a subject).

At senior high levels, schools vary in the way in which scientific subjects are made available within the school and the way they are time tabled against each other are factors which affect the understanding of physics. Smyth and Hannan (2006) highlighted the way in which timetabling requirements for physics produced a gendered understanding in other subject areas.

According to Smyth and Hannan (2006), single sex schools have a positive effect on attitudes to, and understanding of mathematics and science especially for girls. However Daly and Shuttle cited in Mbithe (2012) found that coeducation has no significant effect on understanding patterns when adequate account is taken of the more selective nature of student intake into single sex schools.

According to Millican, Richards and Mann (2005) physics is an experimental subject. General principles and concepts are more easily understood if they are demonstrated in the laboratory. Laws and relationships are more fully appreciated if the student investigates and verifies them at the laboratory bench.

According to Shiundu and Omulando (1992) the school management should endeavor to provide necessary resources for the support of teaching and learning especially the purchase of relevant textbooks, building and equipping laboratories with correct apparatus and chemicals to facilitate effective learning in the school. School with less provisions, fewer teachers, poor school buildings and inadequate facilities will have a negative influence on the attitudes and academic achievements of the learners.

A study conducted by Yildiz, Akpiner, Aydogdu and Ergn (2006) showed that having no science laboratories or inadequate equipment in science laboratories in schools affect teachers attitudes towards the aims of science experiments in a negative way. Science experiments are inseparable and indispensable parts of learning experiences. The experiments provide both acquiring science concepts and learning scientific method for learning experiences.

According to NTI (2007) physics as a subject, is activity oriented and the suggested method for teaching it is guided discovery method and is resource based. This suggests that the mastery of physics concept cannot be fully achieved without the use of instructional learning materials. The teaching of physics without learning materials will certainly result to poor performance.

According to Alabi (2008) provision of necessary facilities in schools will provide a challenging environment for students to learn and for effective teaching by the teachers. On the other hand Olubor (1998) says that lack of adequate facilities such as textbooks, ill-equipped classrooms, laboratories, workshops and library are among the probable causes of students‟ poor performance in examinations.

Smyth and Hannan (2006) found that teachers experience and instructional facilities have also been found to shape physics understanding. Further Smyth and Hannan (2000) indicate that science take up tends to be higher in schools which emphasize practical work and students' participation in classroom activity at senior high levels.

According to Owoyele and Toyobo (2008) professional guidance and counseling services are needed to guide students on how to choose subjects based on their academic ability, interest and relevance of such subjects to their future career aspirations. Schools must endeavour to organize academic and career counseling services before such students are asked to select subjects. Subject choices are considered to be significant in determining career paths. Students need information about the structure and content of the science subjects they want to study. This will help influence their choice of the subject.

Research by Igun (2007) and Obayan (2007) in Aguele (2010) showed that students need information about what they are considering providing an understanding of what in particular a discipline involves.

According to Peel (1998) in Aguele (2010), students often conflicting advice from parents, teachers, friends and career advisors, and upon entering senior secondary school there can be a mismatch between expectations and actual experiences. The difficulty students may have in obtaining informed advice can influence their choice of science subjects.

According to Millican, Richards and Mann (2005) one of the major difficulties inspiring students about careers in engineering is that their main source of information, their teachers, are usually not much better informed than the students themselves

2.11 Need for a Model

The role of analogical thinking in teaching and learning science has received increasing attention in recent years (Brown & Clement, 1989; Lawson, 1993). Research findings suggest that teachers and textbook authors often use analogies, but use them ineffectively (Duit, 1991; Duit & Glynn.1992; Glynn, Britton, Semrud-Clikeinan, &Muth, 1989; Thiele &Treagust, 1991). Sometimes the analogies that teachers and textbook authors use to explain new concepts are clear and well developed; while at other times they are vague and confusing. Teachers and textbook authors need a model to guide their construction of instructional analogies systematically. Analogies could then be made to suit students' own back-ground knowledge. In response to this need, research on a teaching strategy with analogies was initiated (Glynn, 1991, 1989: Glynn *et al.*, 1989; Harrison & Treagust.1993; Thiele & Treagust, 1991).

CHAPTER THREE

METHODOLOGY

3.0 Overview

The purpose of this study was to determine the performance of second year physics students on wave concept at the pre intervention test and post intervention test. This chapter discusses the research methodology that was employed in the study. Thus the chapter described the pre intervention, intervention and post intervention activities that were carried out in the study. This includes the study area, research design, research population, sample techniques, research instrument, research procedure, intervention programme, data collection procedure and data analysis. In pursuance of the purposes stated above, the following questions were formulated to guide the study:

3.1 Research Questions

1. What is the knowledge students have about the concept of wave before the use of analogy instructional strategy?
2. What is the knowledge students have about the concept of wave after the use of analogy instructional strategy?
3. What is the perception of students about the use of analogy instructional strategy?

3.2 Methodology of the study

The study employed mixed methods, where both quantitative and qualitative approaches were followed. According to Johnson and Onwuegbuzie (2004), mixed method research involves combining in a single study techniques, methods, approaches and language of both quantitative and qualitative traditions. Burns and Groove (1993) define quantitative research as a formal, objective and systematic process to describe and test relationships and examine cause and effect interaction among variables using mathematical means or statistical analysis of data. Qualitative research on the other hand seeks to discover the meaning that participants attach to their behaviour, how they interpret situations and what their perspectives are on particular issues (Measor & Woods, 1984). Mixed methods approach is more than simply collecting and analysing either qualitative data; it also involves the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research (Creswell & Plano-Clark, 2007).

To gather the quantitative data, a pre intervention test and post intervention test were conducted to assess student's performance before and after the intervention, so as to check the effective gain in students' performance. Researchers have deployed a variety of tools to perform the average effectiveness of the courses in promoting conceptual understanding. One of such tools, most commonly associated with the work of Richard Hake is called the normalised gain; <g> (Hake, 1998). Since its introduction, the normalised gain has been widely used in assessing students' performance in pre intervention tests and post intervention tests (Bao, 2006). It is defined as the change in score divided by the maximum possible increase, or the ratio of percentage post intervention test score minus percentage pre intervention test score to 100 minus the percentage pre intervention test score.

The normalised gain is calculated using the following mathematical relations:

$$<g> = \frac{\text{Post intervention test-pre intervention test}}{\text{Maximum score-pre intervention test score}}$$

$$<g> = \frac{\text{\% Post intervention test score - \% pre intervention test score}}{\text{100 -\% pre intervention test score.}}$$

The three test scores (maximum, post intervention test and pre intervention test) could be defined for an individual student or as an average measure for a population. In this study, the average normalised gain for the entire class will be calculated to express the effectiveness of the lessons in promoting conceptual understanding. Using the gain score, Hake classified interactive and traditional lecture courses into one of the three groups:

High gain; <g> greater than 0.7

Medium gain; <g> between 0.3 and 0.7

Low gain; <g> less than 0.3 (Hake, 1998)

Hake concluded that instructions that are based on traditional lecture approach usually have a low gain of <g> less than 0.3. However, instructions that depend on moderately used and highly used interactive engagement approaches usually have a medium gain (between 0.3 and 0.7) respectively. In gathering qualitative data, an unstructured questionnaire was used to record the preference of students in relation to analogy instructional strategy and traditional instructional strategy. Thus in investigating the effect of analogy instructional strategy on students' performance on wave concept in physics, both quantitative and qualitative approaches were used.

3.3 The study area

The study area is the Kassena-Nankana Municipality in the Upper East Region of Ghana. It is one of the thirteen (13) Administrative Districts in the Upper East Region. It shares boundaries to the North with Kassena-Nankana West District and Burkina Faso, to the East with Kassena-Nankana West District and Bolgatanga Districts, West with the Builsa North District and South with West Mamprusi District in the Northern Region.

Research Design

The study used an experimental design. According to Ogula (1999), experimental research design attempts to accurately identify a given situation and it is used to observe, collect information, record the information collected, analyse and report conditions that existed.

Moulton (1996) further explained that an experimental design is a study design that gives the most reliable proof for causation. In an experimental study, individuals are randomly allocated to at least two groups; one group is subject to an intervention, or experiment, while the other group is not (Moulton, 1996). Moulton (1996) added that the outcome of the intervention or effect of the intervention on the dependent variable or problem is obtained by comparing the two situations or groups.

The design helps to examine the impact of the performance of second year physics students on wave concept.

3.4 Population

The entire group of interest for a research forms a population (Gravetter & Forzano, 2006). The population of this study was all elective science students offering physics. However, due to a number of constraints such as financial, time, resources and accessibility not all of the population was used for the study. The target population however, was one of the form two (2) science (science B) consisting of 52 students of Navrongo Senior High School studying physics.

The second year class was chosen because they were free from examination stress as they were not examination class. They had also experienced physics teaching at the Senior High School, hence would be able to appreciate effect of the new approach to teaching.

3.6 Sample and Sample Size

A sample offer more detailed information and a high degree of accuracy because it deals with relatively small number units (Sarantakos, 1998; Gravetter & Forzano, 2006).

The sample for the study was one intact elective physics science class randomly selected from form two (2) elective science classes. Since it was an intact class, the entire subjects were involved in the research. The sample chosen was the second year elective physics students who were in the form two science class (Science B). They numbered fifty two (52) students which consisted of 12 females representing 23 percent and 40 males representing 77 percent. The average age of the students was 18 years.

The sample was selected because most topics for WAEC examinations are mostly chosen from second year topics in which the perceived difficult topic of wave concept is inclusive, coupled with that they third years were also preparing for the May/June West Africa Senior Secondary Certificate Examination (WASSCE) and so would not get enough time to respond to the treatment.

3.7 Sampling Technique

The sample technique used was purposive sampling to select the class level for the study. In the purposive sampling, Orodho (2009) states that this method is typically used when focusing on a limited number of informants, whom we select strategically so that their in-depth information will give optimal insight into an issue about which little is known.

Finally at the class level, a simple random sampling was used to select one of the four physics offering classes (Agric classes A and B, Science classes A and B). According to Orodho (2009), simple random sampling is a procedure in which all the individuals in the defined population have an equal and independent chance of being selected as a member. The sampled class was then assigned to both pre and post treatment.

3.8 Variables for the study

The independent variable in this study was an eight (8) week teaching instructional strategy that was administered to an intact second year elective physics class.

The dependent variable in this study was the student's scores obtained in the traditional method of teaching and the analogy method of teaching on the wave concept topic in physics.

3.9 Research Instruments

With the purpose of the study, there was the need to gather data on students' outcomes and views on the preference of the analogy instructional strategy and traditional instructional strategy. Due to these, a form of formative assessment was used to collect data on students' performance. A close-ended objective test item adapted from Conceptual Physics and Prentice Hall Science Explorer – Wave concept and wave phenomenon textbooks were given to the students as pre intervention test and post intervention test to assess the gain in performance. From Smith (1987) view, the closed ended questions were appropriate for this study since it allowed respondents to choose between options provided by the researcher and have increasingly become popular compared with open-ended questions. The students' preference on the traditional and analogy instructional strategies was also investigated through the use of an unstructured questionnaire.

3.10 Intervention Activities

The instructional strategy was implemented through teacher centred and analogy instructional strategy. The samples were subjected to the same treatment for four weeks each.

The samples were first taken through an identified and usual teaching and learning strategy which is teacher-centred instructional approach on wave concept. This was where the teacher transmitted information via the lecture method with little teaching and learning material involved. After using the teacher-centred approach for four weeks, a class test (pre intervention test) was conducted to assess the performance of the students on the lesson taught. The class test consisted of 20 test items of objective questions with multiple answers. The student response was collected, marked and recorded.

For another four weeks, the sample was taught using the analogy approach. This was where the teacher transmitted the same information via the analogy tools. Analogy (TWA) model was used to teach the wave concept where some analogies were shown directly to students in the classroom by using the required tools. However, the pictures of other analogies were drawn on the board and presented to the students. During the presentation of the analogies in the classroom, students were assisted to both join the lesson and make a connection between basic wave concepts and analogies with the help of a few questions. In this way, it contributed to the maximum participation of students in the lessons. At the end of the presented analogies (after the discussion between the students) the teacher explained the similarities and differences between the analogue and actual concepts again. Therefore, the students who made an incorrect connection between the analogue and actual concepts were able to reorganise their opinions. After the four weeks, a class test (post intervention test) was conducted to assess the performance of the subjects on the lesson taught.

The class test consisted of 20 test items of objective questions with multiple answers. The student response was collected, marked and recorded.

3.11 Validity of the Instrument

Validity in quantitative research determines whether the research truly measures that which it was intended to measure or what it was set out to measure how truthfully the research results are (Joppe, 2000). To ensure that the test items for the study were valid, it was given to a supervisor for thorough examination to ensure that it measures the total content area (content validity) of the study.

According to Merriam (1998), to ensure internal validity, two physics experts were employed to study the items and comment on it.

3.12 Reliability of the instrument

Reliability is a measure of the degree to which an instrument yields consistent results or data after repeated trial. (Mugenda & Mugenda, 1999)

Joppe (2000) also defines reliability as the extent to which results are consistent over time and if the results of a study can be produced under a similar methodology, then the research instrument is considered reliable.

To ensure the reliability of the research instrument, a pilot test was carried out on a sample of SHS 2 elective physics science students at Awe SHS. The SHS 2 elective physics students of Awe SHS were used in the study because they had the same characteristics as the actual participants of the study in terms of the learning environment. These students used for the pilot test did not form part of the sample for the study. Data from the pilot test were statistically analysed to determine the reliability of the test instruments using Spearman-Brown prophecy formula since all items on both pre intervention test and post intervention test were dichotomously scored. The analysis yielded reliability co-efficient of 0.58 and 0.63 for the pre intervention test and post intervention test respectively as shown in Table 3.1.

Table 3.1 The Reliability Co-efficient of the Research Instrument

Types of research instrument test	Number of student	Reliability co-efficient
Pre intervention test	52	0.58
Post intervention test	52	0.63

According to Miles & Huberman (1994), if the measurement results are to be used for making a decision about a group or for research purposes, or if an erroneous initial decision can be easily corrected, then the scores with modest reliability co-efficient in the range 0.50 to 0.60 may be acceptable. The above reliability co-efficient for the pre intervention test and post intervention test therefore, signifies that both test instruments are considerably reliable.

3.13 Data Collection Procedure

The test items were administered personally by the researcher to the form two elective physics (Science B) students of Navrongo Senior High School after seeking permission from the headmistress and the head of department of science.

The mode used for administering the test items was the investigator-administered mode.

This mode of administration ensured a 100% collection of the test item response. Also respondents were not allowed to communicate among themselves to ensure that response was not affected by other respondent's views. Again for respondents to be candid about their responses they were made aware of the fact that the test was for academic purpose only and that the information they were providing would be kept strictly confidential and that no name was to be written on the test items.

3.14 Data Analysis

The data collected was examined for consistency and accuracy by reading through all the responses that were provided by the respondents. The responses from the test items were analyzed using SPSS. Coding schemes were developed to organise the data into meaningful and manageable categories. The SPSS was chosen for the data analysis because it was reasonably user friendly and does most of the data analysis one need as far as quantitative and qualitative analysis is concerned (Muijs, 2004)

The raw data entries were done by the researcher in order to ensure accuracy of entry of the data. Descriptive statistics such as means, standard deviation, and percentage scores were calculated.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.0 Overview

This chapter deals with presentation of the data collected and analysis of the results. Percentages, statistics of mean, standard deviation and t-tests were employed to analyse the data collected. The data collected from pre intervention test after the students have been taught using traditional method was analysed. Also the data collected from post intervention test after they have been exposed to the analogy instructional strategy was analysed.

4.1 Analysis of Data

In this part, the data generated from students' pre intervention test and post intervention test results, improvement gained, questionnaire were analysed to reflect on the research questions for this study. Detailed discussion has been made on the findings with related literature.

4.2 Analysis with respect to Research Question One.

RQ 1: What is the knowledge students have about the concept of wave before the use of analogy instructional strategy?

This question sought to find out the knowledge students had on wave concept during the traditional method of teaching. The table below shows scores obtained when a 20 test items on wave concept was administered after the topic was taught through traditional method of teaching. The data also present the raw scores of the respondents, their corresponding percentile marks and grades based on a WAEC and

GES standards. The frequency and percentile distribution of students' scores at pre intervention test are presented in table 4.1. The total score was 20 marks and the number of respondents was 52.

4.3 Students Marks at Pre Intervention Test

The table below was obtained when a 20 test question items on wave concept where administered to the samples before the intervention. The data also present the scores of the samples and their corresponding converted percentile marks on a WAEC and GES standard, with its frequencies and percentages.

Table 4.1 Frequency and Percentile Distribution of Students scores at Pre intervention test

Score	percentile score	Frequency	Percentage frequency
6	30	7	13
7	35	8	15
8	40	10	19
9	45	8	15
10	50	6	12
11	55	4	8
12	60	3	6
13	65	2	4
14	70	2	4
15	75	1	2
16	80	1	2
TOTAL		**52**	**100**

4.4 Pre Intervention Test Grades

The Table 4.2 below presents the pre intervention test marks of the students before the intervention as analysed using the WAEC and Ghana Education Service (GES) grading system. This showed how the subject had performed on the WAEC and GES grading standard

Table 4.2 Grades Obtained by the Students during the Pre intervention test

Expected performance By GES & WAEC	**Grade**	**Remarks**		**Percentages**
'0 – 39	F9	Fail	15	28
40-54	D7-E8	Pass	24	46
55 -69	C4-C6	Credit	9	18
70-74	B3	Good	2	4
75-79	B2	V. Good	1	2
80-100	A1	Excellent	1	2
Total			**52**	**100**

Each raw score was giving a weight of 5% which implies that a total score of 20 is a 100% on the percentile. The raw scores obtained ranged from 6 to 16 which were converted from 30% to 80% on a percentile scale. Gravetter and Wallnau (2004) define a raw score as a single score that is derived from a test or an observation whilst cumulative percentages determine placement among a group of scores. Converting raw scores into cumulative percentages allows for meaningful comparisons. (Gravetter & Wallnau, 2004)

The Table 2 therefore presents the percentile score of 30 which was obtained by seven students representing 13% of the respondents. Also one (1) student obtained the highest percentile score of 80 representing 2% of the sample.

In Table 2, the percentile score of 40 was recorded as the highest frequency mark for the ten (10) students representing 19% of the sample obtained. The Table 3 below presents the Pre intervention score marks of the respondents during the traditional method of teaching based on the WAEC and Ghana Education Service (GES) grading system. This showed how the subjects would have performed on the WAEC and GES grading standard.

From Table 3, the best was grade 'A1' which had a frequency of 1 thus representing 2%, followed by grade 'B2' with a frequency of 1 representing 2%, then grade 'B3' with frequency of 2 representing 4%, grade 'C4' to C6 with frequency of 9 representing 18%, also grade D7 to E8 had frequency of 24 with its corresponding percentage of 46 and finally grade 'F9' representing 28% of the sample obtained. These data suggest the best grade obtained during the Pre intervention test was 'A1' and the least was 'F9', whiles the grade obtained by majority of the student (26 students) was ‘D7’ to 'E8' which represented 46%. The results showed that majority of the students would have had pass remark according to the GES and WAEC grading system. This implies that more than two-third of the sample obtained a pass, which on the WAEC was rated as a very poor remark.

According to Hatim (2011), he elaborates that enhanced learning and increased performance is not only found in the social constructivist classroom but the traditional lecture classroom can also enhance learning and increase students’ performance once there is appropriate content and design of teaching or learning. Cullen *et al* (2004) findings also revealed in their study that there was a positive influence in students’ research abilities when the traditional instructional strategy was employed. However in the findings of Clinton and kohlmeyer (2005), it proved that during the instruction with traditional method, there was no change in the students’ results of the concept taught. Therefore in this study, students' results at pre intervention test were compared to their usual performance before the intervention activities and the results showed that there was no significant change. In line with this, Arquero-Montano (2004) in their study conducted in U K did not affect students' results and performance during the use of traditional method of instruction.

4.5 Analysis with Respect to Research Question Two.

RQ 2: What is the knowledge students have about the concept of wave after the use of analogy instructional strategy?

This question sought to find out the knowledge students had on wave concept during the analogy instructional strategy. The table below shows scores obtained when a 20 test items on wave concept was administered after the topic was taught through analogy method of teaching. The data also present the raw scores of the respondents, their corresponding percentile scores and grades based on a WAEC and GES standards. The frequency and percentile distribution of students' scores at post intervention test are presented in table 4.3. The total score was 20 marks and the number of respondents was 52.

4.6 Students Marks at Post Intervention Test

The table below was obtained when 20 question items on wave concept was administered after students were taught via analogy method of teaching. The table also presents the scores of the samples and their corresponding converted percentile scores as on the WAEC and GES standard, with its frequencies and percentages.

Table 4.3 Frequency and Percentile Distribution of Students Score at Post intervention test

Score	percentile score	Frequency	Percenta
10	50	4	8
11	55	5	10
12	60	3	6
13	65	5	10
14	70	4	8
15	75	7	13
'16	80	5	10
17	85	3	6
18	90	8	15
19	95	4	8
20	100	4	8
Total		**52**	**100**

4.7 Post Intervention Test Grades

The table below presents the standard remarks assigned to grades by WAEC and GES

Table 4.4 Grades obtained by the students during the Post intervention test

Marks	Grade	Remarks	Frequency	Percentage
40-54	D7-E8	Pass	4	8
55 -69	C6 –C4	Credit	13	25
70-74	B3	Good	4	8
75-79	B2	V. Good	7	13
80-100	A1	Excellent	24	46
Total			**52**	**100**

Each raw score was also giving a weight of 5%. As shown in Table 4.4, the raw scores obtained ranged from 10 to 20 which was converted to percentile marking scale of 50% to 100% during the Post intervention test.

Table 4 depicts that four (4) of the students obtained the least percentile marks of 50 representing 8% of the sample. Also four (4) students obtained the highest percentile marks of 100 representing 8% of the sample. The percentile mark of 90 was recorded as the highest frequency mark for eight (8) students representing 15% of the sample.

Table 5 shows the best grade obtained by students would have been grade 'A1' based on GES and WAEC grading system which had a frequency of 4 representing 8%, followed by grade 'B2' which had a frequency of 7 representing 13%, then grade 'B3' with frequency 4 representing 8%, then grade 'C4-C6' with frequency of 13 representing 25%, and finally grade 'D7-E8' of frequency 4 representing 8%.

It can be interpreted from the table 5 that the best grade obtained on the Post intervention test was 'A1' as the grade obtained by majority of student which represented 46% and the least was an 'E8'.

The study of Hosal-Akman and Sigma-Mugan (2010) in Turkey explores the effect of teaching methods on the academic performance of students in some selected concept which revealed that there was no statistically significant difference in their results during the exposure to a conceptual approach. However when content is difficult to relate to and the teacher wants to develop critical thinking skills in a didactic lecture Cardoso, Cristiano and Arent (2009) recommend the need for the development and implementation of new educational practices to make classrooms more interesting and interactive even in a lecture format. Therefore Gujarathi (2005), Marriott (2004), Hoffjan (2005) adopted a contemporary teaching format including analogy which their findings showed that there was an improvement in students' performance when they were exposed to contemporary.

In this study, the data collected on the post intervention test was in support of Zohreh *et al* (2010) study which showed students' performance score in the post intervention test increased when compared to their usual performance before the intervention activities.

4.8 T-test Analysis

With the administration of the test items, the researcher was interested in finding out whether the analogy instructional strategy had any effect on the performance of the students as against the traditional method of teaching. Therefore T – test analysis was performed on the mean scores for pre intervention test and post intervention test. This was done to determine whether significant difference exist between the mean scores.

Table 4.5 T–test Analysis of Pre intervention test and Post intervention test

Test	N	Mean	D F	S D	T –value	P-value	Hake Gain
Pre intervention test	52	9.154	51	2.484	-36.931	.000	0.67
Post intervention test	52	15.154	51	3.077			
Difference		6.000		1.172			

Significance at 0.05; $p < 0.05$

Table 4.5 above presents the mean score for Pre intervention test of subjects in traditional method of teaching and the mean score for Post intervention test of subjects in analogy instructional strategy. It is observed in Table 4.5 that the means of the scores for pre intervention test and post intervention test indicates that the mean scores increased from (M = 9.154, SD = 2.484) to (M=15.154, SD = 1.172). The normalized gain (g) for the pre intervention test and post intervention test was 0.7 indicating that student's marks on post intervention test as compared to the pre intervention test shows a medium gain in improvement in performance during the post intervention test where analogy instructional method was employed. Also total performance scores of the entire sample put together on the post intervention test (788) was higher than the total scores at pre intervention test (476). This implies that there was an improvement in performance of 39.6% during the post intervention test. This finding supports that of Elvis (2013), whose study proved that, when analogy instructional strategy was compared to that of traditional method of instruction, achievement was improved by over 38%.

Conducting a dependent t-test to evaluate whether a significant change occurred between the pre intervention test and post intervention test, results showed that the difference between the mean scores was significant at p value of 0.00 which the significant difference was set at alpha (α) value of 0.05 hence there was a significant difference. The researcher therefore concludes with 95% confidence that the samples performed better at the post intervention test. The researcher therefore had sufficient information to conclude that there was a significant difference between the analogy instructional method of teaching and the traditional instructional method of teaching.
Difference in the mean values of the pre intervention test 9.154 and post intervention test 15.154 was 6.00 indicated that there was a moderate effect. This implies that there was an appreciable improvement in the post intervention test as compared to the pre intervention test. In line with this, Okoronka and Taale (2014) in their research findings supported that superior academic performance was achieved when analogy forms of instruction were utilised.

4.9 Analysis with Respect to Research Question Three

RQ. 3. What is the perception of students about the use of analogy instructional strategy?

It is seeking to establish the views or perception of students about the use of analogy instructional strategy in teaching as compared to the traditional method of teaching.
As indicated earlier, unstructured questionnaire was conducted to the sample to gather their views on the perception of the analogy and traditional instructional strategies. The questions also covered the assimilation of the concept and their preference in terms of the teaching strategies they were exposed to.

Majority of the samples said they perceived the analogy to be illustrative, quick, and practical as it relates familiar objects and learners' environment to abstract concepts. Out of the total sample, most of the sample also said that the analogy method allowed them with different learning skills to communicate with the lesson at their own best ways. This view was supported by Saleeb and Dafoulas (2010) who also found out that learners enjoy interactive learning and it is efficient, effective and flexible; facilitates the understanding of concepts.

The entire sample said that the analogy lesson guided them by identifying the production and propagation of types of wave. The students said that when the traditional method was employed such clarity of identifying the various types of waves, production and propagation was not demonstrated. This was in line with what Lulis (2005), came out with in his research stating that the use of analogy instruction facilitates communication and helps individual to learn in a conceptual domain.

4.10 Assimilation

The student said they absorbed much on the analogy instructional method of teaching than the traditional method of teaching since the familiar objects and animations aided them to view the waves of different types, the production and propagation. They said the analogy method helped them built up a mental picture on their brains on the wave concept as compared to the traditional method.

Lulis (2005) found out in his study that analogy provides concrete basis for understanding abstract and difficult concepts and makes it more meaningful and permanent for learning.

The samples therefore found it interesting and thus motivated them to learn. This finding is similar to that of Kutlu (2014), who said analogy method of teaching increases motivation to learning. Oakes and Lipton (1999) also affirmed that when analogy materials are used for teaching, it stimulates several senses thus making the learner more involved in the learning process. Students felt excited and desired to put in their best in leaning once they are motivated.

4.11 Preference

The student said they preferred the analogy instruction since they could remember what was taught and could narrate enough what they observed and viewed on the analogy than that of the traditional method.

Cross (1999) also supported in her research that analogy instructions make students move through the learning experience faster than in a traditional classroom.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter discusses the findings obtained from analysis of the data in relation to relevant literature. Areas of focus included knowledge of students on the concept of wave based on the traditional method before the use of analogy instructional strategy including summary of the findings and conclusion as well. Also in the chapter are recommendations and areas for further studies.

5.1 Summary of Findings

The purpose of the study was to find out if there was any difference in the application of the traditional method in teaching wave concept and that of analogy method of teaching wave concept in Physics. Test items of 20 were administered using pre intervention test and post intervention test to find out the performance of students on the two methods of teaching being applied. Pre intervention activities was when the samples were taught for four weeks with the traditional method of teaching and a post-intervention activities was when the analogy method of teaching was also employed for four weeks on the samples.

An intact class of fifty two of the form two science students from Navrongo SHS from the Kasena Nankana Municipality in the Upper East Region of Ghana was the sample used for the research. Results from pre intervention test and post intervention test intervention activity were collected, marked, recorded, analysed and discussed.

The results showed that the average normalised gain of the post and pre intervention test scores was a gain of 0.66, indicating that there was a medium gain in students' performance. A dependent sample t-test conducted also showed a significant difference in the pr intervention test and post intervention test score, p= 0.000 (α=0.05). Hence there was a significant difference between the pre intervention test and post intervention test scores indicating that students did perform better when taught using the analogy method of teaching than the traditional method of teaching. Finding from interviews with the sample indicated that students prefer the analogy method of teaching to the traditional method of teaching.

5.2 Conclusion

The analogy learning activities provided an equal support for every student to eventually achieve and enhanced performance and conceptual understanding of the concepts taught. The findings from the pre intervention test and post intervention test results showed that the students' conceptual understanding and performance had improved. From the observations and questionnaire it was revealed that students largely developed conceptual understanding in wave concept due to the intense student-student interactions, peer support, active participation of all students in the interactive lessons, maximum teacher support coupled with the high levels of motivation during lessons.

Results from this study also indicated that majority of the students enjoyed the interactive lessons with analogy and thus, they were motivated more to participate actively in the lessons therefore they preferred analogy instructional strategy to traditional strategy of instruction.

Finally, it was concluded that the analogy method of teaching was an effective way of improving student's performance in the teaching and learning of wave concept in physics. Analogy also made it easier for teachers to communicate the lesson or topic to the students and also help teacher to improvise in the absence of an actual material.

5.3 Recommendations

From the study, the following guidelines are recommended to schools and teachers at Kasena Nankana Municipality especially Navrongo Senior High School who would like to include analogy instructional strategy in the teaching and learning of physics.

- Science teachers should be encouraged to employ the use of analogy method of teaching in the delivery of their lesson so that student can perform better.
- Science teachers are encouraged to improvise in the absence of real material to make their science lesson practically oriented. The ministry of education through GES should organise workshops, in-service training frequently for science teacher on the practical use of analogy in their teaching.
- Science teachers are encouraged to get personal training on the use of analogy that could enhance their teaching.
- Head of institutions should encourage their science teachers to employ the use of analogy in the delivery of their lesson.

5.4 Areas for Further Studies

Reflecting on the findings of this study, the following recommendations are made for further research with respect to the use of analogy instructional strategy on Physics teaching:

- The attitudes of SHS science teachers to the use of analogy method of teaching in delivering their lesson.
- Use of Analogy by science teachers and students in improving their teaching and learning of physics.

- A study should be carried out to find out the number of science teacher who are familiar with analogy, uses analogy and the number of times they use it in the delivery of their lessons.

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APPENDIX 1

PRE INTERVENTION TEST

WAVE CONCEPT TEST (WCT)

ANSWER ALL QUESTIONS

1. A single disturbance that moves from point to point through a medium is called a ___.

a. period   b. periodic wave   c. wavelength   d. pulse

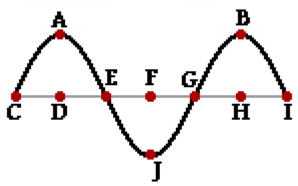
2. If the particles of the medium are vibrating to and fro in the same direction of energy transport, then the wave is a ____ wave.

a. longitudinal   b. sound   c. standing   d. transverse

3. When the particles of a medium are vibrating at right angles to the direction of energy transport, then the wave is a ____ wave.

a. longitudinal   b. sound   c. standing   d. transverse

4. A transverse wave is traveling through a medium. See diagram below. The particles of the medium are vibrating _____.



a. parallel to the line joining AD.   b. along the line joining CI.

c. perpendicular to the line joining AD.   d. at various angles to the line CI.

5. If the energy in a longitudinal wave travels from south to north, the particles of the medium would be vibrating _____.

a. from north to south, only

b. both north and south

c. from east to west, only

d. both east and west

6. As a pulse travels though a uniform medium, the speed of the pulse ____.

a. decreases b. increases c. remains the same d. stops

7. The main factor which affects the speed of a sound wave is the ____.

a. amplitude of the sound wave

b. intensity of the sound

c. loudness of the sound

d. properties of the medium

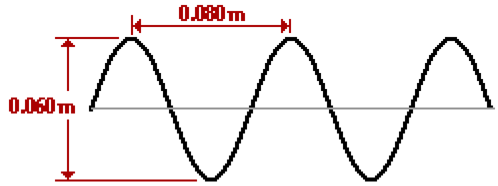
8. As a wave travels into a medium in which its speed increases, its wavelength would ____.

a. decrease b. increase c. remain the same d. becomes zero

9. As a wave passes across a boundary into a new medium, which characteristic of the wave would NOT change?

a. speed b. frequency c. wavelength d. amplitude

10. What is the amplitude of the wave in the diagram below?



a. 0.03 m. b. 0.04 m. c. 0.05 m. d. 0.06 m.

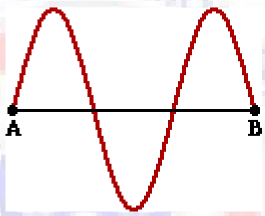
11. The wavelength of the wave in the diagram above (Question #10) is ____ m.

a. 0.030 b. 0.040 c. 0.060 d. 0.080

12. A wave X meters long passes through a medium with a speed of Y meters per second. The frequency of the wave could be expressed as

a. Y/X cycles/sec. b. X/Y cycles/sec. c. XY cycles/sec. d. (X + Y) cycles/sec.

Consider the following diagram for Questions #13-#14.



13. How many complete waves are shown in the diagram?

a. 1 b. 2 c. 3 d. 1.5

14. If the distance from point A to point B in the diagram is 60 cm, then the wavelength is ____.

a. 20 cm. b. 40 cm. c. 60 cm. d. 90 cm.

15. The number of cycles of a periodic wave occurring per unit time is defined as a wave's ____.

a. wavelength. b. period. c. amplitude. d. frequency.

16. A periodic and repeating disturbance in a lake creates waves which emanate outward from its source to produce circular wave patterns. If the frequency of the

source is 2.00 Hz and the wave speed is 5.00m/s then the distance between adjacent wave crests is ___ meter.

a. 0.200 b. 0.400 c. 1.25 d. 2.50

17. What is the frequency of a wave that has a speed of 0.4 m/s and a wavelength of 0.020 meter?

a. 10 hertz. b. 20 hertz. c. 0.008 hertz. d. 0.5 hertz.

18. Many wave properties are dependent upon other wave properties. Yet, one wave property is independent of all other wave properties. Which one of the following properties of a wave is independent of all the others?

a. wavelength b. frequency c. period d. velocity

19. A pendulum makes exactly 40 vibrations in 20.0 s. Its period is ____. (Be cautious of the units.)

a. 0.500 s. b. 2.00 Hz. c. 2.00 s. d. 8.00 x 10^2 Hz.

20. A period of 0.005 seconds would be equivalent to a frequency of ____ Hz.

a. 20 b. 50 c. 200 d. 500

APPENDIX 2

POST INTERVENTION TESTS

WAVE CONCEPT TEST (WCT)

ANSWER ALL QUESTIONS

1. A wave whose speed in a snakey is 4.4 m/s enters a second snakey. The wavelength changes from 2.0 m to 3.0 m. The wave in the second snakey travels at approximately ____.

a. 2.2 m/s b. 2.9 m/s c. 4.4 m/s d. 6.6 m/s

2 If the energy in a logtitudinal wave ravels from north to south, the particles of the medium would be vibrating …………….

a. From north to south only b. both south and north c. from east to west only d. both east and west

3. A 2.0-meter long rope is hanging vertically from the ceiling and attached to a vibrator. A single pulse is observed to travel to the end of the rope in 0.50 s. What frequency should be used by the vibrator to maintain three whole waves in the rope?

a. 1.3 Hz b. 4.0 Hz c. 6.0Hz d. 8.0 Hz

4. Which phenomenon is produced when two or more waves passing simultaneously through the same medium meet up with one another?

a. refraction b. diffraction c. interference d. reflection

5. If the particles of the medium are vibrating to and fro in the same direction of energy transport, then the wave is a ____ wave.

a. longitudinal b. sound c. standing d. transverse

6. As a pulse travels though a uniform medium, the speed of the pulse ____.

a. decreases b. increases c. remains the same d. stops

7. A vibrating object is necessary for the production of sound.

a. True b. False

8. The main factor which affects the speed of a sound wave is the ____.

a. amplitude of the sound wave b. intensity of the sound

c. loudness of the sound d. properties of the medium

9. As a wave travels into a medium in which its speed increases, its wavelength would ____.

a. decrease b. increase c. remain the same d. stops

10. Which one of the following CANNOT transmit sound?

a. Liquid air b. Liquid water c. Solid steel d. Perfect vacuum

11. As a wave passes across a boundary into a new medium, which characteristic of the wave would NOT change?

a. speed b. frequency c. amplitude d. wavelength

12. Constructive interference of waves occurs when two crests meet.

a. True b. False

13. A vibrating object is necessary for the production of sound.

a. True b. False

14. Wave motion in a medium transfers

a. neither mass nor energy b. energy, only c. both mass and energy

d. mass, only

15. What is an example of a longitudinal wave?

a. gamma ray b. water wave c. x-ray d. sound wave

16. As the frequency of a wave increases, the period of that wave

a. remains the same b. increases c. decreases d. stops

17. A periodic wave with a frequency of 10 hertz would have a period of

a. 100 s b. 0.1 s c. 10 s d. 1 s

18. An opera singer's voice is able to break a thin crystal glass if the singer's voice and the glass have the same natural

a. speed b. frequency c. amplitude d. wavelength

19. A police officer's stationary radar device indicates that the frequency of the radar wave reflected from an automobile is less than the frequency emitted by the radar device. This indicates the automobile is

a. not moving b. moving away from the police officer c. moving toward the police officer

20. A pendulum makes exactly 40 vibrations in 20.0 s. Its period is ____. (Be cautious of the units.) a. 0.500 s. b. 2.00 Hz. c. 2.00 s. d. 8.00 x 10^2 Hz.

APPENDIX 3

ANSWERS TO PRE INTERVENTION TEST (WAVE CONCEPT TEST; WCT)

1. D
2. A
3. D
4. A
5. B
6. C
7. D
8. B
9. B
10. A
11. D
12. A
13. D
14. B
15. D
16. D
17. B
18. D
19. B
20. C

APPENDIX 4

ANWERS TO POST INTERVENTION TEST (WAVE CONCEPT TEST; WCT)

1. D

2. B

3. C

4. C

5. A

6. C

7. A

8. D

9. B

10. D

11. B

12. A

13. A

14. B

15. D

16. C

17. B

18. B

19. B

20. C