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GUIDED DISCOVERY TEACHING ON PERFORMANCE OF STUDENTS IN MODES OF HEAT ENERGY TRANSFER

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DECLARATION

Candidate's Declaration

I, Ben Kofi Adams declare that this declaration , with the exception of quotations and references contained in published works which have all, to the best of my knowledge ,been identified and acknowledged is entirely my own original work, and it has not been submitted, either in part or in whole, to any institution anywhere for the award of another degree.

..... Date.....

Ben Kofi Adams

Supervisor's Declaration

I hereby declare that the preparation and presentation of this dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by the University of Education, Winneba

..... Date.....

Dr. Victor Antwi (Supervisor)

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DEDICATION

I dedicate this work to the Almighty God. I also dedicate it to my wife and kids for their moral support and daily encouragement.

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ABSRTACT

The concern of this study was to investigate the effect of guided-discovery learning strategy on the performance of students on mode of heat transfer. Students from two selected public senior high schools were used. The research was a quasi-experimental one and the main instruments for data collection were a 20-item multiple choice Physics Achievement Test drawn from West African Examination Council past questions on mode of Heat Transfer and a questionnaire. The questionnaire items were seven (7) in number and were related to students' interest in physics. Three research questions were raised with three corresponding hypotheses tested. The size of the population was 350 senior high school two (SS2) physics students. The sample of the study was 90 SS2 physics students of which 63 were males and 27 were females taken from two schools. This comprises two science classes of forty-five (45) students from each school. Purposive sampling technique was used to select the schools from the target population. Excel was used to analyse the data obtained from the Pre and Post test data analysis. The outcome of the results revealed a significant difference in favour of those exposed to guided-discovery learning strategy compared to those taught using the traditional lecture method since their means were 2.19 and 3.55 respectively. It was deduced after the study that students interest in the study of Mode of Heat energy transfer was improved as well. It was recommended among others that physics teachers should make the teaching and learning of physics interactive and activity – based for the students, using strategy that all students could benefit from, irrespective of the ability levels of the individuals in the classroom.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with the background to the study, statement of the problem, purpose of the study, the objectives of the study, research questions and hypothesis. Significance of the study, limitations and delimitations of the study will also be dealt with.

1.1 Background to the study

Science education plays prominent roles in determining scientific and technological advancement of every individual and the nation as a whole. According to Godek (2004), there cannot be any meaningful development without science education. Science advancement has been seen as the single most important factor in sustained economic growth. It has also been described as the principal driving force behind long-term economic growth of developed countries and their rising standard of living. According to Bilesanmi-Awoderu (2006), the level of development of a country is a measure of its scientific advancement; as such science education cannot be undermined in any country's development. Despite very many efforts that have been made over the years to improve the quality of science learning in our schools, students' achievement in physics has remained persistently not encouraging at the Senior High School. The primary goal of science education is to enable us to construct knowledge of how our universe works, in order to explain, and possibly control phenomena (Carin, 1997). To achieve this goal we need to educate our students in a way that will make them competent. Science educators and in particular

physics teachers in secondary schools need to change their teaching approach to make them more effective and relevant to much larger proportion of student population than in the past (International Bureau of Education, 2000; Wieman & Perkins, 2005).

Teaching methods are the most important techniques employed by teachers to realize the objectives of a lesson (Borich, 2007). Thus, teachers of all disciplines including physics use various teaching methods for achieving lesson objectives. For physics students to achieve their full potential in schools, it is important that teachers engage in effective teaching practices (Borich, 2007).The desire to pursue physics at higher levels (beyond secondary education) is influenced by the success rate and foundation a student receives in physics at the senior high school. A study by Buabeng and Ntow (2010) revealed a wide range of reasons which accounted for students' negative response to physics in Ghana. Prominent among these factors were teacher factor, poor performance, perceived difficult nature of physics and unknown career opportunities in the subject. Most of the students are of the view that there is a reduced interest in the subject at the Senior High School (SHS) level because the subject is poorly presented to them (Buabeng & Ntow, 2010).

To teach any subject effectively, one must know what the subject is all about and for what purpose the subject has been introduced into the school curriculum (Obomanu, 1999). Hence, it is pertinent for science teachers to raise questions like "For what purpose was science first introduced into elementary and secondary school programme?" and "What are the historical backgrounds of the development of science programme from their early appearances as part of the general education of children?" Teacher's knowledge of subject matter alone does not guarantee effective teaching and learning. We may not have the best method of teaching and learning in our educational system, but there is a choice of one method over the other due to the

nature of learners and the desired output of the lesson. Teaching physics for students to understand has been a problem to many teachers at the secondary school. Students often have difficulties in explaining real-life phenomena with the physics they learn (Moore, 2004). Moreover, physics is often considered as having little to do with the real world and more to do with plugging numbers into formulas to solve textbook problems. Although the problems have been there in the past, many teachers are not aware of these problems. They adopt a teaching strategy which centres on the teachers while the students are only a passive audience, hence the incorrect prior knowledge is not properly addressed. Traditionally, a teacher presents the material from the textbook, models the problem solving examples and occasionally performs demonstrations. The students listen to the presentation, take notes, but rarely ask questions or give comments. During the lesson the students just copy the solutions presented by the teacher into their notebooks. The students may have to do some practical activities in the laboratory; but they just follow the prescribed procedures without thinking for themselves. Changing the gimmicks we use to teach in the classroom without changing the way we think about teaching and learning is, according to Lester and Onore (1990), insufficient to change our practice. A complete rethinking of what teaching and learning are is necessary if we are to really change what happens in the classroom. The physics teacher is therefore required to design teaching sequences with appropriate teaching pedagogies that has the potential to develop students' interest in the subject and their abilities to properly respond to situations they may encounter in their world of life that their knowledge in physics may be of benefit.

According to Okoro (2002), in many countries particularly in the developing countries, the science education in general education in schools does not seem to help

students achieve scientific and technological literacy or feel confident either in applying their knowledge or dealing with societal problems. Therefore, to achieve meaningful learning, appropriate strategies, methodologies or techniques become very necessary to the teacher.

Ajiboye and Ajitoni (2008) observed that children learn best by being interested fully in their own work, by seeing themselves, doing themselves, by puzzling themselves, by verifying their own suppositions; by experimenting themselves, by drawing conclusions themselves on the strength of evidence which they have collected themselves. They should always make mistakes which they then should rectify themselves in the light of new information and evidence that they have uncovered themselves. This pedagogic concept should be participatory through social interaction, togetherness, and action-oriented communication. Guided discovery strategies belong to these pedagogic concepts. Once an individual acquires the right skills and attitude through appropriate teaching methods she/he can survive even in all situations. The challenge that seems to have lingered for quite some time now is the question of female participation in science and related subjects. Literature shows that gender could be a strong prediction of human conduct and that differences have been documented between the attitudes, behaviours, and achievement of males and females (Aguele and Uhumuavbi, 2008). Some studies have shown that there are distinguishing differences in the cognitive, affective, and psychomotor skill achievements of students with respect to gender (Ogunkola, 1998), whereas some others provided reports that there are no distinguishing differences (Bilesanmi-Awoderu, 1998; Duch, 2001). This tends to suggest that there is the need to examine gender influence in teaching strategies as one of the intervening variables in this study.

Okere (1996) discussed that teachers should maximize the degree to which learners expand their knowledge by developing and testing hypothesis rather than merely reading or listening to verbal presentations of information. Emphasis is to be put on activities that encourage students to search, explore, analyze or actively process input rather than merely respond to it. When this approach to teaching is practiced in physics, the students mind is opened to understanding how the general physics principles and laws came about.

Thus having a better understanding of physics and technology and better technical problem-solving skills will enable people to meet the challenges and demands of the work place (Effandi & Zanaton, 2006). Studies indicate that many teachers prefer the traditional lecture method of teaching and shy away from innovative methods like inquiry, discovery and laboratory approach to learning without showing regard to students' learning abilities. These traditional teaching methods are theoretical, extremely didactic and teacher centred, instead of being activity-based and learner centred.

Teachers are expected to be intellectually and professionally competent as well as dynamic enough to adapt to the dynamics of scientific growth and development and discharge their duties to a much more satisfying level. To buttress this point, it was emphasized that even a good curriculum in a well-stocked laboratory would still not give the desired result in the hands of an incompetent teacher (Ossai, 2004).

Guided Inquiry means careful planning, close supervision, ongoing assessment and targeted intervention by an instructional team of teachers through the inquiry process that gradually leads students towards independent learning. Its ultimate goal is to develop independent learners who know how to expand their knowledge and expertise

through skilled use of a variety of information sources employed both inside and outside of the school (Crede and Kuncel, 2008).

Guided discovery requires students to find out things for themselves. This cannot be done where the teaching method is lecture oriented and study habit inactive. The use of guided discovery method for teaching physics in combination with an active study habit would motivate the interest of students in a lesson. It focuses students' attention and initiates problem solving. If guided discovery and active study habit for teaching physics are utilized, the students will be self-reliant after graduation. Effective teaching of physics does not only stimulate students' interest in the subject but also enhances performance in examination (Nwagbo, 2004).

1.2 Statement of the problem

According to Akuma, (2008), different instructional strategies employed in teaching physics have not improved students' performance in the subject to any appreciable extent. This mean that the most desired scientific and technological application of physics cannot be sustained. According to Kohle (2002), the traditional pedagogical practice, which is confined to transmitting information and involves telling, reading, and memorizing, and the teacher adopting the "fountain of knowledge" approach, have failed to cope with the problems of scientific knowledge needed for development. The implication is that the teaching of physics does not lead to students' understanding of concepts and application of its ideas. The expository approach is a teacher centred, student-peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials. Iheonu (2005) indicated that in using this approach, the teacher talks about science while the students read about science.

According to Nwagbo (2004), during the early 70's the rational for science teaching shifted as discovery strategy was adopted worldwide. This was because students tended to memorize facts and concepts, most of which they did not understand. This resulted in a lack of retention and application of concepts. They maintained that there was a great burst of interest as the guided discovery strategy was adopted in the Nigeria curriculum. Many factors may influence students' performance; however, choosing appropriate teaching method may greatly increase one's effectiveness in teaching and learning.

The poor performance in physics may be attributed to inappropriate teaching methods and approaches used by physics teachers and low students motivation to learn physics. Considering that physics is a requirement for many technical courses, the universities and other tertiary institutions, there is the need to enhance student's performance and motivation to learn the subject.

Reflecting on one's teaching practice contributes to one's ability to cross the bridge in terms of the way one thinks and believes about teaching. This enables him or her to move, for example, from a transmission instructional practice to a constructivist and transactional one (Gray, 1997).

Lester and Onore (1990) suggest that the main construct affecting a teacher's ability to teach in a transactional, constructivist way is the belief that knowledge is constructed by human beings. So teachers would need to make a shift in thinking and change what they believe about knowledge in order to really change their teaching. If they have the chance to present what they think and hear others' ideas, students can build a personal knowledge based on what they understand. Discovery learning takes place in problem solving situations where the learner draws on his own experience and prior knowledge and is a method of instruction through which students interact with their environment

by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments (Burner, 1967). Alternatively, constructivists hold the view that individuals actively construct their own reality in an effort to make sense of their experience. An effective learning in science is interactive, involving the learner in constructing ideas as a result of experiences

Nwagbo (2001), quoting research reports, noted that teachers shy away from the more effective activity oriented teaching methods in preference for methods that are easy and most times inadequate and inappropriate. But because the quality of any educational programme is the function of those who teach it, teachers are expected to be intellectually and professionally competent as well as dynamic enough to adapt to the dynamics of scientific growth and development and discharge their duties to a much more satisfying level. There is a famous saying of Confucius about the success of the students learning as:

"Tell me, and I will forget, show me, and I may remember, involve me, and I will understand". Teaching is effective when the approach brings about a desirable change in the behaviour of the learner. Nwagbo (1999) explains that guided discovery mode which is an example of constructivist's learning, is an approach to enquiry. On the other hand, the teacher provides illustrative materials for students to study on their own. Leading questions are then asked by the teacher to enable students think and provide conclusions through the adoption of the processes of sciences. Nwagbo believes that if the learner is allowed to discover relationships and methods of solution by him or herself make his or her own generalizations and draw conclusions from them, he or she may then be better prepared to make wider applications of the material learned. According to Ugwuanyi (1998), a learner is active in discovery learning, and provides for individual difference as well as makes the process of

learning to be self-sequenced, goal directed, with the goal perceived and self-determined. Guided discovery is a teaching method where the teacher guides students through open ended activities in order to encourage them to discover concepts for themselves.

In this vein the problem of the study is that students have not been performing well in modes of heat energy transfer due to the traditional lecture approach that many teachers use as their mode of teaching. This research study is pertinent to find out the extent to which the use of guided discovery teaching affects the performance of Ebenezer Senior High school two science students in Accra.

1.3 Purpose of the Study

This study was designed to investigate the effect of guided discovery approach on secondary school students' performance in the learning of the mode of heat transfer in physics.

1.4 Objectives of the Study

The objectives of the study were to:

1. Determine the difference in performance of students when taught using guided discovery approach and traditional lecture method.

2. Assess the performance of male and female students in physics when taught using guided discovery approach.

3. Determine the influence of guided discovery approach on the interest of students towards the study of physics.

1.5 Research question

The following research questions guided the study:

1. Is there any difference in the performance of students when taught using guided discovery approach?
2. What is the performance of the male and female students in physics when taught using guided discovery approach?
3. To what extent will the use of guided discovery teaching strategy have on the interest of students towards the study of Physics?

1.6 Research hypotheses

The following hypotheses were tested in this study:

1. There would be no significant difference in the performance of students when taught mode of heat transfer using guided discovery approach and those taught using the traditional lecturer method.
2. There would be no significant difference in the performance of male and female students in physics when they are taught mode of heat energy transfer using guided discovery approach.
3. There would be no significant influence on the interest of students towards the study of physics when taught mode of heat energy transfer using guided discovery method.

1.7 Significance of the study

1. It is the view of the researcher that the findings made in this study will go a long way to help teachers improve their teaching and to select appropriate teaching materials for their lessons.

2. It is also hoped that the findings of the research will make policy makers and stakeholders in science education and especially Curriculum Research and Development Division (CRDD) of Ghana Education Service to effectively restructure the skill and knowledge to be imparted in the science and physics syllabi.
3. It may also serve as basis for future research in to other science related issues to enhance teaching and learning.

1.8 Delimitations

The scope of study was for all senior secondary two (SS2) physics students but due to time and financial constraints, Ebenezer Senior High School and Wesley Grammar Senior High School were selected from the schools in Dansoman area of Accra.

1.9 Limitations of the study

The teacher who would teach the control group using the traditional lecture approach might not strictly use that approach and that might influence the result of the control group in a way.

Also students might not be truthful in answering the questionnaire items which might affect the results.

2.0 Organization of the chapters

The dissertation is in five chapters. Chapter one is the introduction to the study. It consist of the background to the study, statement of the problem, purpose of the study, objective of the study, research questions and research hypotheses, significance of the study, limitation and delimitation of the study.

Chapter two focuses on the review of available literature related to the study. Chapter three comprises the general methodology of the work. It touches on the research design, population, sampling and sampling procedure, instrumentation, validity and reliability, treatment procedure and instructional strategy.

Chapter four consists of statistical analysis of the data collected. The final chapter is on research summary, conclusion and recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter reviews the theories, related literature and ideas expressed by other writers concerning the effectiveness of using guided discovery approach in the teaching and learning of physics. It also discusses the aim of physics education at the secondary schools in Ghana, teachers' role in teaching and the teaching strategies used in teaching physics and the challenges that confront teachers in the effective teaching and learning of physics.

2.1 Underlying theoretical framework

The study is targeting senior high school physics students, physics teachers and the teaching approach suitable for the students. It is in this regard that the research is designed to study the effectiveness of guided discovery approach in teaching physics on performance of students at Ebenezer Senior High School and Wesley Grammar Senior High School in Dansoman area of Accra.

John Dewey, a well-known philosopher of education at the beginning of the 20th century was the first to criticize the fact that science education was not taught in a way to develop young scientific thinkers. Dewey proposed that science should be taught as a process and way of thinking not as a subject with facts to memorize (Dewey, 1997).

Physics teachers therefore have to change their perceptions about how the subject is taught. The attitude and approach of teachers in the learning of physics play a vital role in the learner. Guided discovery approach is helping to do meaningful learning.

In the preface of his book, Educational Psychology: A Cognitive view, Ausubel says that, if he had to reduce all of educational psychology to just one principle, he will say this: the most important single factor in influencing learning is what the learner already knows, ascertain this and teach him accordingly (Ausubel,1968). Physics as a discipline deals with the nature of matter and energy, their interaction and measurement. The study of physics has had, and continues to have, a big impact on the world. The ideas, skills and attitude derived from the study of physics are being widely applied in various scientific and technological developments. The principle and applications of physics cut across the various spectrums of everyday life activities like walking, lifting objects, seeing and taking photographs.

2.2 Cognitivist view

According to the cognitive view of learning, learners actively modify their mental structure to make sense of the world they experience. Knowledge is represented by this mental structure which constantly undergoes modification through interactions between the learner and the information received. Early cognitive views were concerned with how knowledge is acquired, but current perspectives emphasize how knowledge is constructed (Greeno, Collins & Resnick, 1996; Mayer, 1996).

Cognitive learning theorists believe that learners do not simply absorb information from the environment nor simply respond to external stimuli. They actively engage in mental work to make sense of what they experience. They seek information to satisfy their curiosity, they restructure their knowledge in light of new information, and they modify their behaviour accordingly. Learners refer to what they already know to understand new information. Prior knowledge is developed from past experiences and interpretation of meaningful information. Because prior knowledge is used as a

reference in understanding new information, simply telling the learners to change what they believe does not often work.

According to the cognitive perspective of learning, the change in learners' behaviour could be explained by the change in mental associations arising from experiences. This school of scientific psychology became increasing popular during the 1970s and remains as the most prominent school in psychology (Robins, Gosling & Craik, 1999).

Learners' existing knowledge and needs determine which information they choose to attend to. Information which does not make sense, is contrary to the learner's beliefs, or is regarded as unimportant will disappear from the memory system. Once the information is attended to, it goes through the perception phase before reaching the working memory. Perception is "the process to attach meaning to stimuli" (Eggen & Kauchak, 2004, p. 250)

Cognitive development is "gradual orderly changes by which mental processes become more complex and sophisticated" (Woolfold, 2005, p. 20). Children need to interact with their physical and social environments (Piaget, 1977). The physical environment includes objects and events that children can explore or experience. Cognitive development is promoted if children have opportunities to engage in activities, and is a process of building knowledge. In addition to being exposed to the physical environment, children need to have interactions with other people. This helps children towards the process of modifying their existing knowledge and understanding the world better.

Vygotsky (1978) believe that interactions with peers or knowledgeable adults initiate the process of developing understanding. Children actively participate in dialogues with other people, discover how others think about their experiences, and then

incorporate the ways others interpret the world into their own ways of thinking. This process of internalization is possible through interactions with adults from whom children receive explanations, directions, and feedback as well as with their peers who often provide several ways to view a particular situation.

Vygotsky introduced the concept of "zone of proximal development" which is a range of tasks that individuals cannot yet accomplish on their own, but can be successful under the guidance of more capable persons or in collaboration with their peers. Learners do not benefit much from doing the tasks they are independently capable of. Instead, by successfully learning something beyond their current knowledge with the help of others, learners are able to develop their knowledge towards more complex and sophisticated structure. Some principles embedded in Vygotsky's theory have been utilized in various teaching strategies, for example scaffolding, guided participation and peer interaction. Support and guidance are provided to help learners to perform a task in their zone of proximal development. This support is then gradually withdrawn so that learners become more independent. Scaffolding can be done by modelling, thinking aloud, questioning, adjusting instructional materials, providing prompts and cues, doing part of the problem, giving detailed feedback and allowing revisions (Eggen & Kauchak, 2004; Rosenshine & Meister, 1992).

In guided participation, assistance is provided for learners to perform adult-like tasks (Radziszewska & Rogoff, 1990). Learners are encouraged to use terminologies and to carry out procedures typically involved in activities conducted by more knowledgeable or skilful people. According to Bruner there are three main stages of intellectual development that learners go through from simple to complex thinking. The basic stage is called enactive stage where learners manipulate objects to learn about the world around them. Objects exist in the real sense where they can be seen,

touched, smelled and played with. The next stage is iconic stage where learners represent experiences and objects as concrete images. Instead of handling concrete objects, learners are able to use models, demonstrations and pictures to learn something new. In the most advance stage, the symbolic stage, learners are able to think abstractly with symbols. At this stage, learners can mentally process hypothetical objects or situations they have not previously experienced with. Bruner suggested that instruction follows a sequence of the three stages. To achieve an optimum result, learners should first have a concrete experience which they can physically do something about. Then, learners should be encouraged to create representations of what they learn in some forms (diagrams and pictures). Finally, learners can be motivated to extend what they learn and apply it in a hypothetical situation. Normally, learners follow the order of these developmental stages. Bruner believed, however, that learners who are already at the symbolic stage often get some benefit when they are provided with opportunities of experiencing the previous stages (Bruner, 1966).

Teaching science by discovery methods will not only increase their knowledge base of scientific facts, but it will augment students' confidence in their ability to discern knowledge.

Magno, Lajom and Regodon (2005) concluded that the classes receiving the guided discovery activity on memory had significantly higher performance in the test and had higher attitude as compared with the other classes who received instruction through traditional method.

Science is more than collecting and manipulating data or memorizing knowledge. It is a process of inquiry that requires asking questions, observing, data exploration and data manipulation. It requires learning to apply and generalize scientific knowledge.

Creating such learning environment requires engaging learners in different activities. Active engagement in learning activities develops conceptual understanding and motivates students to seek further information (Brophy, 1995).

Hussain, Anwar and Majoka (2011) reached on the conclusion about the effect of activity-based learning that, it is more effective to teach physics at secondary level as compared to traditional method of teaching. Teaching science through guided discovery is not just providing hands-on activities for students. It is designing experiments and talking about it. It is reporting on their investigations, reflecting, and making and communicating self-assessment (Joseph, 2010). Discovery learning is an inquiry-based approach in which students are given a question to answer, a problem to solve, or a set of observations to explain, and then work in a largely self-directed manner to complete their work and draw conclusions (Fleer & Hardy, 2007). Each country is striving towards producing more and better trained scientists and technologists. This is justified for; science has lately assured the importance of the foundation of national power and productivity. Therefore, the primary task of the science teacher is the transmission of selected experiences in science to his students. One of the best means of helping children know the world at hand is to organize materials so children can explore, question, reason and discover answers through their own physical and mental activity (Featherston, 2007). Guided discovery learning adds freshness to the classroom and creates a partnership in learning between the children and teacher. Learning something when you want to learn it – on a "need-to-know" basis- is both memorable and emotionally satisfying (Olson, 2009). Guided discovery is based on asking a series of questions that allows information to be brought into the client's awareness. The client is therefore encouraged to discover things for himself or herself. Guided discovery is sometimes also known interchangeably as Socratic

questioning as it is derived from the method of teaching employed by Socrates, as recorded in the Socratic Dialogues (Cooper, 1997).

2.3 Constructivist theory

Constructivism is a theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. It has influenced a number of disciplines, including psychology, sociology, education and the history of science. During its infancy, constructivism examined the interaction between human experiences and their reflexes or behaviour patterns (Wikipedia, 2011).

Constructivist teaching is based on constructivist's learning theory. Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Learners are the makers of meaning and knowledge. Constructivist teaching fosters critical thinking, and creates motivated and independent learners. Constructivist theory is the basis for discovery learning. Under both constructivism and discovery learning, educators subscribe to the idea that "knowledge cannot be transferred from one person to another" (Domin 1999, p.1). Instead, a student needs to experience an event in order to make it truly meaningful. In a constructivist classroom, the role of the teacher is less defined than with traditional instruction. According to Wikipedia (2011), discovery method of teaching is based on constructivist's learning theory. This theoretical framework holds that learning always builds upon knowledge that a student already has; this prior knowledge is called aschema. Because all learning is filtered through pre-existing schemata, constructivists suggest that learning is more effective when a student is actively engaged in the learning process rather than attempting to receive knowledge

passively. A wide variety of methods claim to be based on constructivist learning theory. Most of these methods rely on some form of guided discovery where the teacher avoids most direct instruction and attempts to lead the student through questions and activities to discover, discuss, appreciate and verbalize the new knowledge.

Constructivism is a theory that suggests that learners construct knowledge out of their experiences which is associated with pedagogical approaches that promote learning by doing or active learning (Afolabi & Akin-bobola, 2009).Under constructivist theory, the emphasis is not on the amount of content that a student manages to retain, but it is on the manner in which the students learns, or constructs knowledge (Honebein, 1996). For Dewey education depended on action. Knowledge and ideas emerged only from a situation in which learners had to draw them out of experiences that had meaning and importance to them. These situations had to occur in a social context, such as a classroom, where students joined in manipulating materials and, thus, created a community of learners who built their knowledge together. Piaget's constructivism is based on his view of the psychological development of children. In a short summation of his educational thoughts, Piaget called for teachers to understand the steps in the development of the child's mind. The fundamental basis of learning, he believed, was discovery. In autonomous activity, children must discover relationships and ideas in classroom situations that involve activities of interest to them. Understanding is built up step by step through active involvement.

Constructivist teaching fosters critical thinking and creates active and motivated learners.

Providing greater opportunity to students to share their opinion, value opinion of others, developing consensus among class fellows on the various opinion raised, and

appreciate new scientific ways of describing phenomena are the major domains that affect classroom practices upon applying constructivist principles (Mahmood, 2007).

This perspective of learning presents an alternative view of what is regarded as knowledge, suggesting that there may be many ways of interpreting or understanding the world. No longer is the teacher seen as an expert, who knows the answers to the questions she or he has constructed, while the students are asked to identify their teacher's constructions rather than to construct their own meanings. In a constructivist classroom, students are encouraged to use prior experiences to help them form and reform interpretations. From a constructivist perspective, where the student is perceived as meaning-maker, teacher-centred, text-centred and skills-oriented approaches to literature instruction are replaced by more student-centred approaches where processes of understanding are emphasized. A wide variety of methods claim to be based on constructivist learning theory. Most of these methods rely on some form of guided discovery where the teacher avoids most direct instruction and attempts to lead the student through questions and activities to discover, discuss, appreciate and verbalize the new knowledge. One of the primary goals of using constructivist teaching is that students learn how to learn by giving them the training to take initiative for their own learning experiences. According to Gray (1997), the characteristics of a constructivist classroom are as follows:

1. the learners are actively involved
2. the environment is democratic
3. the activities are interactive and student-centred
4. the teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous

In the constructivist classroom, students work primarily in groups and learning and knowledge are interactive and dynamic. There is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. This is contrary to the traditional classroom in which students work primarily alone, learning is achieved through repetition, and the subjects are strictly adhered to and are guided by a textbook. Providing each student with opportunity to find solution to a problem personally or in group increases the students' responsibility for what they do. Zemelman, Daniels and Hyde (1993) tell us that learning in all subject areas involves inventing and constructing new ideas. They suggest that constructivist theory be incorporated into the curriculum, and advocate that teachers create environments in which children can construct their own understanding. Learning that is meaningful to students is developed through discoveries that occur during exploration motivated by curiosity (Bruner, 1964). Okere (1996) discussed that teachers should maximize the degree to which learners expand their knowledge by developing and testing hypothesis rather than merely reading or listening to verbal presentations of information. Emphasis is to be put on activities that encourage students to search, explore analyze or actively process input rather than merely respond to it. When this approach to teaching is practiced in physics, the students mind is opened to understanding how the general physics principles and laws came about. The constructive perspective of learning states that knowledge is inbuilt by the learner, not supplied by the teachers. In other words learners play active role in constructing learning in the learning process rather than accepting that of the teacher. Through the use of such method, teachers can provide opportunity for students to learn, think critically and discuss among their peers. This theoretical framework holds that learning always builds upon knowledge that a student already knows; this prior

knowledge is called a schema. According to constructivism, the centre of instruction is learner (Karagiorgi & Symeou, 2005) and its approach is to work with the learners, helping them to develop their own models. It is not good enough to teach them to give a superficial appearance of advanced knowledge. Twomey-Fosnot (1989) recommends that a constructivist approach be used to create who are autonomous, inquisitive thinkers who question, investigate and reason. A constructivist approach frees teachers to make decisions that will enhance and enrich students' development in these areas. Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in. Each of us generates our own "rules" and "mental models," which we use to make sense of our experiences. Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences. The purpose of learning is for an individual to construct his or her own meaning, not just memorize the "right" answers and regurgitate someone else's meaning. In order for students to construct their own meaning, they must be allowed to independently discover the concepts and knowledge, and then make this understanding their own. The central idea of constructivists is the notion that reality is determined by the experience of the knower. The assertions pivotal to constructivist epistemology are considering knowledge as a way of making sense of experience and as an interpretation open to uncertainty that is based on prior knowledge (Mohan, 2007). Freiberg (1996) argues that these epistemological foundations led constructivists to the conclusion that knowledge is a personal construction rather than imparted from a teacher; constructivism in classroom incorporates three important dimensions:

1) Valuing the student’s point of view,

(2) using higher-level questions to elicit student thoughts, and

(3) valuing the process of student thinking rather than student answer or product.

Belenky, Clinchy, Goldberger and Tarule (1986) report that at the constructivist level of knowing and thinking, we continually re-evaluate our assumptions about knowledge; our attitude towards "the expert" is transformed; we are not troubled by ambiguity but are enticed by complexity; and we take on a never-ending quest for truth and learning where truth is seen as a process of construction in which the knower participates.

Belenky, Clinchy, Goldberger and Tarule (1986) explain that in "real talk", domination is absent, while reciprocity, cooperation, and collaborative involvement are prominent. Consequently, constructivist activities in the classroom that focus on speaking and listening promote not only constructivist thought but also important connections between teacher and students.

2.4 Aims of physics education at the secondary schools.

The general aims of the Senior High School physics programme are to:

1. develop in students skills and attitudes that will enable them practice science in the most efficient and cost effective way.
2. develop in students desirable attitudes and values such as precision, honesty, objectivity accuracy perseverance, flexibility, curiosity and creativity.
3. stimulate and sustain students' interest in physics as a useful tool for the transformation of society.
4. Provide , thorough well designed studies of experimental and practical physics, a worthwhile hands on educational experience to become well informed and productive citizens.

2.5 Effectiveness of using guided discovery

Guided discovery, an approach to instruction and learning, will help students personalize the concepts under study, creating an understanding that cannot be matched using any other method of instruction. The teacher must guide the students towards the discovery. This can be accomplished by providing appropriate materials, a conducive environment, and allotting time for students to discover. Bruner believes that teachers are better not to deal directly with learners' needs but to provide a condition to recognize needs and to choose them. In addition to trust the growth and capabilities of learners, teachers do not act as a source of information. Thus, predetermined contexts in pedagogy are rejected and the emphasis is not merely on transferring past culture and civilization to learners. In other words, by individually searching and following, anyone should creatively make his/her values. In fact, these values belong to the person when engage in acquiring them (Kadivar, 2007). Calkins (1986) laments that in most classrooms, we neither teach students to ask questions in schools nor allow students to ask questions, but simply require them to answer our questions, although asking questions is a challenging and important part of thinking and learning, especially if students are continually encouraged to ask more probing, more appropriate, and more effective questions. By asking their own questions, students acquire more consciousness of and control over their thinking.

Lester and Onore (1990) believe that beliefs and practices about schooling are so difficult to change. They suggest that we need to examine the constructs or beliefs that influence our decisions about teaching and learning in order for change to occur. They believe that by changing our beliefs about teaching and learning, we are able to change our practice.

Change can occur through having experiences that present and represent alternative

systems of beliefs and trying to find a place for new experiences to fit into already held beliefs. Giroux (1986) notes that teachers are often trained to use various models of teaching and evaluation yet are not taught to be critical of the assumptions that underlie these models. Giroux advises that teachers must be more than technicians but transformative intellectuals engaging in a critical dialogue among themselves. Guided discovery greatly impacts instruction. It is the responsibility of the teacher to "set" the students up to make the desired discovery. The teacher must provide all the necessary background knowledge to lead the students to the discovery. The students must realize the method(s) to be used to make the discovery. To assure this, the teacher may demonstrate what the students are expected to do.

Applebee (1993) remarks that "rather than emphasizing characteristics of the final products, process-oriented instruction focuses on the language and problem-solving strategies that students need to learn in order to generate those products" (p. 5). And as students interact with their teacher and with each other as part of either whole class activities, small group activities, or individual activities, they practise using language in a variety of contexts developing and honing many different skills as they do so.

Guided discovery is characterized by convergent thinking. The instructor devises a series of statements or questions that guide the learner, step by logical step, making a series of discoveries that leads to a single predetermined goal. In other words the instructor initiates a stimulus and the learner reacts by engaging in active inquiry thereby discovering the appropriate response. (Wikepedia,2015)

According to Spencer (1999), key features of guided discovery learning are:

1. a context and frame for student learning through the provision of learning outcomes;

2. learners have responsibility for exploration of content necessary for understanding through self- directed learning;
3. study guides are used to facilitate and guide self-directed learning;
4. understanding is reinforced through application in problem oriented; task based, and work related experiences;

Discovery learning approaches, in particular, are designed to engage students in inquiry through which, guided by the teacher and materials, they "discover" the intended content (Hammer, 1997). Guided discovery helps students to be autonomous, self-directed and take the responsibility of self-learning.

Generally, one can say that successful discovery learning is related to reasoning from hypotheses, to applying a systematic and planned discovery process (like systematic variation of variable values), and to the use of high quality heuristics for experimentation (de Jong, & van Joolingen, 1998). The central idea of constructivists is the notion that reality is determined by the experience of the knower. The assertions pivotal to constructivist epistemology are considering knowledge as a way of making sense of experience and as an interpretation open to uncertainty that is based on prior knowledge (Mohan, 2007). The Guided inquiry teaching method according to Massialas (1991) is a teaching method that enables students to move step-by step from the identification of a problem, defining the problem formulation hypothesis, collection of data, verification of results, and generalization to the drawing of conclusion.

2.6 Teachers' role in teaching

Teacher roles in constructivist teaching is to serve as facilitator of learning in which learners are allowed to construct their own understanding of each of the scientific concept. Whereas a teacher gives a lecture that covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. The teacher gives answers according to a set curriculum; a facilitator provides guidelines for the learner to arrive at his or her own conclusions;

Providing each student with opportunity to find solution to a problem personally or in group increases the students' responsibility for what they do.

Inyang (1993) argues that activity based teaching allows students to explore their environment and discover nature. As such, a lot of inquiry prevails in the classroom, with the teacher acting as a motivator, getting from point-to-point to guide the learning of students and help them overcome difficulties. The teachers perform the role of a resource person who guides the learners to source of information. The discovery method is based on the notion that learning takes place through classification and schema formation. This teaching method is believed to increase retention of material because the student organizes the new information and integrates it with information that has already been stored (Gallenstein, 2004).

Discovery learning is a process during which students specify the desired problem, consider the possible solutions, try the solutions according to the available evidence, achieve some results based on experiments, apply the results in new situations and finally reach general rules (Safavi, 2007).

Harbor-Peters (2000) pointed out that the Guided inquiry teaching approach is techno-scientifically oriented. It places the learner's constructive mental ability first in all instructional processes. In other words it is learner centred. Also the guiding inquiry teaching method effectiveness has been investigated in some aspects of the sciences. The traditional instructional strategy employed by most physics teachers in teaching physics concept has resulted in low learning outcomes. There is the need to employ a strategy such as guided discovery particularly, among secondary schools students.

Guided inquiry is a process in which students are provided with both direction and freedom in the classroom. Teachers provide coaching and modeling by using "guided discovery methods" (Mayer, 2004, p.15).

With guided inquiry, students retain the discovery learning advantage of developing true scientific thought processes. They will also benefit by building their knowledge based on a combination of facts, theories, and experiences.

Extensive review of the literature showed that generally speaking guided discovery leads to better results than non-guided ones. It aided better understanding of concepts and of course better training for the discovery process itself. (De Jong & Van Joolingen, 1998). Eggen and Kauchak (2001) believe that guided discovery learning is more effective than unstructured discovery method. According to them, this method would result in learning development and reaching a high level thinking.

Santroch (2004) thinks that discovery learning is useful for teaching sciences in the level of elementary and high school and for developing creativity. The strategy has been proven in literature to have exposed students to a better response to life change in the real world but it has not been adopted in the teaching of physics concepts. This study, therefore, examines the effects of guided discovery on performance of secondary school students 'in physics

2.7 Teaching strategies and challenges that confront teachers

In recent years, a number of studies have investigated the teaching of Science subjects among which Physics is a core science subject (Bello, 2011). Tobin and Gallagher (1987) have investigated teachers' beliefs and epistemological commitments, and the effect of these beliefs on teaching of science and classroom management. There are different methods adopted by an individual in the teaching of science. In some, the teacher does all the talking and tends to disseminate the message that science is a bundle of facts, a collection of right answers determined by authority. This method of teaching is known as the lecture method (Bello, 2011)

According to Smith and Laslett (1993), the lecture method involves the teacher doing all the talking with little or no input from the students. This method of teaching appears problematic because the student takes on a passive role, and this can hinder learning. Students need to be active learners to keep the brain working and integrating new information. However, the lecture method seems to be the most prominent strategy employed by most science teachers in the various Senior High Schools in Ghana. The result is that, the learners generally are less apt to ask questions in class, and thus shun the study of the subject.In recent times, there seem to be public outcry on the declining standard of Science education in the country. There is obviously a problem with the method of teaching Science in Senior High Schools all over the nation and therefore an urgent need to investigate into this problem and propose solutions to help solve it (Anamuah-Mensah, 2004).

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter presents the methodology employed for the study. It focuses on the research design, population, sample and sampling procedure used in the study. Also in this chapter are the research instruments used, validity and the reliability of the instrument, data collection procedure and how the data collected would be analyzed.

3.1 Research design

The study design used was quasi-experimental which employed the pre-test and post-test for experimental and control group. It was quasi-experimental because intact classes were used. The pre-test was administered before treatment commenced. The main treatment for the study was using the discovery approach of teaching for the experimental group while traditional lecture approach was used for the control group. The intervention lasted for six (6) weeks. Immediately after the intervention, the post-test was administered again to students.

3.2 Population

The population for the study was all the senior secondary two (SS2) physics students in the public senior high school in Dansoman area of Accra. The size of the population was 350 senior high school two (SS2) physics students. A total of 90 students was the accessible population for the study.

3.3 Sample and Sampling procedure

The sample of the study was 90 SS2 physics students of which 63 were males and 27 were females taken from two schools. This comprises two science classes of forty-five (45) students from each school. Purposive sampling technique was used to select the schools from the target population. The criteria were:

1. Availability of experienced physics teachers with at least three years teaching experience and accessibility to the school.
2. Schools that have well equipped and functional physics laboratory;
3. Schools that are currently presenting candidates for the Senior Secondary School Certificate Examination (SSSCE) and have at least one professional graduate physics teacher.
4. School in which the concept of heat energy transfer has not been taught already.

Two schools amongst the four senior high schools met the above criteria and two of the science classes were selected by balloting. The selected classes were randomly assigned as experimental and control groups.

3.4 Instrumentation

Pre-test and Post test

The main instruments used for data collection were 20 multiple choice test and questionnaire. The Students' Physics Achievement Test (SPAT) was constructed by modifying it from the West African Examinations Council (WAEC) past examination papers to make them suitable for this study. The test items were constructed based on the topic "modes of heat Transfer" and was used as pre-test and post-test to allow for comparison between pre-test and post-test results (Appendix C and F). The SPAT

consisted of 20 multiple choice questions for students to answer. The duration was twenty- five minutes.

Questionnaire

The questionnaire items used were on students' interest towards physics (Appendix I). The items were seven (7) in number and related on students interest in physics. Students used fifteen minutes (15 min) to answer the questionnaire items. Students from the experimental and control groups answered the questionnaire at the same time but each in their school. The researcher and the teacher for the control group did the supervision of their groups.Students were to rate the items using a five-point liker with responses ranging from strongly disagree-SD (1), disagree - D (2), not sure-NS (3), agree-A (4) and strongly agree- SA (5). Students were made to answer the questionnaire before the intervention as pre-response and after the intervention as post-response. The outcome of their responses (pre and post) were compared to see the effect of guided discovery on their interest in physics.

3.5 Validity and Reliability

The SPAT and the questionnaire items were validated by experts in physics from the Department of Physics Education, University of Education, Winneba making sure that the test and questionnaire items were the best to produce the desired results. It was also tried and tested with some students before using it for it intended purpose. Their comments and corrections were incorporated into the final form of the instrument.

For reliability, the test and the questionnaire were administered to two intact physics classes of non-participating schools. After two (2) weeks the same tests were administered to the same set of students (test-retest method). Their second answers

were compared with their first results and was found that about 90% and 94% of the students reproduced the same answers giving the test items and the questionnaire items a high reliability respectively. The instructional approach was drawn on guided discovery approach and the traditional lecture approach. The experimental group were taught using guided discovery by the researcher while the control group were taught using the traditional lecture method by a graduate from the other school. After the teaching of the concept of the mode of heat transfer, post-test was administered to both groups. The data obtained was analyzed using paired sampled t-test to see whether there will be a significant difference between the two methods of teaching in students' academic performance in the concept of mode of heat transfer. With the students' interest in physics, the paired sample t-test was used to see whether there would be any significant difference in their pre-response and post response means. All the hypotheses were tested at 0 .05 level of significance.

3.6 Administration of Pre-Test

All the ninety (90) Students (45 as control group at Wesley grammar SHS and 45 as experimental group at Ebenezer SHS) were given a pre-test on the topic mode of heat transfer. The pre-test was administered the same day and at the same time by the researcher and the graduate teacher for the control group. After the pre-test, the students were also made to respond to the questionnaire items at the same time also in their various schools. The students' scores were gathered as pre-response.

3.7 Treatment Procedure

Lesson note was structured according to Physics syllabus for Senior High School in Ghana (Appendix A).

The treatment was carried out on the experimental and control groups. During this

Period, students were taught on mode of heat transfer, aspects of the Physics concepts by the researcher and the graduate physics teacher of the second school. In all four (4) weeks were used for the intervention.

1. **Guided Discovery Instructional strategy for the experimental group.** The following steps were followed:

Week 1: Grouping of learners and presentation of the topic. The researcher led a discussion with the students on the mode of heat transfer: conduction, convection and radiation. For example the researcher (teacher) discussed the meaning of the modes of heat transfer as follows:

Conduction: the process by which heat is directly transmitted through the material of a substance when there is a difference of temperature between the adjoining regions without movement of the material. Molecules vibrate about their mean position.

Convection: movement caused within a fluid by the tendency of hotter and therefore less dense material to rise, and colder and denser material to sink under the influence of gravity, which consequently result in transfer of heat. Sea and land breeze are example of convection.

Radiation: energy that comes from a source and travels through space. Dark surfaces absorb radiant heat better than bright surfaces.

Week 2: Setting up of the task to be accomplished by the learners and undertaking of the task through the supervision of the teacher. The students were made to have hands on practical activity on conduction. Some of the materials include metal rod(copper, aluminium and lead), candle wax, hot water, wood and cork.

Activities: To verify heat transfer by conduction

1 Dip the rods into the candle wax and allow them to become solid.

2 Pass the rod through corks inserted in the container.

3 Pour the hot water into the container and record your observation.

Observation: The wax on the rod began to melt from the hot ends and after some time, it was found that the wax had melted to different distances along the rods, with the copper rod having the longest length while the wooden rod hardly melted at all. There was no movement of the particles/molecules of the different materials used. Hence the transfer of heat along the rods to melt the candle waxes at the tip of the rods/materials was done by the particles vibrating within their mean positions. And in so doing they hit the next particle/molecule and transfer their energy to it. This continued till the heat energy got to the particle/molecule at the tips of the waxes at the tips of the rods to absorb heat and melt. The difference in the length of the melted waxes was due to the fact that some of rods absorb heat faster than the others.

Conclusion: Different substances conduct heat at different rate.

Evaluation: When a man steps from a mat on a cemented floor with bare feet, his feet become cooler. Why?

Week 3 : The third week followed in with the same activity as in week 2 but in this case the practical activity designed was on Convection, with some materials used such as round bottomed flak, crystals of potassium permanganate, glass tube and water.

Activities:

1 Place a small crystal of potassium permanganate into the round bottomed flask filled with water.

2 Heat the bottom of the Flask.

3 Record your observation.

Observation: On heating the bottom of the flask with a small flame about 0.5cm high, a rising column of coloured water will be observed. On reaching the top, the column spreads out and descending current of coloured water will be observed.

Conclusion: The observation showed the set-up of convection currents. Thus the molecules of the coloured water (a mixture of water and potassium permanganate) beneath the flask rose after they absorb enough heat (energy). They became lighter and rose up to the surface of the water. A colder molecule of water, which has a higher density went down to replace the displaced molecule. This continued till the whole water became coloured.

Evaluation: The following statements distinguish thermal conduction from convection?

i. Conduction requires a material medium while convection does not.

ii. In convection, there is actual motion of hot materials, while in conduction molecules vibrate faster about their mean position.

iii. Conduction takes place in solids whiles convection takes place in fluids.

Week 4: Week four (4) also followed with the setting up of the task to be accomplished by the learners and to be supervised by the teacher. The students were made to have hands on practical activity on radiation. Some of the materials used include two metal sheets with one side coated, paraffin wax, screws and electric heater.

Activities:

4 Place the identical plates so that the polished surface and the dull black surface face each other.

5 On the reverse side of the plates stick screws with Paraffin wax.

6 Place the electric heater at equal distance between the plates and switch it on for a short time.

7 Record your observation.

Observation: A short time after the heater is switched on; it was observed that the screw at the back of the blackened plate fell off with the wax melted, while the one on the other plate remained in position for a long time.

Conclusion: From the observation it can be concluded that polished bright surface, which is good reflector, is a poor absorber while the black surface has high absorbing power. Thus we note that surfaces that are good radiators are also good absorbers while those that are poor radiators are poor absorbers. Also, it was observed that radiant heat form the electric heater did not need any material medium to transfer heat to the surface of the black plate and the white plate. Thus radiant heat can travel through a vacuum. Thus radiation is the process of heat transmission which does not require a material medium.

Evaluation: Which of the following surfaces will radiate heat energy best?

A. Red surface

B. White surface

C. Black surface

D. Yellow surface

2. Traditional lecture approach for the control group

The following steps were followed:

Week 1: Teacher explained the mode of heat transfer, thus conduction, convection and radiation.

Week 2: Teacher explains conduction into details to students, feedback from the learners was analysed and **c**onclusion drawn as well. Example, Conduction is the

process by which heat is directly transmitted through the material of a substance when there is a difference of temperature between the adjoining regions without movement of the material. Molecules vibrate about their mean position.

Evaluation: The following statements distinguishes thermal conduction from convection?

i. Conduction requires a material medium while convection does not

ii. In convection, there is actual motion of hot materials, while in conduction molecules vibrate faster about their mean position

iii. Conduction takes place in solids whiles convection takes place in fluids

Week 3: The third week followed in with the same activity as in week 2 but in this case the teacher explained Convection and convection current, also feedbacks from learners was analysed and conclusion drawn. For example, Convection is the movement caused within a fluid by the tendency of hotter and therefore less dense material to rise, and colder and denser material to sink under the influence of gravity, which consequently result in transfer of heat. Sea and land breeze are example of convection.

Evaluation: In the formation of sea breeze, wind blows from

A. Sky to land

B. Sea to sky

C. Land to sea

D. Sea to land

Week 4: Week four (4) also followed with the teacher explaining to the students the concept of radiation and afterwards feedback from the learners was analysed. Eg.

Radiation is the energy that comes from a source and travels through space. Dark surfaces absorb radiant heat better than bright surfaces.

Evaluation: Which of the following statements about radiant heat is/are **not** correct

i Radiant heat cannot travel through a vacuum.

ii Rough surfaces emit radiant heat better than polished surfaces.

iii Dark surfaces absorb radiant heat better than bright surfaces.

A. i only

B .ii only

C. iii only

D. i and ii only.

3.8 Administration of Post-Test

All the ninety (90) Students (45 as control group at Wesley grammar SHS and 45 as experimental group at Ebenezer SHS) were given a post-test on the topic "Mode of Heat Transfer. The post-test was administered the same day just after the close of the last discussion by the researcher and the graduate teacher for the control group in their various schools. After the post-test, students' scores were gathered as post-test scores.

Administration of the questionnaire

The questionnaire was administered to the experimental group at Ebenezer Senior High School after the administration of the post test. The scores were gathered as post response scores.

3.9 Summary

The chapter dealt with the methodology employed for the study. It discussed the research design, population sample and sampling procedure. It also looked at the

instrument used to carry out the research, the validity and reliability of the instrument, the administration of the pre-test, the treatment procedure, the post-test and the administration of questionnaire to students. In the next chapter, the findings and results gathered through data collected will be dealt with.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter is devoted to the discussion of findings and results gathered through data collected. The results of the study were gathered out of the oral answering of questions by students, written tests and finally observation made by the researcher.

4.1 Demographic Description of Respondents

Demographic description may be referred to as how people are classified into groups using common characteristics such as race, gender, income level or age. Demographic information provides data regarding research participants and is necessary for the determination of whether the individuals in a particular study are a representative sample of the target population for generalization purposes (Lee & Schuele, 2010). The profile of the respondents in this study is looked upon in terms of age and gender.

Gender of Students

The students' gender is presented in the table 1 below

Table 1: Gender of Students at Ebenezer S.H.S

Gender	Frequency	Percentage (%)
Males	29	64.44
Females	16	35.56
Total	45	100.00

The SHS two (2) science class at Ebenezer SHS is a male dominated class. Out of the total of 45 students, 29 (64.44%) are males while 16 (35.56%) are Females. Ever since the introduction of Science as a course into the second cycle educational system of Ghana, the enrolment of boys has always been higher.

Table 2: Gender of Students at Wesley Grammar S.H.S

Gender	Frequency	Percentage (%)
Males	33	73.33
Females	12	26.67
Total	45	100.00

The same way in Wesley Grammar SHS, the SHS two (2) science class is also a male dominated class. Out of the total of 45 students, 33 (73.33%) are male while 12 (26.67%) are female.

4.2 Pre-intervention Data Analysis

This section explains the analyses made after the pre-test has been administered to the students in the experimental and control groups.

Students mean scores on the classroom tests from the pre-intervention data analysis is shown in Table 3.

Table 3: Students Mean Values of Pre-intervention tests

	N	Mean	Std. Deviation	Std. Error Mean
Pre-test (Control Gp.)	45	9.37	2.489	0 .371
Pre-test (Experiment Gp.)	45	9.33	2.705	0 .403

Table 3 shows the mean score obtained by the students in the pre-intervention test conducted. The mean score for the Control group gave 9.37 while that of Experimental group was 9.33. The table shows that there was not much difference between the mean test scores for the students.

4.3 Intervention

The samples used were students from Wesley Grammar Senior High School and Ebenezer Senior High School both in Dansoman. Students fromWesley Grammar were taught using traditional lecture method (control group) whiles students from Ebenezer Senior High School were taught using guided discovery approach (experimental group).

4.4 Post-intervention Data Analysis

This section explains the analyses made to answer the research questions and hypotheses.

Analysis of test results with Respect to the Research Question one

Research question 1:

What is the difference in the performance of students taught using guided discovery approach and traditional lecture method?

To analyse the difference in performance of the control and the experimental group, paired sample t-test was used on the pre-test scores and post-test scores of both groups. Tables 4 and 5 were used to compare the pre-test scores and post-test scores of the control and experimental groups respectively.

Students mean values of Pre- intervention tests is presented in Table 4.

Table 4: Students Mean Values of Pre-intervention tests for Ebenezer SHS

	N	Mean	Std. Dev.	Std. mean error	Df	Sig
Control Group	45	9.37	2.489	0.371	88	.936
Exp'tal Group	45	9.33	2.705	0.403		

*p<0.05 significance (α=0.05)

Table 4 shows the mean score obtained by the students in the pre-intervention test conducted. The mean score for the Control group gave 9.37 while that of Experimental group also 9.33. This results shows that there was not much difference between the test scores for the students. The means scores of both schools in table 3 and table 4 show that they were not statistically significantly different since $p > 0.05$. This meant that the groups used in the study exhibited comparable characteristics. The groups were therefore regarded suitable for the study.

Students mean values of Post- intervention test is presented in Table 5.

Table 5: Post-test score for the students taught using guided discovery method and traditional lecture method.

	N	Mean	Std. Dev.	Std. mean error	df	Sig
Control Group	45	11.00	2.504	0.373	88	0.000
Exp'tal Group	45	14.31	3.390	0.505		

*p<0.05 significance (α=0.05)

Table 5 shows the mean score obtained by the students in the post-intervention test conducted. The mean score for the Control group gave 11.00 while that of the Experimental group also gave 14.31. This result indicated that there was much difference between the test scores for the students. The means in the table for the Experimental group (guided discovery) was higher than the control group (Traditional lecture method) which indicated that the use of guided discovery gave better results and is largely seen in the result for the post intervention test. The significance (2-tailed) is given by 0.000 which is also the p-value, in the study it is set at 0.05, significance (α=0.05). This means that the use of guided discovery gave better results than the traditional lecture method and it led to an increase in student's performance in the modes of heat transfer (Physics).

HO1: There would be no significant difference in the performance of students taught using guided discovery approach in physics and those taught using the traditional lecture method.

Tables 5 reveals that the p-value of .000 < 0.05 alpha level. Since the p value is less than the alpha level of 0.05, the null hypothesis one was rejected and the alternative

hypothesis that, there would be a significant difference in the performance of students taught using guided –discovery approach and those taught using traditional lecture method was upheld.

Analysis of test results with respect to the Research Question two

Research question 2:

What is the performance of the male and female students in physics when taught using guided discovery approach?

The research question two focused on the performance of male and female students in the study after the intervention. An independent sample t-test was used to analyse the research question.

Students' scores of post-test when males were compared to females is presented in Table 6.

Table 6: Comparison of post-test mean scores of males and females

Test	Gender	N	Mean	Std. Deviation	Std. Error Mean	Sig(2-tail)
Post-test	Male	29	14.31	3.424	0.636	0.578
	Female	16	13.69	3.628	0.907	

*p>0.05 significance (α=0.05)

Table 6 shows the means of the post-intervention tests of both males and females. From the table both males and females performed very well after going through the guided discovery teaching. However, the mean value of the males were slightly higher

HO2: There would be no significant difference in the performance of male and female students in physics when they are taught using guided discovery approach

From Table 6, the analysis reveals that the p-value 0.58 is greater than the 0.05 alpha level. It implies that the null hypothesis two which states that "there would be no significant difference in post-test mean scores of male and female students in physics when they are taught using guided discovery approach" was accepted. In other words, the performance of male and female students taught using guided discovery approach shows no difference. Hence, the hypothesis is upheld.

Analysis of test results with respect to the Research Question three

Research question 3:

What influence will the use of guided discovery have on the interest of Senior High School Students towards the study of Physics?

Quite often than not, students' interest towards the study of Physics is not encouraging. So this research question sought to check the interest of students towards the study of Physics before and after the use of guided discovery teaching strategies.

Comparing students mean values of Pre- and Post- responses based on their attitude towards the teaching and learning of Physics are presented in Table 7.

Table 7 Comparing Students Mean Values of Pre- and Post-responses on their interest towards Physics Teaching and Learning

	Pre/Post	N	Mean	Std. deviation	Sig
Students' Interest towards	Pre	45	2.19	0.73	0.000
Physics Teaching and Learning	Post	45	3.55		

*p<0.05 significance (α=0.05)

In Table 7, the students' mean values of pre- and post-responses on attitudes towards Physics teaching and learning were compared. The mean scores of the students' pre-

intervention responses were relatively lower than their mean scores for post-intervention responses for the same category of items. To determine whether the differences in the pre- and post-intervention responses were statistically significant, a paired sample t-test analysis was used. The results confirmed that the differences in most of the pre- and post-intervention responses were statistically significant. Thus, the students' interest towards the teaching and learning of Physics significantly improved after their exposure to guided discovery in the classroom teaching strategy.

HO3: There would be no significant influence on the interest of students towards the study of physics when taught using guided discovery method.

Table 10 reveal that the p-value of .000 < 0.05 alpha level. Since the p value is less than the alpha level of 0.05, the null hypothesis was rejected and the alternative hypothesis that, there would be a significant influence on the interest of students towards the study of physics when taught using guided –discovery approach was upheld.

4.5 Discussion

The central focus of this study was to investigate the effects of guided discovery learning strategy on students' performance in modes of heat energy transfer and the findings from the t-test of the post-test mean scores of hypothesis one revealed that the experimental group students exposed to guided-discovery learning strategy performed significantly better than the control group students exposed to the traditional lecture method. The study however showed that both male and female students benefitted equally when exposed to guided discovery strategy of learning. Therefore, gender had no effect on the performance of the students in heat energy transfer using guided discovery learning strategy. The interest of students towards the

learning of physics also changed and this is seen in their performance after the treatment.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter deals with the research summary conclusion and recommendations.

5.1 Summary

Science is perceived to be very difficult. This is confirmed by Bello (2011) that science programme or teaching in the secondary (middle school) is now characterized by learning modules which make learning procedures in science especially Physics to be more complicated and difficult for learners to grasp. The perceived nature of Physics makes students shun or avoid the subject. The use of the traditional lecture approach in the teaching of physics has rendered most of the students to be disinterested in the subject. In effect, many students, more especially, girls have lost interest and the enthusiasm to study Physics in Senior High Schools due to the old and traditional ways of teaching the subject (Donnellan, 2003). The concern of this study was to investigate the effect of guided-discovery learning strategy on students' performance on the topic "Modes of Heat Transfer". Two science classes from two different senior high schools, all in the Dansoman area of Greater Accra, were used. Each class consisted of 45 students. One science class was used as the experimental group, while the other was designated as the control group. Guided-discovery approach was used in teaching the experimental group, while the traditional lecture approach was used for the control group. About six weeks was used for the study.

5.2 Summary of key findings

The following are the summary of major findings in this study:

1. The experimental group taught using guided-discovery learning strategy had a significantly higher score than the control group taught using the traditional lecture method.
2. Post test mean scores of male students was not significantly higher than that of the female students when taught using guided-discovery learning strategy.
3. The post responses of the experimental group taught using guided discovery showed an improvement on students' interest towards the learning of physics.

5.3 Conclusion

Results from this study have shown that there was a significant difference in the performance of students taught using guided discovery learning strategy over the students taught using traditional lecture method.

The study has also shown the potency of guided discovery learning strategy in improving student's performance.

Lastly, findings from the present study have also shown that gender has no role to play in the performance of the students, especially when the appropriate teaching approach like the guided discovery is used in teaching them.

5.4 Recommendations

Based on the findings of the study, the following recommendations were made:

i. Physics teachers in Ebenezer Senior High School should take into consideration teaching methods when presenting teaching materials in the classroom.

ii. Physics teachers are advised to use the guided-discovery teaching method since it could boost female students' interest and also enhances performance in the learning of physics.

iii. Workshop and seminars should be organised for teachers on the use of guided discovery teaching method.

Suggestion for further research

- The sample size was quite small due to the focus of this study. It is therefore recommended that the study be replicated using larger samples to provide a basis for more generalisations of the conclusions drawn from the findings of the study about the effectiveness of guided discovery teaching of Physics.
- The study can be conducted for different levels and different science topics to investigate the effectiveness of guided discovery teaching.

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APPENDIX A

SAMPLE OF TEACHER'S LESSON NOTE

ON MODES OF HEAT TRANSFER

SUBJECT: PHYSICS

REFERENCE: MASTERING PHYSICS FOR S.H.S **PAGES:** 309 - 311

DATE/ DURATION	TOPIC	OBJECTIVES	T/LM	ACTIVITIES	CORE POINTS	EVALUATION AND REMARKS
28/04/15 80munits	Transfer of heat	The learner will be able to explain the mode of heat transfer	Thermometer	Discuss conduction, convection and radiation	Heat can be transferred from one point to another by conduction convection & radiation.	Why does a thick glass cup crack when boiling water is poured into it?
05/05/15 80munits	Transfer of heat (conduction)	The learner will be able to carry out experiment to investigate transfer of heat by conduction	Rods made of copper, copper, aluminium iron, lead and wood or equal length and diameter. Mental container, candle wax and hot water	Dip the rods into the candle wax and allow them to become solid. Pass the rod through corks inserted in the container. Pour the hot water into the container and record your observation	Conduction is the process by which heat flows from hotter region to the colder region without there being any net movement of the substance itself.	What are good conductors? List three examples of good conductors.
12/05/15 80munits	Transfer of heat (Convection)	The learner will be able to carry out the experiment to investment transfer of heat by convection	Round-bottomed flask, crystals of potassium permanganate, glass tube.	Place a small crystal of potassium permanganate into the round bottomed flask filled with water. Heat the bottom of the Flask. Record your observation	Convection is the process by which heat energy is transferred in a fluid by the actual movement of the heated fluid.	What is the difference between conduction and convection?
19/05/15	Transfer of heat through	The learner will be able to investigate	Two identical metal sheets, one face of one is	Place the identical plates so that the polished surface and	Radiation is the process by which heat is	By which means do

80munits	radiation	transfer of heat by radiation	polished and a face of the other painted dull black, paraffin wax, two screws, electric heater.	the dull black surface face each other. On the reverse side of the plates stick screws with Paraffin wax. Place the electric heater at equal distance between the plates and switch it on for a short time. Record your observation	transferred from one body to another without heating the intervening medium but by means of electromagnetic waves.	the rays from the sun get to us on earth?

APPENDIX B

SAMPLE OF TEACHER'S LESSON NOTE

TEACHERS LESSON NOTE ON THE TRADITIONAL LECTURE METHOD

SUBJECT: PHYSICS

REFERENCE: MASTERING PHYSICS FOR S.H.S **PAGES:** 309 - 311

DAY/DATE	TOPIC	OBJECTIVE	T/LM	ACTIVITIES	CORE POINTS	EVALUATION AND REMARKS
28/04/15 80 mins	Transfer of heat	The learner will be able to explain the mode of heat transfer	Thermometer	Teacher explains the mode of heat transfer to students.	Heat can be transferred from one point to another by conduction, convection & radiation.	Why does a thick glass cup crack when boiling water is poured into it?
05/05/15 80 mins	Transfer of heat by conduction	The learner will be able to explain transfer of heat by conduction	Metal bar and a source of heat.	Teacher explains conduction into details students.	Conduction is the process by which heat flows from hotter region to colder region without there being any net movement of the substance itself.	What are good conductors ? List three examples of good conductors .
12/05/15 80 mins	Transfer of heat by convection	The learner will be able to explain and state conditions for convection,	Source of heat flat bottomed flask and water.	Teacher explains convection and convection current to students.	Convection is the process by which heat energy is transferred in a fluid by the actual movement of the heated fluid	What is the difference between conduction and convection ?

19/05/15 80mins	Transfer of heat by radiation	The learner will be able to explain transfer of heat by radiation.	Thermos flask	Teachers explain radiation to students.	Radiation is the process by which heat energy is transferred from any body to another without heating the intervening medium but by means of electromagnetic waves.	By which means do the rays from the sun get to us on earth?

APPENDIX C

SAMPLE OF PRE-TEST QUESTIONS ADMINISTERED

Pre-test questions

Answer all questions

1. When a man steps from a mat on a cemented floor with bare feet, his feet become cooler. This is because:

A. Concrete floor is a better conductor of heat than the mat.

B. Mat is a better conductor of heat than the feet.

C. Mat looses heat to the bare feet at a faster rate than concrete floor.

D. Mat looses heat to the bare feet while the concrete floor extracts heat from them.

2. Which of the following statements about radiant heat is /are **not** correct

i Dark surfaces absorb radiant heat better than bright surfaces

ii Radiant heat cannot travel through a vacuum.

iii Rough surfaces emit radiant heat better than polished surfaces.

.

A. i only

B .ii only

C. iii only

D. i and ii only.

3. Heat transfer by convection in a liquid is due to the

A. Expansion of the liquid as it is heated

B. Increase vibration of the molecule of the liquid about their mean position.

C. Latent heat of vaporisation of the liquid

D. Translatory motion of the molecule of the liquid.

4. Which of the following is **no**t correct?

A. Heat energy can be transformed into mechanical energy.

B. If a body is cooled, molecular movement remains constant.

C. If a body is heated, its molecules move faster

D. The total heat content of a body is the sum of the kinetic of its molecules.

5. The inside of a vacuum flask is usually coated with silver to reduce heat lost by

A. Absorption

B. Conduction

C. Convection

D. Radiation

6. Which of the following explains why a thick glass cup cracks when boiling water is poured into it?

A. Anomalous expansion of water

B. High density of water

C. Large increase in the heat capacity of the cup.

D. Unequal expansion of the interior and exterior walls of the cup

7. The average kinetic energy of the molecule of a perfect gas is directly proportional to the

A. Celsius temperature of the gas

B. Kelvin temperature of the gas

C. Pressure exerted by the gas

D. Volume of the gas molecule

8. Which of the following statements is/are correct?

i pure water freezes at 0^0C under normal pressure.

ii the volume at 4 is the maximum

iii water has its highest density at 4^0C ,

A. i only

B. ii only

C. i and iii only

D. ii and iii only

9. Expansion of solid can be considered a disadvantage in the

A. Balance wheel of a watch

B. Fire alarm system

C. Riveting

D. Thermostat

10 .One useful importance of thermos flask is

A. decrease the temperature of the liquid in it

B. increase the temperature of the liquid in it

C. increase the volume and the temperature of the surrounding air of the flask

D. maintain the temperature of the liquid in it

.

11. Rays from the sun get to us by the process of

A. Boiling

B. Conduction

C. Convection

D. Radiation

12. Good conductors are materials that allow:

A. Either heat or electric charges to pass through it

B. Heat is readily absorbed

C. Only heat to pass through it.

D. Only electric charge to pass through

13. Which of the following materials would **no**t be considered suitable for lagging?

A. Cotton wool

B. Glass fibre

C. Paper

D. Sand

14. When a large mass of air containing dust is cooled below its dew point, one of the following is formed

A. Cloud

B. Fog

C. Mist

D. Snow

15. The thermopile is a device for detecting

A. The presence of electrons

B. Radioactive radiation

C. Radiant energy

D. X-rays

16. In the formation of sea breeze, wind blows from

A. Land to sea

B. Sea to land

C. Sea to sky

D. Sky to land

17. Which of the following statements distinguishes thermal conduction from convection?

i. Conduction requires a material medium while convection does not

ii. Conduction takes place in solids whiles convection takes place in fluids

iii. In convection, there is actual motion of hot materials, while in conduction

molecules vibrate faster about their mean position

A. i and ii only
B. ii and iii only
C. i and iii only
D. i , ii and iii only

18. Which of the following surfaces will radiate heat energy best?

A. Black surface

B. Red surface

C. White surface

D. Yellow surface

19. Which of the following statements is correct?

A. A liquid changes to solid when heated to a sufficiently high temperature

B. The density of a liquid decreases when it expands

C. The densities of liquids increase when the liquids are heated

D. The real expansivity of a liquid is less than its apparent expansivity.

20. Which of the following best explains why a person suffers a more severe burn when his skin is exposed to steam than when boiling water pours on his skin?

A. Steam is at a higher temperature than boiling water

B. Steam penetrates more deeply into the skin than boil

C. Steam possesses greater heat energy per unit mass than boiling water.

D. Steam spreads more easily over a wider area of the skin than boiling water

APPENDIX D

SAMPLES OF MARKING SCHEME FOR PRE-TEST QUESTIONS ADMINISTERED

1 A

2 B

3 A

4 D

5 D

6 D

7 A

8 C

9 A

10 D

11 D

12 A

13 D

14 B

15 C

16 B

17 B

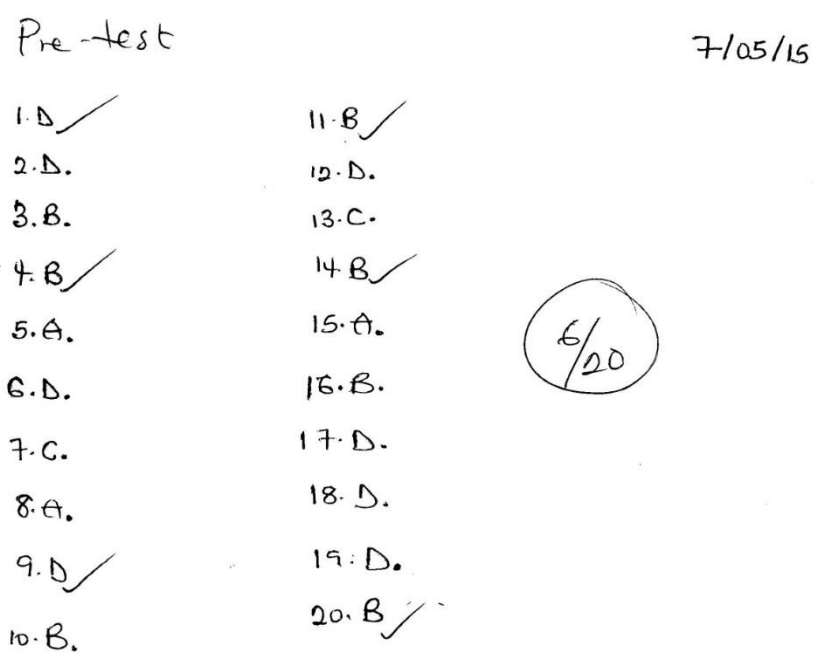
18 A

19 B

20 C

APPENDIX E

SAMPLE OF STUDENTS' MARKED SCRIPTS FOR THE PRE-TEST ADMINISTERED



Pre-Test 7/05/15

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

5/20

Pre-Test

7/05/15

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

9/20

Pre - Test

7/05/15

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

7/20

Pre test

7/05/15

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

8/20

APENDIX F

SAMLE OF POST-TEST QUESTIONS ADMINISTERED

ANSWER ALL QUESTION

1. Which of the following materials would **no**t be considered suitable for lagging?

A. Cotton wool

B. Glass fibre

C. Paper

D. Sand

2. When a large mass of air containing dust is cooled below its dew point, one of the following is formed

A. Cloud

B. Fog

C. Mist

D. Snow

3. The thermopile is a device for detecting

A. Radiant energy

B. Radioactive radiation

C. The presence of electrons

D. X-rays

4. In the formation of sea breeze, wind blows from

A. Land to sea

B. Sea to land

C. Sea to sky

D. Sky to land

5. When a man steps from a mat on a cemented floor with bare feet, his feet become cooler. This because:

A. Concrete floor is a better conductor of heat than the mat.

B. Mat is a better conductor of heat than the feet.

C. Mat looses heat to the bare feet at a faster rate than concrete floor.

D. Mat looses heat to the bare feet while the concrete floor extracts heat from them.

6. Which of the following statements about radiant heat is/are **not** correct?

i Dark surfaces absorb radiant heat better than bright surfaces

ii Radiant heat cannot travel through a vacuum.

iii Rough surfaces emit radiant heat better than polished surfaces.

.

A. i only

B .ii only

C. iii only

D. i and ii only.

7. Heat transfer by convection in a liquid is due to the

A. Expansion of the liquid as it is heated.

B. Increase vibration of the molecule of the liquid about their mean position

C. Latent heat of vaporisation of the liquid

D. Translatory motion of the molecule of the liquid

8. Expansion of solid can be considered a disadvantage in the

A. Balance wheel of a watch

B. Fire alarm system

C. Riveting

D. Thermostat

9 .One useful importance of thermos flask is

A. decrease the temperature of the liquid in i

B. increase the temperature of the liquid in it

C. increases the volume and the temperature of the surrounding air of the flask.

D. maintains the temperature of the liquid in it

10. Rays from the sun get to us by the process of

A. Boiling

B. Conduction

C. Convection

D. Radiation

11. Good conductors are materials that allow:

A. Either heat or electric charges to pass through it

B. Heat is readily absorbed

C. Only electric charge to pass through

D. Only heat to pass through it.

12 .The following statements distinguishes thermal conduction from convection?

i. Conduction requires a material medium while convection does not
ii. Conduction takes place in solids whiles convection takes place in fluids
iii. In convection, there is actual motion of hot materials, while in conduction molecules vibrate faster about their mean position

A i and ii only
B. ii and iii only
C i and iii only
D i, ii and iii

13. Which of the following surfaces will radiate heat energy best?

A. Black surface

B. Red surface

C. White surface

D. Yellow surface

14. Which of the following statements is correct?

A. A liquid changes to solid when heated to a sufficiently high temperature

B. The densities of liquids increase when the liquids are heated

C. The density of a liquid decreases when it expands

D. The real expansivity of a liquid is less than its apparent expansivity

15. Which of the following is **not** correct?

A. Heat energy can be transformed into mechanical energy

B. If a body is cooled, molecular movement remains constant

C. If a body is heated, its molecules move faster.

D. The total heat content of a body is the sum of the kinetic of its molecules.

16. The inside of a vacuum flask is usually coated with silver to reduce heat lost by

A. Absorption

B. Conduction

C. Convection

D. Radiation

17. Which of the following explains why a thick glass cup cracks when boiling water is poured into it?

A. Anomalous expansion of water

B. High density of water

C. Large increase in the heat capacity of the cup

D Unequal expansion of the interior and exterior walls of the cup

18. The average kinetic energy of the molecule of a perfect gas is directly proportional to the

A. Celsius temperature of the gas*

B. Kelvin temperature of the gas

C. Pressure exerted by the gas

D. Volume of the gas molecule

19. Which of the following statements is/are correct?
i pure water freezes at 0^0C under normal pressure.

ii the volume at 4 is the maximum

iii water has its highest density at 4^0C

A. i only

B. ii only

C. i and iii only

D. ii and iii only

20. Which of the following best explains why a person suffers a more severe burn when his skin is exposed to steam than when boiling water pours on his skin?

A. Steam is at a higher temperature than boiling water

B. Steam penetrates more deeply into the skin than boiling water

C. Steam possesses greater heat energy per unit mass than boiling water.

D. Steam spreads more easily over a wider area of the skin than boiling water

APPENDIX G

SAMPLE OF MARKING SCHEME FOR POST-TEST QUESTIONS ADMINISTERED

1 D

2 B

3 A

4 B

5 A

6 B

7 A

8 A

9 D

10 D

11 A

12 B

13 A

14 C

15 D

16 D

17 D

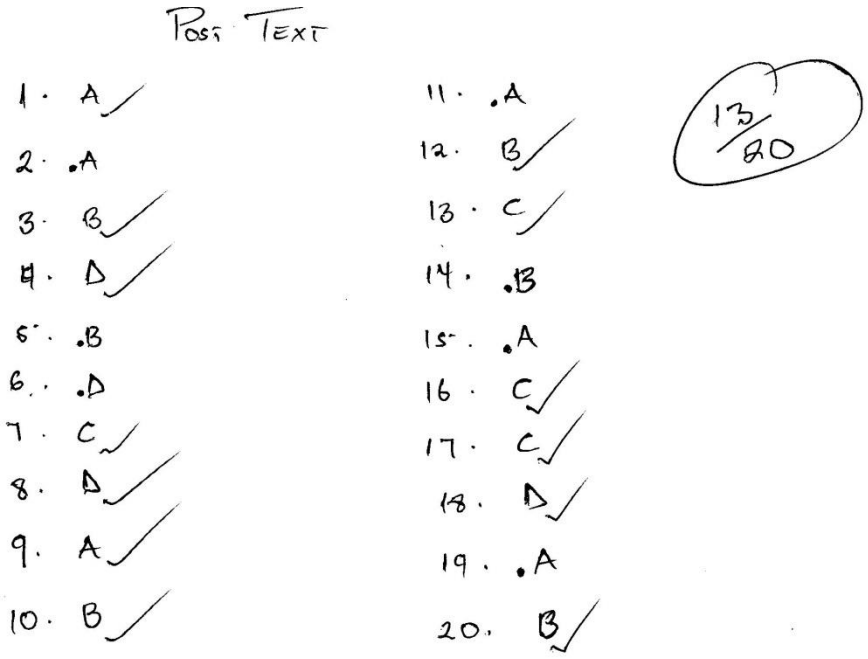
18 A

19 C

20 C

APPENDIX H

SAMPLE OF STUDENTS MARKED SCRIPTS OF POST TEST ADMINISTERED



Post test.

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

16/20

Post test

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

20/20

Post test.

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

16/20

Post test

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

19/20

APPENDIX I

QUESTIONNAIRE ADMINISTERED

All information is confidential and will be treated as such

I. **Items in students' opinions about their interest in physics.**

A five-point Likert scale questionnaire with responses ranging from strongly disagree SD (1), disagree-D (2), not sure-NS (3), agree-A (4) and strongly agree-SA (5) is used

Students Interest towards Physics

N/O		SD (1)	D (2)	NS (3)	A (4)	SA (5)
1	Lessons in the class were fun					
2	I disliked lessons in the class					
3	Lessons in the class bored me					
4	The class was one of the most interesting classes					
5	I enjoyed lessons in the class					
6	Lessons in the class were a waste of time					
7	The lessons made me interested in Physics					