UNIVERSITY OF EDUCATION, WINNEBA

THE ROLE OF PRACTICAL WORK IN SENIOR HIGH SCHOOL PHYSICS TEACHING

LUKE MENSAH EDOH

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A DISSERTATION IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF THE MASTER OF EDUCATION IN SCIENCE

DECEMBER, 2016

DECLARATION

STUDENT'S DECLARATION

I, LUKE MENSAH EDOH, declare that this Dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: …………………..………………

DATE: …………………………………………

SUPERVISOR'S DECLARATION

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

NAME OF SUPERVISOR: PROF. MAWUADEM KOKU AMEDEKER, (Ph.D)

SIGNATURE: …………………..………………

DATE: …………………………………………

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DEDICATION

This dissertation is dedicated to the Almighty God and members of my family.

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ABSTRACT

The purpose of this study was to find out the role of practical work in senior high school physics teaching. Action Research design was adopted. Form two, 30 science students from Ngleshie Amafro Senior High School Kasoa randomly selected were involved in the study. Five physics topics were taught over a period of four weeks. Five lessons were therefore held in which practical work was used as the main teaching strategy. Findings from the students' practical activities and discussions made during the lessons served as data. Other observations made during the lesson also served as information. Quite apart from those, students' responses to evaluation questions were also used as data. Findings from the study showed that the practical work enabled the students to explain the phenomena being studied or physics concepts. The practical work made the lessons interesting and as a result motivated the students to learn more. Additionally it improved upon the manipulative skills of the students while encouraging cooperative learning. Finally the practical work made the work of the teacher easy as teacher involvement was greatly reduced.

CHAPTER ONE

INTRODUCTION

1.1 Overview

The perception about science in general and physics in particular is that it is a difficult subject. The main reason ascribed to this alternative conception is the way the subject is taught. Science is a practical subject hence teaching science without practical work makes it too abstract. Many studies have shown that practical work plays a key role in teaching and learning of physics. The researcher has noted that the value of practical work is underestimated in the senior high schools in Ghana. Technology hinges on physics and physics hinges on practical work. If the full potential of practical work is tapped our country will move from a developing country to a developed status. Stakeholders such as physics teachers could use the outcome of this study to improve upon their work. The Ministry of Education could also adopt the findings of this study to improve physics education in Ghana.

1.2 Background of the Study

There has been growing concern about the poor results of students in science and mathematics at the West Africa Senior School Certificate Examinations (WASSCE) in recent times. Students in our universities are also shying away from science disciplines and opting for courses in humanities. This trend of events if not curbed or addressed will have serious consequences for us as a nation. This is because we are in the Technological age. Technology is the engine for growth in this era. Science in general and physics in particular is the basis for technology. One of the reasons ascribed to the aforementioned problem is the way students perceive science. The perception is that science is a difficult subject. Research however shows that practical work is a teaching strategy that facilitates the teaching and learning of science. In other words it makes the learning of science very easy. Conficus old adage goes: I hear and I forget. I see and I remember. I do and I understand (Conficus as cited by Sharpe, 2012). In Great Britain, for instance practical work is widely and frequently used in the teaching of science in secondary schools (Bennett, 2003). It is unfortunate that the full potential of practical work in education has not been tapped in this country due to constraints. The aim of this study is to explore the role of practical work in senior high school physics teaching. It also looks at effective practical teaching and how it can be used as an intervention to improve the teaching and learning of physics in the Senior high School.

1.3 Statement of the Problem

The importance of practical work as a teaching strategy cannot be overemphasized. Science is a practical subject. Science without practical work is like swimming in a pool without water. Time allocated for physics practical lesson in senior high schools in Ghana is 80 minutes (two periods) per week (Ministry of Education, 2010). This is woefully inadequate. This and other factors hinder physics teachers from conducting enough practical work. Physics teachers in Ghana mostly teach using the traditional lecture method. This makes the understanding of physics concept difficult. The problem under investigation is that practical work is not adequately and effectively adopted as a teaching strategy at the senior high school level, in Ghana.

1.4 Purpose of the Study

The main purpose of the study is to adopt practical work as a major teaching strategy to enhance the learning of physics in senior high schools in Ghana. The study also exposed teachers to effective practical work.

1.5 Research Questions

The research questions to guide the study are:

1. What is the importance of practical work in the teaching and learning of physics in senior high schools in Ghana?
2. What is the effect of practical work on senior high school physics students' performance in Ghana?
3. What is the role of practical work in the teaching of physics in senior high schools in Ghana?

1.6 Significance of the Study

It is hoped that the Curriculum Research and Development Division (CRDD) will adopt it as physics curriculum innovation design to bring improvement in our educational system. The study is an intervention as such physics teachers will adopt it to make the teaching of physics effective, interesting and easy to learn. Tertiary institutions may use the outcomes of the study to produce practically oriented graduates to feed our industries, more importantly the newly found oil industry. The study will undoubted bring about a marked improvement of physics results in the West Africa Senior School Certificate Examination (WASSCE) of Ngleshie Amanfro Senior High School.

1.7 Delimitations of the Study

The study was restricted to Ngleshie Amanfro Senior High School Kasoa in the Central Region of Ghana. This was due to its proximity to the researcher and available resources. The findings of this study cover only Ngleshie Amanfro senior school and as such could not be used as a case in other senior high schools. Quite apart from that, findings could not be generalized to cover other science subjects as the study focused on only Physics.

1.8 Limitations of the Study

The research was affected by absenteeism by some students involved in the study. This made repetition of lessons to confirm certain information difficult. Some teachers were not willing to forfeit their teaching periods for the study with the explanation that the research would affect their scheme of work for the term. Consequently some of the lessons for the study were rushed through. Quite apart from that the school's extra curriculum activities such as inter school sports completion disrupted the study a number of times. All these could have affected the data.

1.9 Organization of the Study

This dissertation is organized in five chapters. Chapter One deals with introduction of the study. It includes the background of the problem, statement of the problem, purpose of the study, research questions and significance of the study. It also covers delimitations, limitations and organization of the study. Chapter Two deals with the literature review. Chapter Three describes the methodology. Chapter Four focuses on analysis of data and discussion. Chapter Five, which is the final chapter, deals with the summary, conclusions and recommendations based on the findings of the study in relation to the literature that was reviewed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter presents a review of relevant literature of this research. It covers the concept of practical work; reasons for poor content knowledge of physics; purpose of practical work; impact of practical work on students. It also identifies constraints to practical work and its effective implementation. The literature focuses on various teaching strategies, taking cognizance of the fact that: teachers' use of the best instructional methods is considered to be a prerequisite for successful teaching. It also looked at types of research designs and explained the choice of Action Research for this study.

2.2 The Concept of Practical Work

Various terms exists in science education to describe different activities that constitute practical work. For instance, Lunetta, Hosfstein and Clough (2007) defined practical work as:

> Learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world (for example: aerial photographs to examine lunar and earth geographic features; spectra to examine the nature of stars and atmospheres; sonar images to examine living systems. (p. 394).

The Royal Society's position on the terminology is that practical science is the full programme of experimental and investigative activities including fieldwork (House of Commons Science and Technology Committee, 2002).

Cerini, Murray and Reiss (2003) in a survey to find out the thoughts of students, aged 16-19 about the science teaching methods they enjoy, came out with the following findings: ‘ going on a science trip or excursion’ (85%), ‘looking at videos’ (75%), ‘doing a science experiment in class’ (71%). Practical work in their view encompasses a broad category of activities including laboratory work, experimental work, and fieldwork and computer simulations.

In contrast, Abraham and Millar (2008) in analysing 25 science lessons to determine the effectiveness of practical work, defined practical work as activities in which the students manipulate and observe real objects and materials. This excludes virtual objects such as computer simulations. Similarly, Woodley Emma (2009) in her work identified computer simulations, presentations, role play, excursions and modeling as complementary to practical work and not substitutes.

In my view any activity that helps students to link the domain of objectives and observables and the domain of ideas as illustrated in Fig. 1 should be considered as practical work. This is because every activity is intended to achieve specific goal.

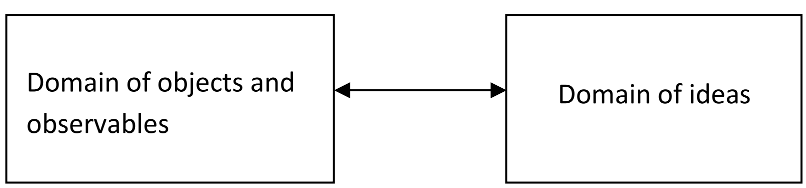

Fig. 1: Practical work: helping students to make links between two domains. (Millar, 2009)

In the context of this study where classroom teaching is the focus the term ‘practical work’ is used to refer to laboratory work and investigational work.

2.3 Physics Content Knowledge

Abraham and Millar (2008) identified lack of practical work as a major reason for science students' poor content knowledge in developing countries. Other factors are: lack of physics teachers' content knowledge and pedagogical knowledge.

Ishak and Mohammed (2008), stated that science teachers' primary skills in mediating the concept of science for secondary students lie in understanding and conveying a complex and fascinating subject, such as physics. According to Asikainen and Hirvonen, (2010) Physics teachers should have knowledge of instructional approaches, experimental work, mathematical problem-solving, and students' preconceptions and models. It is also important to note that teachers' use of the best instructional methods is considered to be a prerequisite for successful teaching (Klafki, 2000).

In a non-empirical research study on the role of science teachers' practical knowledge in reforming science teaching conducted in the Netherlands, van Driel et al. (2001) found that science is generally taught as a rigid body of facts, theories and rules to be memorized and practiced. Similarly, in another theoretical research study on science education in India, Ranade (2008) pointed out the boring and mechanical style of teaching science, as one of many reasons for the poor quality of science education and states that this poor quality of teaching discourages students from doing further study in science.

In a research report based on the perspectives of developing science teachers' practical knowledge, van Driel et al., (2001) explained that teachers 'practical knowledge and beliefs bear explicit relation to their classroom practice.

However Halai (2008) cautioned that if practical activities are not complemented by theoretical fact they rather confuse students because natural phenomena are govern by theoretical laws. Hence practical work should involve both 'minds-on' and 'hands–on' activities.

2.4 The Purpose of Practical Work

According to Millar (2004) practical work is used in science when students are unlikely to have observed the phenomena we are interested in, or to have observed it in insufficient detail, in their everyday lives. In a research literature review, science teachers, in a survey, identified the following reasons for carrying out practical work; to teach skills; motivate pupils ; encourage enquiry ; teach concepts; link practical to theory; encourage creativity; encourage group/team work.

When students engage in practical work, they test, rethink and reconstruct their ideas and thoughts. Many researches have revealed that practical work improves students' learning and understanding. For instance Abraham and Saglam (2010) conducted a survey to determine why science teachers conduct practical work. 397 questionnaires were administered to teachers. The results showed that the purpose for carrying out practical work is to develop students' conceptual and procedural knowledge as well as arouse and maintain interest in the subject. Millar (2004) also indicated that students designed better through Practical work than when asked to write on paper. Thus it is an important tool for teaching experimental design.

Joyce (2000) mentioned that in learning new materials or skills, students should be given extensive opportunity to manipulate the environment. Millar (2004) cautioned however that the aim for conducting practical work should not be solely to confirm theories; else it becomes fun-work rather than an activity to develop understanding. According to Millar (2004) open-ended and investigative types of practical work enhances the scientific knowledge of students.

2.5 The Impact of Practical Work on Students

Research has shown that practical work has positive effect on learners. For instance Kibirige, Osodo and Tiala (2014) using a quasi-experimental design with pre-and –post-test. N=30 for the experimental group (EG) taught using practical work while (N=30) for controlled group (CG) taught without practical work. The findings showed that the EG outperformed the CG. Similarly, an empirical research study conducted on university students (N=143) showed that the physics laboratory work contributes towards the achievement of specific desirable goals (Hanif et al., 2008). Furthermore, the work of Masasia, Abacha and Biyoyo (2012) identified practical work as an influencing agent in the process of learning physics. The study involved 2 groups of girls. Experimental group was exposed to intensive practical work whereas the control group taught by the conventional method. A performance test of reliability index r_{xy}=0.879 administered to both groups. The Experimental group outperformed the control group. Thompson and Soyibo (2002) in a comparison study, reported positive impacts of a combination of lectures, teacher demonstration, discussion and practical work on Jamaican 10^{th} grade [age 15-16] students' attitude to chemistry and understanding of electrolysis. Additionally, Johnstone and Al-Shuaili (2001) reported that practical work increases students' sense of ownership of their learning and their motivation.

Notwithstanding the benefits mentioned above of practical work, Lunetta, (2007) suggests that practical activities which have no context and are simply set up to practice skills or for assessment purposes, may generate lower quality performance than tasks.

In my view even though practical work can impact positively on the learning process of students as indicated above it does not mean it should be used alone. It should be adopted alongside other teaching strategies as demonstrated by Thompson and Soyibo.

2.6 Limitations to Practical Work

Onwu and Stoffels (2005) using mixed methods research with 53 practicing teachers in Venda, Limpopo established that meager training, large and poorly resourced science classrooms hindered teachers from conducting practical lessons. Similarly, a qualitative study on 4 secondary schools in Bangladesh showed that lack of equipment and technicians as well as low teacher/student ratio were constraints to practical work (Banu, 2011). Furthermore, Heeralal (2014) conducted a study to identify barriers to practical work in the Gautang province of South Africa. A descriptive survey was adopted in which questionnaire were administered to 25 natural science teachers. Findings revealed that main barriers to practical work were lack of resources and laboratories, time, large classroom size and assessment pressure. Afemikhe and Imobekhai (2014) conducted a survey to determine problems which confront proper integration of science practical in

Edo state, Nigeria. 200 secondary school teachers were interviewed using questionnaire. Results showed that factors which inhibit practical work include lack of equipment and consumables; loaded curriculum content; limited time and student behaviour.

2.7 Effective Practical Work

Abraham and Reiss (2010) reported in a study on primary and secondary school students (n = 857) that practical work was highly effective in enabling students to do what the teacher intended to do. However less effective in enabling them understand their actions and the data collected. Similarly, Abraham and Millar (2008) in a study that analysed a sample of 25 science lesson, found out that practical work is effective in getting students to do what it is intended with physical objects but less effective in getting them understand their action. Turpin et al., (2000) investigated the effect of integrated, activity –based science curriculum on science content achievement, science process skills and attitude towards science. Iowa Test of Basic Skills (ITBS) was used to measure science achievement. South Eastern Region Vision for Education (SERVE) to measure the process skills and SERVE Science Attitude Survey to measure students' attitude. Pre and post tests were conducted. 532 7^{th} grade scores of the experimental group and 450 from the control groups were analysed. Results indicated that the experimental group had significantly higher scores in the three areas of measurement than the control group. In my view if teachers are supported by appropriate instructional materials they will provide activities which will engage learners both mentally and physically.

2.8 Implementation of Practical Work

For any method to be successful, effective lesson plan is essential (Cimer, 2007). Griffiths and Moon (2002) also suggest that teachers can bring the natural world into the classroom by providing live plants, animals, pictures, models and display of student work. Nivalainen et al. (2010) emphasized that teacher education programmes should be provided for physics teachers with well-designed courses in practical work. Furthermore, Halai (2008) suggest that there should be a minor change in the ways of doing demonstration to increase the effectiveness of demonstrations, for example, to include activities as "prediction-observation-explanation". For instance Erb and Winkelmann (2014) in a study compared small group practical work and teacher demonstration in Geometric optics in Frankfurt University, Germany. 428 pupils in grade seven classes took part in the study. The learning efforts as well as changes in interest and self-efficacy were measured by pre-post- test. The results revealed that both small group practical work and demonstration enhance the learning process in physics lesson. The study also showed that step-by-step instruction is mostly helpful for girls.

2.9 Science Teaching Strategies or Models

Teaching is an act of impacting knowledge. There are a number of teaching strategies but all can be broadly categorized into Direct and Indirect teaching.

2.9.1 Direct teaching

Direct instruction results in the teacher (who is the expert) passing knowledge directly to students. The student's role is a passive one, and the lecture delivery mode is often equated with direct instruction. Dash, Patro and Behera (2013) conducted a study to elicit the perception of medical students (N=337) about teaching methods they found effective. Questionnaires were used and choice made per liker scale. The analysed results showed that 77.02% stated normal lecture as the most effective teaching method followed by group discussion 68.02%.

2.9.2 Indirect teaching

Indirect teaching emerges from the body of learning theory known as constructivism. In the broadest terms constructivist learning is based on the understanding that learners construct knowledge themselves (Krause et al., 2003). Cimer (2007) suggested the following methods and activities as effective for the teaching of science: Practical work, Inquiry-based teaching and learning, Field work, Use of ICT facilities, Co-operative teaching, Simulations, Discussions, Role-play, Offering continuous assessment and providing feedback.

The theory behind the use of role-play in science teaching is that it supports ‘student-centred’ learning (McSharry & Jones, 2000). For example, in the work of Mothabane and Dichaba (2013) a purposive sample of 46 teachers was selected. Eight video recordings of the teachers doing practical using role play in science classroom were analysed. The results of the study showed that teachers acquire valuable skills through role-play. Similarly, Gray (2004) conducted a study of experimentation of role-play with 14-15 year old students. Data was from semi-open ended questionnaire, researchers’ notes and discussion transcript. The results revealed that role-play can be a means for developing students’ cognitive and emotional involvement.

Simulation as a teaching strategy can be defined as a programme that incorporates an interactive model, which can be repeatedly changed and re-run in order for students to understand that model (Alessi, 2000). Compared with traditional more expository forms of instruction, several studies have shown that learning with simulation is more effective for promoting science content knowledge, developing process skills, and facilitating conceptual change. For instance, Huppert, Lomask and Lazarowitz (2002) investigated the computer simulation impact on students' academic achievement and mastery of science process skills. The programme involved 10th grade biology students solving problems while manipulating simulated experiment. The results indicated that the experimental group achieved significantly higher academic achievement than their counterparts in the control group. Similarly, Alinier et al. (2006) examined the effectiveness of high simulation training on the acquisition of knowledge and skill by nursing students. An experimental group was given simulation learning training whereas the control group learnt through the conventional way. The two groups were given pre and post clinical objective tests. The results showed that the experimental group outscored the control group. This indicates that simulation is an effective teaching method.

Discussion is designed to encourage students to think more deeply about a topic while developing their thinking skills. For instance, Murphy et al., (2009) conducted an empirical study to examine evidence of effects of classroom discussion on students' comprehension and critical thinking. 42 documents were examined using meta-analysis. The inter-rater agreement was 94%. The results revealed that several discussion approaches produced substantial improvements in students' text comprehension and reasoning power. In a study Junti et al., (2010) analysed Finnish grade 9 students' actual experiences with science teaching and their preferences to science teaching methods. Survey data were collected from 3,626 grade 9 students (1,772 girls and 1,832 boys) across randomly sampled secondary schools. Data were analysed using nonparametric tests. Results showed that while boys preferred traditional science teaching methods like direct teaching, solving basic problems, reading textbooks, and conducting practical work, girls desired more discussion.

2.9.3 Inquiry-based teaching and learning

Within the access mode an important instructional strategy is inquiry which most certainly uses questioning. Amos and Boohan (2002) reported that, up to one-fifth of what a teacher says in a classroom is likely to be in the form of questions. It is important to note that although inquiry teaching is based on questions it also involves other activities. Hence, according to Trowbridge et al. (2000) inquiry is the process of defining and investigating problems, formulating hypotheses, designing experiments, gathering data and drawing conclusions about problems. Amos and Boohan (2002) identified that, a potential result in inquiry-based teaching is that it enables students to gain insights into the nature of scientific inquiry and understand how and why to apply the scientific method at the same time understand the subject. Studies have shown that inquiry based approach to teaching has positive impact on students than the traditional lecture methods. For instance, Gibson and Chase (2002) investigated longitudinal impact of summer Science Exploration Programme (SSEP) on students. It involved a 2- week inquiry-based science camp at Hampshire College, Amherst. N=22 for students who attended the programme and N=35 for those who applied but were not chosen. Findings suggest that the SSEP students maintained a more positive attitude towards science and a higher interest in science career than students who applied for the programme but were not chosen.

2.9.4 Using information communication technology (ICT)

ICTs undoubtedly have affected teaching and learning positively in recent times (Yusif, 2005). For example, studies by the British Educational Communications and Technology Agency (Becta, 2001a, 2001b), showed that students at schools with 'good' ICT resources achieved significantly better results in national tests in English, Mathematics and Science at ages 11 and 14, than students at schools with 'poor', ICT resources. Similarly Huffman et al., (2003) conducted a study to determine the extent to which computers can alter pedagogy and students achievements. 23 high school physics classes and 13 teachers were examined. Results suggest computers can significantly alter both teaching methods and students' achievement. Furthermore, Chang (2000) investigated the comparative efficiency of computer assisted instruction (CAI) and the traditional teaching methods on tenth-graders' learning of earth science in Taiwan. A total of 151students participated. They were examined through pre and post-test. An experimental group learned earth science concepts through the CAI, whereas comparison group students were taught by the traditional approach. The results showed that students in the experimental group had significantly higher scores than students in the comparison group.

2.9.5 Field work

Field trip involves organising a group of students to visit companies or industries where things taught in theory are seen practically. According Cimer (2007) an investigation revealed that students who participated in a lesson outside the classroom demonstrated significantly greater ability to recognize plants than the students who studied plants only in the classroom.

2.9.6 Co-operative model

Cooperative model is a group teaching strategies that provide structured roles for students while emphasizing social interaction. According to Joyce (2000) the teachers' role in encouraging students inquiry is often dependent on the creation of a co-operative social environment, where students learn how best to negotiate and solve conflicts necessary for problem solving. Co-operative learning can foster the development of deep understanding. Cimer (2007) explained that a peer may help a confused student by rewording the teacher's explanation. Four characteristics features that students engaged in cooperative learning should exhibit are: Team player, Tolerance, Acceptance and Readiness to share information.

2.9.7 Offering continuous assessment and providing feedback

According to Joyce (2000) Feedback helps students find out how well they have understood the new material; what they have done correctly and what their errors are. Goodrum, (2001) explained that feedback helps students modify their learning behaviours. It is important to note that the main reason in giving feedback is to help students discover their own mistakes, rather than simply telling them what they have done wrong.

2.10 Summary of Related Literature Review

Practical work is a learning process in which students interacts with materials or secondary sources of data to observe and understand the natural world. Physics is a branch of science concerned with the nature and properties of matter and energy. If Physics is a complex and fascinating subject involving natural phenomena and practical work is a learning process to understand the natural world, then the two are inseparable. The purpose of practical work is to encourage accurate observation and description; make phenomena more real; arouse and maintain interest; promote logical and reasoning method of thought; develop a critical attitude and an ability to cooperate; for finding facts and arriving at new principles .It increases students' sense of ownership. Practical work therefore plays an important role in the teaching of physics.

Nonetheless practical work should not be used as a way of just confirming theories or following 'recipes', else it becomes fun-work rather than an activity to develop understanding. It must be effectively implemented to achieve set goals. This calls for the adoption of the best teaching strategy, since teacher's use of the best instructional methods is considered to be a prerequisite to a successful teaching. It is a fact that there are a number of research designs, but researcher choses the most appropriate and generally accepted type which will help him/her achieve the objectives of the research. Hence the choice Action Research for this study.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This is chapter presents the methodology used for this study. It focuses on the reason for the chosen research design. It also describes the population of the study, sample size, data collection techniques, and collection instruments and data analysis used to achieve the objective of the study.

3.2 Research Design

According to Cohen, Manion and Morrison (2011) research design is the overall plan for connecting the conceptual research problems to the pertinent empirical research. Put in other words it articulates what data is required, and how this data will be collected and analysed to answer the research question. There are various types of research designs such as Action Research, Descriptive Survey, Quasi- Experimental design, Designed Based Research and Mixed Method.

3.3 Action Research

The research design chosen for this study is Action Research which is a method within the qualitative inquiry tradition that seeks to improve professional practice through better understanding of a particular aspect of a situation (Mills, 2000). Creswell (2009) states that Action Research is the most commonly applied practical research designed in education today. It is well-suited to the social science, particularly to educational issue where there can be ethical problems experimenting with treatments on students (Denzin & Lincoln, 2005).

According to Rebeiro, Day, Semeniuk, O'Brien and Wilson (2001), what separates Action research from general professional practices or daily problem-solving is the emphasis on scientific study, which is to say the research studies the problem systematically and ensures the intervention is informed from theoretical considerations. Much of the researcher's time is spend on refining the methodological tools to suit the exigencies of the situation.

Several attributes separate Action research from other types of research. Primary is its turning the people involved into researchers too. People learn best and more willing apply what they have learned; when they do it themselves. Secondly the research takes place in real-world situations. Finally, the imitating researcher's, unlike in other disciplines, makes no attempt to remain objective, but openly acknowledges their bias to the other participants. Action research encourages teachers to become continuous learners within their classrooms and schools (Mills, 2000). A quasi-experimental design was also used to measure the effect of practical work on the students. In this study the researcher conducted practical lessons for students to help them demonstrate and explain certain physics concepts. The study turned the students into researchers too. As has been stated Action Research takes place in a real-world situation. This study also took place in a natural classroom environment. Finally, this research as an intervention could be adopted by the physics teachers in the school it was conducted to enhance teaching and learning.

3.4 Population

A research study population refers to the number of persons or subjects covered by the study or with which the study is concerned. It can also be defined as a complete set of elements (persons or objects) that possess some common characteristic defined by the sampling criteria established by the researcher. Population can be categorised into Target population and Accessible population.

3.5 Target Population

Target population refers to people or objects to which the researcher wishes to generalize the study finding. For example all people with AIDS or all school-age children with asthma. The target population of this study was all senior high school physics students in Ghana.

3.6 Accessible Population

Accessible population is the portion of the population to which the researcher has reasonable access. It may be limited to region, state, city, country, or an institution. For instance all people with AIDS in Kasoa. The accessible population for this study was physics students of Ngleshie Amanfro Senior High School Kasoa, totaling 150 students.

3.7 Sampling and Sampling Technique

Sampling refers to the process of selecting a group of people, events, behaviours, or other elements with which to conduct a study. Random sampling technique was adopted in this study. From the accessible population 30 students were sampled for the research.

3.8 Data Collection Techniques

According to Chaleunvong (2013) Data collecting techniques allow us to systematically collect information about our objects of study (people, objects, phenomena) and about the settings in which they occur. If data is collected haphazardly it will be difficult to answer our research question in a conclusive way. Data Collecting is the process of gathering and measuring information on targeted variables in an established systematic fashion which then enables one to answer relevant questions and evaluate outcomes. A formal data collection process is necessary as it ensures that data gathered are both defined and accurate and that subsequent decisions based on their findings are valid. There are various types of Data collecting techniques such as Observing, Interviewing, Administering written questionnaire, Focus group discussion and using available information. In this study five physics topics were taught for four weeks. Practical activities were used as the main instructional mode. Five lessons were therefore held. Findings from students' practical activities and discussions made during the lessons were used as data. As a qualitative study other relevant observation made during the lessons also served as information or data. All the lessons were video recorded. Data collection tools therefore included video recorder, field notes books used in recording findings from students discussions on phenomenon being studied and evaluation questions or exercise. Essentially the researcher must ensure that the instrument chosen is valid and reliable.

3.9 Research Instruments

Data collection instruments are very important in any research. Instruments for collecting data include questionnaire, evaluation or achievement tests, video recorder, tape recorder, available information, interview guide as well as field notes books used in recording findings from observations.

3.9.1 Questionnaire

Questionnaire is a form of inquiry document which contains a systematically compiled and well organized series of questions intended to elicit information which will provide insight into the nature of the problem under study. Questionnaires may be designed as: Structured or closed form and Unstructured, or Open ended form. Open ended questionnaire calls for a free response in the respondents own words.

3.9.2 Interview

Interviews are used when the researcher finds it necessary to interact personally with the respondents and elicit information. Interviews range from formal to less formal and completely informal interviews. Interviewers must always ensure that the atmosphere of an interview is congenial to establish interviewer-interviewee rapport.

3.9.3 Observation

Observation is a way of gathering data by watching behaviour, events, or noting physical characteristics in their natural setting and systematically recording the results of those observations. It involves all our senses but sight and sound predominate. Observations can be overt (everyone knows they are being observed) or covert (no one knows they are being observed). The benefit of covert observation is that people are more likely to behave naturally. Observation is one of the very important methods for obtaining comprehensive data in qualitative research when questionnaire and interviews are failing to be effective. By the use of observation strategy, researchers are able to obtain firsthand information about objects and events. Observations can be either direct or indirect. Direct observation is when one watches events as they occur; for example, observing a teacher teaching a lesson to determine whether they are delivering it with fidelity. Indirect observation is when one observes the results of an event; for example, measuring the amount of food left by students in a school cafeteria to determine whether a new food is acceptable to them. In this study, students' actions during the practical activities were observed. Their contributions during discussion time were also listened to and noted. Video tape recorder was also used to collect data. Overt and direct observations were adopted.

3.10 Transcribing

Transcription involves listening to a recording of something and typing the contents up into a document. Transcription must be made from the original recordings of any speech or interview. Even though interviews are always dotted with non-verbal communication such as hand, face and body gestures, they must not influence the transcription in anyway. In this study, the video recording of the practical lessons was transcribed and cross checked with information in the researcher's field notes to ensure accuracy or consistency.

3.11 Administration of the Instrument

In this study data was collected over four week period, during which five physics topics were treated. Five practical lessons were held. All the lessons were video recorded. Findings from students' practical activities and discussions made during the lessons were used as data. As a qualitative research other relevant observations made during the lessons also served as information. Quite apart from that students' answers to evaluation questions during the practical lessons also served as data. Topics taught were melting, evaporation, sublimation, solidification, forward and reverse bias mode of P-n junction semiconductor. Lesson notes (Refer Appendix A).

3.12 Data Analysis

Data analysis is a process of inspecting, cleaning, transforming and modeling data with the goal of underling essential information, suggesting conclusions, and supporting decision making (Ader, 2008). Qualitative data analysis is a process that seeks to reduce and make sense of vast amounts of information often from different sources, so that impressions that shed light on a research question can emerge. In this study, how each practical work helped the students to understand or learn the phenomenon being studied was analyzed. Other revelations that were noted during the practical lessons were also analysed to shed light on the research questions.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSIONS

4.1 Overview

This chapter presents the findings of the four weeks teachings. The reports have been presented in five different lessons and analysed. The discussions were based on the practical activities that went on in the classroom, the procedure as well as the observation that were made during the lessons.

4.2 Lesson One

Procedure and Practical Activities

In Lesson one the topic “Change of State of Matter” was treated. The teaching and learning.

Objectives

By the end of the lesson, students would be able to explain that increasing the heat to a wax enables the wax to melt faster.

RPK

Students are aware that when solid palm oil is placed on fire it melts.

Practical work

4.2.1 Activity

Students placed candle wax in a pan and heated it on fire at low heat intensity. They observed that the candle wax was melting but very slowly. They increased the intensity of the heat by getting the fire closer to the pan. They noticed that the candle wax had started melting at a faster rate. They discussed their observation.

4.2.2 Discussion

Teacher: Use your observation in the experiment to discuss how candle wax melts.

Student No 2: I think that the solid candle wax changed into liquid because the heat melted it.

Student No 4: In my opinion the fire had heat energy and it is that energy which melted the molecules of the wax into liquid.

Student No 17: How was the heat able to do that?

Student No 5: It was able to do that because it broke the intermolecular bonds of the solid wax and they melted into liquid.

Student No 10: I think the solid candle melted because initially its molecules were closely packed and bonded together by strong intermolecular force. The heat from the fire gave the molecules kinetic energy. This broke their bonds and they started moving freely as liquid molecules.

Student No 20: I also noticed that the closer we sent the fire to the pan the faster the wax melted. This means the greater the heat energy the faster the rate of melting.

4.2.3 Findings from lesson one

In this practical work the students were able to demonstrate the process of melting using simple tools. They were also able to explain that the greater the heat intensity the faster the rate of melting. Quite apart from that they could explained that heat is needed to break the strong intermolecular bonds of a solid substance before it can melt. During the practical activities the students working in groups shared ideas and came out with techniques to hasten the process of melting. For instance some raised the heating source while others increased the intensity of the heat to quicken the process.

4.2.4 How practical work has helped the students understand the phenomena being studied

The practical work helped them to learn that the greater the heat intensity the faster the rate of melting.

4.3 Lesson Two

Topic: Evaporation

Objectives

By the end of the lesson, students would be able to explain that increasing the heat and wind to Methyl alcohol enables it to evaporate faster.

RPK: Students are aware that when water is boiled it turns into vapour.

Practical work

4.3.1 Activity

Students measured 10ml of Methyl alcohol into 200ml beaker. They left it in a room for 10 minutes. After the 10 minutes they measured the quantity of alcohol in the beaker. They noticed that the volume had reduced by 2ml. The students measured another 10ml of methyl alcohol into 200ml beaker. They placed the beaker and its content in warm water for 10 minutes. After the 10 minutes they measured the quantity of spirit left in the beaker. They noticed that it had reduced by 10ml or got finished in the beaker. Students measured another 10ml of Methyl alcohol into 200ml beaker. They placed it on a table outside the classroom. They fanned the surface for 10 minutes. After the 10 minutes they measured the quantity of spirit left in the beaker. They noticed that the volume had reduced by 8ml.

4.3.2 Discussion

Teacher: Use your observation from the experiment to discuss how methanol evaporates.

Student No 20: I noticed that the quantity of the methanol had reduced. In my opinion it reduced because it evaporated.

Student No 21: I want to add to what Student pw 20 has said. The methanol reduced in quantity because its molecules escaped into the atmosphere.

Student No 15: I do not agree with them. We did not heat it so where did they get the energy from to escape into the atmosphere?

Student No 16: I think the molecules at the surface of the liquid gained energy from the atmosphere.

Student No 2: I agree with Student No16. They gained heat energy from the warm environment. They were also able to escape because the beaker was opened.

Teacher: Did the wind play any role?

Student No 30: Yes it played a part. The molecules at the surface of the methanol first got warmed up by the heat from the environment. Their kinetic energy increased and they also became light. They then became light. The wind was therefore able to carry them away easily.

4.3.3 Findings from lesson two

Students were able to demonstrate and explained that evaporation results in loss of water or liquid molecules. They also leant that heat and wind increases the rate of evaporation. The researcher observed that the experiment helped them to answer their own curios questions.

4.3.4 How practical work has helped the students understand the phenomena being studied

The practical work has helped them to learn that the greater the heat and wind intensity the faster the rate of evaporation.

4.4 Lesson Three

Topic: Sublimation

Objectives

By the end of the lesson, students would be able to explain that increasing the heat to naphthalene enables the naphthalene to sublime faster.

RPK

Students are aware of how camphor reduces in size when it is placed in wardrobe for a couple of weeks.

4.4.1 Activity

Students placed naphthalene ball in a pan and started heating it using small amount of fire. They observed that the naphthalene turned into gas but rather slowly. They increased the intensity of the heat by increasing the amount of charcoal in the coal pot. They noticed that the naphthalene had started subliming at a faster rate. They discussed their observation.

4.4.2 Discussion

Teacher: Use your observation from the experiment to discuss the process of sublimation.

Student No 19: I learnt that sublimation is the transformation from solid to gas. Why did the naphthalene first melted into a small liquid before changing quickly into gas.

Student No 11: I think that it was because the pan was heating up gradually and so the molecules of the naphthalene were also heating up gradually. When the molecules had not warmed up sufficiently a small liquid formed but when they gained enough kinetic energy they quickly moved into the gaseous state.

Student No 13: I read that naphthalene is a substance that can reach their triple point at the same time. The heat first broke the intermolecular bonds of the solid naphthalene. The molecules gained kinetic energy and stated moving. First slowly and reached the liquid state but just at the same time it reached its gaseous state.

4.4.3 Findings from Lesson Three

Students were able to demonstrate and explained that the greater the heat intensity the faster the rate of sublimation. The researcher noticed that the students were extremely happy when they saw the naphthalene subliming. They were motivated to learn more.

4.4.4 How practical work has helped the students understand the phenomena being studied

The practical work has helped them to learn that the greater the heat intensity the faster the rate of sublimation.

4.5 Lesson Four

Topic: Solidification

Objectives

By the end of the lesson, students would be able to explain that decreasing the heat to melted candle enables the melted candle to solidify faster.

RPK: Students are aware that when liquid water is placed in a deep freezer it turns into ice block.

4.5.1 Activity

Students placed candle wax in a pan and heated it with fire in a coal pot. After it had melted they reduced the intensity of the heat by reducing the quantity of charcoal in the coal pot. They noticed that the liquid wax had started solidifying but at a slower rate.

They removed it from the fire and placed it in a cool environment in the open. They noticed that the rate of solidification had increased. They discussed their observation.

4.5.2 Discussion

Teacher: Use your observation in the experiment to discuss how melted candle solidifies.

Student No 18: I think the melted candle became solid because when the heat was removed the molecules lost kinetic energy. They stopped moving and became hard again.

Student No 30: I agree, the cool environment made the molecules of the liquid wax lose their kinetic energy. They therefore slowed down in movement and finally became stationary, forming strong intermolecular bonds as in solids.

Student No 23: I noticed that when the candle was in liquid state it was colourless but after it had solidified the colour changed to whitish. I do not understand.

Student No 15: It means the properties of solids and liquids are different For instance the molecules of liquid are fairly separated but those of solid candle are closely packed.

4.5.3 Findings from lesson four

Students were able to demonstrate and explained that the lower the heat intensity the faster the rate of solidification. This was excellently done when they removed the hot melted wax from the heat source and they saw it solidifying. Quite apart from that they were able to explain that during solidification the molecules of the substance lost kinetic energy. They slowed down, eventually became stationary and formed strong bonds with each other. The researcher realized that the practical activities enabled the students to understand the phenomena being studied very fast. This made the teaching very easy. In fact it cut the teacher's long talk short. Students were also seen cooperating effectively with each other in their experimental groups. It afforded students who were not academically bright the opportunity to contribute during group discussion as they saw practical activities taken place. The implication is that practical work encourages cooperative learning.

4.5.4 How practical work has helped the students understand the phenomena being studied

The practical work helped them to learn that the lower the heat intensity the faster the rate of solidification.

4.6 Lesson Five

Topic: Forward and Reverse bias of P-n junction diode.

Objectives

By the end of the lesson, the students would be able to explain that creating a narrow depletion zone in a diode enables current to flow through it while creating a wide depletion zone in a diode prevents current from flowing through it.

RPK

Students have experienced bulbs go off and on with the aid of a switch.

Practical Work

4.6.1 Activity

Students identified the positive and negative terminals of a Light emitting diode (LED) and a cell. They then connected Circuit A (Refer Appendix A).That is Forward bias mode of P-n junction semiconductor. They noticed that the LED lit. Students then connected circuit B (Refer Appendix A). That is by reversing the terminals of the LED while maintaining those of the cell. They noticed that the LED did not light. They discussed their observation.

4.6.2 Discussion

Teacher: Use your observation from the experiment to discuss forward and reverse bias modes of P-n junction semiconductor.

Student No 22: In the first connection which is the forward bias mode the positive terminal of the cell was connected to positive terminal of the LED and the negative terminal of the cell was connected to the negative terminal of the LED. In this connection the LED lit. However in the Reverse bias mode the positive terminal of the cell was connected to the negative terminal of the LED while the negative terminal of the cell was connected to the positive terminal of the LED. In this connection the LED did not light. Why?

Student No 27: I think that the LED did not light in the reverse bias mode because the terminals were connected wrongly.

Student No 11: I also think that it was because the LED prevented the current from flowing through it.

Teacher: That is true, but how was it able to do that? What role did the charges play?

Student No 20: In the forward bias mode the positive charges from the cell and the positive charges (holes) from the LED were all moving in the same direction. The negative charges from the cell and the negative charges (electrons) from the LED were also moving in the same direction so current could flow. However in the second circuit or reverse bias mode the charges were moving in the opposite directions. That was why current could not flow through the LED.

Student No 13: I think that in the reverse bias mode the positive charges from the cell attracted the negative charges from the LED and the negative charges from the cell also attracted the positive charges from the LED. So there were no charges in the LED for current to flow.

Student No 12: How were they able to attract?

Student No 13: It is because they were unlike charges.

Teacher: That is true. Who else can build on that?

Student No 19: It means during the forward bias mode there were plenty of positive and negative charges in the LED. This created a narrow depletion zone. The electrons and holes were therefore able to cross over for current to flow. However during the reverse bias mode there was attraction of charges. The charges from the diode were attracted to the cell. This created a wide depletion zone in the diode. Electrons and holes could therefore not jump over to conduct electricity. That was why the LED did not light.

Student No 30: To add to what Student No 19 has said I think that during the forward bias mode the positive charges from the cell repelled the holes or positive charges from the diode. This made the holes rushed back in the diode. The negative charges from the cell also repelled the negative charges or electrons from the diode. So the electrons from the diode also rushed back into the LED. This created a narrow depletion zone in the LED for electrons to cross over and conduct electricity. However during the reverse bias mode the negative charges from the cell attracted the positive charges or holes from the diode. The holes in the LED were therefore pulled into the cell. Similarly the positive charges from the cell attracted the negative charges or electrons the diode. Majority of the electrons from the LED were therefore pulled into the cell. This resulted in the creation of a wide depletion zone in the LED. The LED now acted as an insulator. The electrons and holes could not cross over to conduct electricity. That was why the LED did not light.

4.6.3 Findings from lesson five

In this practical work students were able to demonstrate reverse bias of a P-n junction diode and also explained why current does not flow in the reverse mode of semiconductor. They were also able to explain the creation of a narrow depletion zone in a P-n junction diode leading to flow current. The practical activities also enabled the students to acquire skills of connecting electric circuit. Students were excited, motivated and developed keen interest in the lesson when they saw the LED lit. The practical work gave the students the opportunity to verify facts told them by the teacher. For instance they were able to investigate and got convinced that the shorter lead of a LED is the negative terminal while the longer lead is its positive terminal. They therefore acquired and demonstrated the attitude of learning through the investigative way.

4.6.4 How practical work has helped the students understand the phenomena being studied

The practical work has helped them to learn that the creation of a narrow depletion zone in a P-n junction semiconductor results in the flow of current in a diode. Conversely the creation of a wide depletion zone in a P-n junction semiconductor prohibits the flow of current in a diode.

4.7 Discussion of Results

4.7.1 Research Question 1: What is the importance of practical work in senior high school physics teaching?

In answering research question one it was evident from the study that the practical lessons helped the students to learn and explain the process of melting, evaporation, sublimation, solidification as well as the operation of forward and reverse bias modes of a P-junction diode. Practical work therefore enhances the understanding of physics concepts. This confirms the findings of Abraham and Saglam (2010) that the purpose of practical work is to develop students' conceptual knowledge. Students also improved upon their manipulative skills as they performed the practical activities. For instance during lesson five students leant to read circuit diagrams as well as improved upon their skills in connecting electrical or electronic circuits. It was also observed that the practical activities made the lessons interesting as students got excited at the sight of their experimental results or findings. This motivated them to learn more. Practical Work therefore makes physics lessons interesting and motivates students to study more. This also collaborates the finding of Johnstone and Al-Suaili (2001) that practical work motivates students to learn. It also enables them to develop interest in the subject. The practical work enabled the academically weak as well as bright to contribute in the lesson as they were all engaged in the activities given. This was also evident in the effective way all the students contributed during the discussion stage. The implication is that Practical work encourages cooperative learning. In this study it was observed that students were eager to know the outcome of experimental results. It also helped them to develop an attitude of solving problems through the investigative way. The practical activities in the research gave the students the opportunity to investigate facts or information received from the teacher. This was evident in the determination of the positive and negative terminals of the LED in lesson five. Finally it was noticed that explanation of physics concepts to students took a short time due to the complementary role played by the practical activities. Practical work therefore made the work of the physics teacher easy as teacher involvement was greatly reduced.

4.7.2 Research Question 2: What is the effect of practical work on senior high school physics students' performance in Ghana?

With regards to research question two, it was found out that all the students were able to answer the evaluation questions correctly. This was because the practical activities greatly enhanced their understanding of the physics concept or phenomenon being studied. Practical work can therefore be said to improve upon the academic performance of students. This confirms the finding of Musasia, Abacha and Biyoyo, (2012), that practical work is an influencing agent in the process of Physics learning. The practical activities in this study made the students curious and creative. This was evident in the questions they asked and the suggestions they made in their experimental groups.

4.7.3 Research Question 3: What is the role of practical work in senior high school physics teaching?

It was evident in all the five lessons that the practical activities helped the students to understand and explain the phenomenon being studied. A major role of practical work in the teaching of physics is therefore to enhance the understanding of physics concepts. Another role is to improve upon the manipulative skills of students. As stated earlier this was evident in lesson five where the learners were able to connect circuit diagrams. A third role of practical work in the teaching of physics is to make physics lessons interesting and motivating. This was also manifested in the participatory role the students played in both the demonstrative and discursive stages of the five lessons. The final role of practical work found in this study was to make the teaching of physics easy. This was also revealed in all the lessons as teacher involvement was greatly reduced.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Overview

In this chapter findings of the study have been summarised and conclusion drawn based on the outcome of the findings. Finally recommendations for improvement of the teaching of physics in Negleshie Amanfro Senior High School have been made.

5.2 Summary of Key Findings

The major findings that emerged from this study were as follows:

1. The practical work enabled the 30 students of Negleshie Amanfro Senior High School to explain that increasing heat intensity to candle wax increases its melting rate.
2. The practical activities helped the 30 students to demonstrate that the greater the heat and wind intensity the faster the rate of evaporation of methanol.
3. Quite apart from that practical work helped the 30 students of Negleshie Amanfro Senior High School to learn that the greater the heat intensity the faster the rate of sublimation of naphthalene.
4. It also helped them to learn that the lower the heat intensity the faster the rate of solidification of melted wax.
5. Practical work made the teaching of the four physics topics very easy as teacher involvement was greatly reduced.
6. The activities made the lessons interesting as all the 30 students got actively involved.

7. The academic performance and manipulative skills of the 30 students of Negleshie Amanfro Senior High School, involved in the study improved greatly due to the practical work they were exposed to.

5.3 Conclusion

The findings from this study showed that practical work greatly facilitated the teaching and learning of selected physics topics taught to the 30 Negleshie Amanfro Senior High School students. It helped the 30 students who were involved in the study to understand and explain the physics concepts or phenomenon being studied well. The implication was that their academic performance improved. It also enabled the 30 students of Negleshie Amanfro Senior High School to improve upon their manipulative skills. The practical work made the physics lesson interesting. The students were, therefore, motivated to learn. They developed interest in the subject. Additionally the practical activities made the teaching of the physics topics easy. Quite apart from that the practical work enabled the academically weak as well as bright students of Negleshie Amanfro Senior High School who participated in this research to contribute in the lesson as they were all engaged in the activities given. Practical activities also helped the students to develop an investigative attitude as they became curious. Finally the practical work made the students creative as they came out with ideas or suggestions to make their experiments work. It can, therefore, be concluded from this study that practical work has played an important role in Negleshie Amanfro Senior High School physics teaching.

5.4 Recommendations

The followings recommendations have been made based on the findings of this study:

- It was evident from the study that the practical work enabled the 30 students of Negleshie Amanfro Senior High School to explain that increasing heat intensity to candle wax increases its melting rate. It is, therefore, recommended that in the teaching of melting as a topic in Negleshie Amanfro Senior High School, their physics teachers would let the students vary the heat intensity to enable the learners understand the phenomenon.
- The findings also revealed that the practical work enabled the 30 students of Negleshie Amanfro Senior High School to explain that the greater the heat and wind intensity the faster the rate of evaporation of methanol. Physics teachers in Negleshie Amanfro Senior High School could adopt the procedure in this study and set up their experiment on evaporation in such a way that the wind and heat intensity could be varied by the students. This could enhance the learners understanding of the concept.
- Findings from the study showed that the practical work enabled the 30 students of Negleshie Amanfro Senior High School to learn that the lower the heat intensity the faster the rate of solidification of melted wax. Physics teachers in Negleshie Amanfro Senior High School could adopt the procedure used in this study to teach the topic solidification. In this regard the students could start the process with high heat intensity and gradually reduce it. This would enable the students to understand the concept better.

- It was evident from the study that one important role that practical work played was to make the teaching of physics topics easy. Physics teachers in Negleshie Amanfro Senior High School could therefore adopt this teaching strategy to make their work easy.
- Publishers of books and authors could take advantage of findings of this study and publish more physics practical text and work books to facilitate physics teaching and learning in Negleshie Amanfro Senior High School. This will benefit both teachers and the learners.
- The findings also showed that the practical activities made the physics lessons interesting. Physics teacher in Negleshie Amanfro Senior High School could therefore adopt practical work as a major teaching strategy to make their lessons interesting.

5.5 Future Research

This study focused on the role of practical work in senior high school physics teaching. A future study could focus on physics teaching in colleges of education. A topic such as ‘The role of practical work in college of education physics teaching’ could be considered. The prospective teachers could adopt the practical teaching strategy they would be exposed to, to aid their teaching when they get to the classroom.

This research focused on physics teaching. A future study could be done in other disciplines of science such as chemistry and biology. The topic could be ‘The role of practical work in senior high school chemistry teaching’. The topics treated in this practical work study were melting, evaporation, solidification and sublimation as well as forward and reverse mode of p-n junction semiconductor. A future research could focus on physics topics other than these.

This study was limited to a small sample size of 30 students from the selected school. Future research could be done to cover a larger sample size. A further study could focus on a particular region in Ghana where two schools would be involved. The same practical work teaching strategy with the same topics taught in school A could be replicated in school B. The purpose would be to find out whether the effect would be the same.

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APPENDIX

LESSON PLAN 1

Week Ending ……………………………………………

Class: **No. of Students:**

Day/Date/Duration: **Average Age:**

Topic: Change of State of Matter

R.P.K.:- Students have experienced ice block melt.

References: 1. Zitzerwitz, P. W. (2002*) Glencoe Physics: Principles and problems*. Ohio. USA: McGraw-Hill.

2. Nelkon, M., & Parker, P. (2000). *Advance Level Physics*. Daryaganj: Heinemann (Oxford) Ltd. U.K.

Unit	Objective	Core Points	Teaching and Learning Materials	Teaching and Learning Activities	Evaluation
Step I Review of R.P.K.	Link students' previous knowledge to topic.	Melting		Question: What happens to ice block when it is placed on the sun? Answer: Melts	Which other substances behave in a similar way.
Step II Melting of Candle wax	By the end of the lesson the student would be able to explain that increasing heat to a wax enables the wax to melt faster.	Changing from solid to liquid	Candle wax Pan Fire from coal pot	Students place candle wax in a pan and heat it with fire at low heat intensity. They note their observation.	

				Expected result – Candle wax melts slowly.	
				Student increase the intensity of the heat by getting the fire closer to the pan. They note their observation. Expected result – Candle wax melts faster.	What does the heat do to the molecules of the candle wax?
Step III Discussion on rate of melting	To discuss how candle wax melts.	Rate of melting.		Students discuss how candle wax melts.	What is the effect of heat on melting? Expected answer – Increasing the heat to a wax enables the wax to melt faster. The molecules gain more kinetic energy to move.
Step IV Closure	To review the Lesson.	Increasing heat intensity increases melting process of wax		Students copy summary notes.	

Remarks:

LESSON PLAN 2

Week Ending ……………………………………………

Class: **No. of Students:**

Day/Date/Duration: **Average Age:**

Topic: Evaporation

R.P.K.:- Students are aware that water turns into vapour when boiling.

References: 1. Aseidu, P., & Baah, H. A. (2011). *Physics for Senior High Schools in West Africa*. Accra, Ghana: Aki-Ola Publication.

2. Nelkon, M., & Parker, P. (2000). *Advance Level Physics*. Daryaganj: Heinemann (Oxford) Ltd. U.K.

Unit	Objective	Core Points	Teaching and Learning Materials	Teaching and Learning Activities	Evaluation
Step I Review of R.P.K.	Link students' previous knowledge to topic.	Evaporation		Question: What happens to water when it is boiled? Answer: It vaporizes.	What other substances behaves in a similar way?
Step II Evaporation	By the end of the lesson the student would be able to explain that increasing heat to Methyl alcohol enables it to evaporate faster.	Changing from liquid to gas	200ml beaker Methyl alcohol Warm water	Students measure 10ml of methanol into 200ml beaker. They place it in a room for 10 minutes. After the 10 minutes they measure the quantity of methanol in the beaker. They note the difference.	How does the methanol change into gas?

				Expected result- Methanol had reduced by 2ml.	
Step III Effect of heat on evaporation.	To explain that increasing heat to methanol increases its rate of evaporation.	Increasing heat intensity increases the rate of evaporation of a substance.		Students measure another 10ml methyl alcohol into 200ml beaker. They place the beaker with its content in warm water for 10minutes.After the 10minutes the quantity of methanol left in the beaker is measured. Students note their observation. Expected result – Methanol had finished in the beaker.	What does the heat do the molecules of the methanol?
Step IV Effect of wind on evaporation.	To explain that increasing wind intensity increases the rate of evaporation of methanol.	Increasing wind intensity increases the rate of evaporation methanol.		Students measure another 10ml of Methyl alcohol into 200ml beaker. They place it on a table outside their classroom. They fanned the surface for 10 minutes. After the 10munites the	What does the wind do the molecules of the methanol? Expected answer – It aids the warm light methanol molecules to escape from the surface of the liquid.

				quantity of methanol in the beaker is measured. Students note their observation. Expected result – Methanol had reduced by 8ml.	
Step V Discussion on rate of evaporation	To discuss rate of evaporation of methanol	Warmth and wind increase rate of evaporation.		Students discuss how methanol evaporates.	
Step VI Closure	To review the Lesson	Rate of evaporation. Increasing heat and wind increases rate of evaporation of methanol.		Students copy summary notes.	

Remarks:

LESSON PLAN 3

Week Ending ……………………………………………

Class: **No. of Students:**

Day/Date/Duration: **Average Age:**

Topic: Sublimation

R.P.K.:- Students are aware that camphor reduces in size when it is placed in a wardrobe for a couple of weeks.

References: 1. Zitzerwitz, P. W. (2002*) Glencoe Physics: Principles and problems*. Ohio. USA: McGraw-Hill.

2. Nelkon, M., & Parker, P. (2000). *Advance Level Physics*. Daryaganj: Heinemann (Oxford) Ltd. U.K.

Unit	Objectives	Core Points	Teaching and Learning Activities	Teaching and Learning Activities	Evaluation
Step I R.P.K.	Link student's previous knowledge to topic.	Sublimation		What happens to the size of camphor when it is placed in a wardrobe for a long time? Answer: It reduces in size.	What other substance behaves in a similar way?
Step II Sublimation	By the end of the lesson the student would be able to explain that increasing the heat to naphthalene enables it to sublime faster.	Changing from solid to gas.	Fire in a coal pot Naphthalene ball	Students place naphthalene ball in a pan and heat it using small amount of fire. They note their observation.	Explain how the solid naphthalene changed into gas.

				Expected result – Naphthalene sublimes slowly.	
				Students increase the heat intensity by increasing the amount of charcoal in the coal pot. They note their observation. Answer – Naphthalene sublimes faster.	
Step III Rate of Sublimation	To discuss the process of sublimation	Increasing heat intensity increases rate of sublimation		Students discuss the process of sublimation.	Explain the effect of heat in the process of sublimation. Expected answer- When the heat intensity was increased the rate of sublimation also increased.
Step IV Closure	To review the Lesson	Rate of Sublimation Increasing heat intensity increases rate of sublimation.		Students copy summary of notes on the whiteboard	

Remarks:

LESSON PLAN 4

Week Ending …………………………………………….
Class: **No. of Students:**
Day/Date/Duration: **Average Age:**
Topic: Solidification
R.P.K.:- Students are aware that when liquid water is placed in a deep freezer it changes into ice block.
References: 1. Zitzerwitz, P. W. (2002*) Glencoe Physics: Principles and problems*. Ohio. USA: McGraw-Hill.
2. Aseidu, P., & Baah, H. A. (2011). *Physics for Senior High Schools in West Africa*. Accra, Ghana: Aki-Ola Publication.

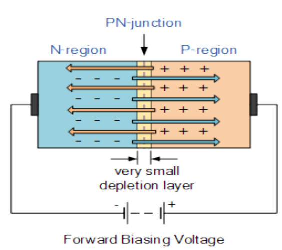
Units	Objectives	Core Points	Teaching and Learning Material	Teaching and Learning Activities	Evaluation
Step I R.P.K.	Link students' previous knowledge to topic.	Solidification		What happens to liquid water when it is placed in deep freezer? Answer: It freezes.	What other substance behaves in a similar way?
Step II Solidification	By the end of the lesson the student would be able to explain that decreasing the heat to melted candle enables it to solidify faster	Changing from liquid to solid.	Candle wax Pan Fire in a coal pot.	Students place candle wax in a pan and heat it with fire in a coal pot. After melting they reduce the intensity of the heat by reducing the quantity of charcoal in the coal pot. Students note their observation.	

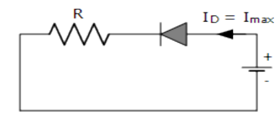
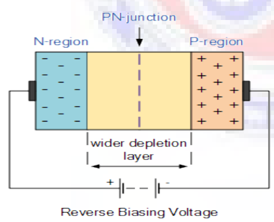
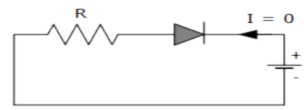
				Expected result - Wax solidifies slowly;	
				Students remove the solidifying liquid wax from the fire and place it in a cool environment in the open. They note their observation. Expected result - It solidifies faster.	Explain how the solid wax formed.
Step III Effect of heat on solidification	To discuss how melted wax solidifies.	Decreasing heat increases the rate of solidification		Students discuss how melted candle solidifies.	Explain the effect of temperature solidification. Expected answer – The lower the temperature the faster the rate of solidification.
Step IV Closure	To review Lesson	The lower the temperature the faster the rate of solidification		Students copy summary note.	

Remarks:

LESSON PLAN 5

Week Ending ……………………………………………
Class: **No. of Students:**
Day/Date/Duration: **Average Age:**
Topic: Forward and Reverse bias of P-n junction diode.
R.P.K.:- Students have experienced bulbs go off and on with the aid of a switch.
References: 1. Zitzerwitz, P. W. (2002*) Glencoe Physics: Principles and problems*. Ohio. USA: McGraw-Hill.
2. Nelkon, M., & Parker, P. (2000). *Advance Level Physics*. Daryaganj: Heinemann (Oxford) Ltd. U.K.

Unit	Objectives	Core Points	Teaching and Learning Material	Teaching and Learning Activities	Evaluation
Step I R.P.K.	Link students previous knowledge to topic	Flow of current		Question: What happens to when the switch is turned on? Answer: It lights	Explain how the light came on?
Step II Forward Bias of P-n junction diode.	By the end the Lesson the student would be able to explain that creating a narrow depletion zone in a diode enables current to flow through it.	Forward bias creates narrow depletion zone leading to flow of current. 	LED Connecting wires 9v battery	Students identify the positive and negative terminals of a LED and a cell. They connect circuit A. That is forward bias mode of P-n junction diode. Expected result - LED lights.	Explain the creation of a narrow depletion zone in the forward bias mode of a P-n junction semiconductor. Expected answer – Holes and electrons are repelled or pushed to the

				Circuit A 	junction of the diode. This leads to the creation of a narrow depletion zone in the diode which permits the flow of current.
Step III Reverse bias of P-n junction	To explain that creating a wide depletion zone in a diode prevents current from flowing through it.	Reverse bias mode of P-n junction diode. Wide depletion zone is created, prohibiting flow of current. Diode acts as an insulator. 		Students connect Circuit B That is reversing the terminals of the LED while maintaining those of the cell. Expected - LED does not light. Students note their observation. Circuit B 	Explain why current flow is prohibited in a diode during reverse bias mode. Expected answer- There is the creation of wide depletion zone in the diode. This blocks current from flowing.
Step IV Operation of P-n junction diode.	To discuss forward and reverse bias mode of P-n junction diode.			Students discuss forward and reverse bias mode of P-n junction semiconductor	
Step V Closure	To review the lesson	Forward bias modes Creation of a narrow		Students copy summary notes.	

		depletion zone. Current flows through diode. Reverse bias mode Creation of wide depletion zone. Current does not flow the diode.			

Remarks: