AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

INADEQUATE SCIENCE PRACTICAL ACTIVITIES IN BASICS SCHOOLS: IMPACT ON PERFORMANCES OF STUDENTS IN INTEGRATED SCIENCE EDUCATION IN SENIOR HIGH SCHOOLS

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BY

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DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my original research and that no part of it has been presented for another degree at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development or elsewhere.

Sarah Addai

Signature:……………………………….. Date:…………………………….

Supervisor's Declaration

I hereby declare that the preparation and presentation of the project work were supervised in accordance with guidelines on supervision of dissertation laid down by Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development

Dr. Charles Amoah Agyei

Signature:------------------------------ **Date:…………………………….**

ABSTRACT

This study sampled students from three Senior High Schools and science teachers from four basic school in the Old Tafo Municipality for different levels of assessments through questionnaires. Descriptive statistics of frequency counts and percentages were used to analyse the demographic data of the respondent while chi-square test and Pearson corelation test were used to test the impact of science practical lessons in Junior High Schools on performances of students in science in Senior High Schools. Chisquare test and Spearman correlation indicated a significant effect of exposure to science practical lessons in basic schools on student's ability to do simple practical lessons in Senior High Schools. Results from the responses showed that many Basic Schools do not have some basic scientific equipment. Moreso, there are inadequate field visits, test books and practical guides to support science practical lessons. Inadequate science periods, teachers' low confidence in some selected science practical topics and large class size of some schools are hindrances to the success of science practical lessons in the Basic Schools. Students who do not get access to practical lessons in Basic Schools are over-shadowed by their other counterparts in the Senior High School science lessons and therefore individual students need proper exposure in Basic Schools before they enter Senior High Schools. Community science laboratories are needed for students to do supplemental practical activities during and after school hours. Stakeholders and other agencies in the education sector need to supply enough science equipment in Basic Schools to increase pupils' interest in science and then properly adjust them for senior High education.

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Lastly, I show my warmest appreciation to my mother and sisters for supporting my education.

DEDICATION

This work is dedicated to my kids, Tobias Opoku Mensah-Djin, Titus Obeng Mensah Djin and Teddy Addai Mensah-Djin for keeping me busy all the time.

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CHAPTER ONE

INTRODUCTION

Science education, especially Integrated Science, trains students the broad and sound knowledge base to meet the challenges of living in a technologically advancing society (Arokoyu, 2012). In so doing, students acquire skills of solving problems that may occur in their natural environments. Problems such as human health, environmental degradation, biodiversity depletion and food scarcity are combated when students develop the requisite skills in science education, meaning, life without science education would make life very unbearable (Opuh, 2014). To develop students to help solve such problems in the environment, science education aims at preparing students to acquire skills in science through practical and theoretical training (Torres, 2018). In effect, the 7E model (elicit, engage, explore, explain, elaborate, evaluate, and extend) is developed to guide students in actively acquiring new knowledge in science (Amini and Usmeldi, 2020). Practically, students are expected to have hands-on experiences in both laboratory and field skills and then the ability to apply the knowledge obtained to solve daily life challenges (Beatty and Woolnough, 2010). Therefore, measures are normally put in place from various information sources to bring research closer to disciplinary contents (Callan et al., 2001; Smith, 2011) and make science practical lessons integrate content knowledge with students' scientific skills developments (Luckie et al., 2004). As a result, the curriculum is planned in such a way to enhance students research skills through Basic and Senior High School training programmes to help develop students thinking skills and processes of research in their future endeavours (Brew, 2012; Wilson and O'Regan, 2007).

The WAEC Chief Examiners' report of 2021 while elaborating the candidates' weaknesses, indicated that candidates had difficulties in plotting graphs, providing right units of some physical quantities such as kilogram (kg) for mass, joules (J) for energy and degree Celsius (ºC) for temperature, as well as understanding most of the concepts of practical questions such as the concept of rusting, determination of volume of irregular shaped balls, reasons of carrying out some activities in photosynthesis such as boiling of leaves to stop photosynthesis and many more (WAEC, 2021). Reading the whole report for Integrated Science showed that students had problems in answering almost all the practical lessons (WAEC, 2021) due to inadequate training in science practical lessons. It appears some candidates do not have strong background in basic practical concepts in science; hence, are not used to simple practical concepts such as graphs reading, identification of parts of organisms and matching up units to the physical quantities. In leu, WAEC recommended, among others, the need of frequent practical lessons as well as diagrams connected to every topic be drawn well on the blackboard and labelled correctly according to scientific method of labelling. Science education curriculum should be reviewed to focus more on the practical aspects where students match what has been learnt in abstract to what is happening in the real world to encourage students to set up work and observe the concepts in Integrated Science lessons on their own and form their own meaning through practical activities in the laboratory. Students tend to understand better when they have practical experiences and when they are involved in experiments, to develop interest in Integrated Science as a course (Kardash, 2000; Wilson and Wilson, 2010). It is noted that student's understanding in the Natural Sciences is low (Amini and Usmeldi, 2020) and would need more practical feel to relate abstracts to realities.

1.1 Statement of the Problem

Science and technology constitute the basis of advancement in nearly all fields of human endeavours. Obiekwe (2018) noted that science teachers lay extreme emphases on content and the use of chalk and talk method, neglecting the practical activity method which enhances teaching and learning. This negligence and shying away attitude from activity-oriented method of teaching has led to abstraction which makes students less active and more prone to rote learning thereby leading to poor performances. It is based on this background that the Ministry of Education in Ghana through the new education reform is emphasizing on both the conventional and computer assisted approach to teach science at all levels of education (Ministry of Education, 2006; Klutse, 2020; Okrah et al., 2020). Conventional approach involves the use of standard laboratories, science kits and demonstrations by teachers while the computer assisted approach involves simulation activities, videos and pictures using computers (Taale et al., 2011; Cotton, 1991). A lot has been done to improve science practical lessons in secondary schools in Ghana but the fundamental from the Basic Schools is still weak.

Learning of Integrated Science starts in Basic Schools where students are introduced to science and nature and then knowledge about their own body and the environment around them. Pupils at all places are expected to have adequate practical experiences in Integrated Science to help prepare them for senior High curriculum. But many pupils in Basic Schools never get such opportunities until they get to Senior High Schools. Affected pupils may meet many challenges in adjusting to Senior High School practical lessons and may not have interest in the course. It is against this background that the intent was to examine the impact of science practical lessons in Basic Schools on the performances of students in the Senior High Schools. This work investigated whether students who get practical exposure in their Basic Schools had advantages over their colleagues without such exposures.

Most of the literature talk more on poor performances of students in Senior High Schools (Tordzro et al., 2021; Ackon, 2014; Anamuah-Mensah 1998) with less emphasis on the impact of effective science practical lessons in Basic Schools on students' performances in Senior High Schools. Therefore, the student's foundation skills for science practical lessons in the basic school practical coursework generally appear to be an overlooked outcome in our school curriculum (Di Trapani and Clarke, 2012). In view of this, students continue to perform poorly in science of which Integrated Science is one. This situation has created the need for more effective method.

It then becomes necessary to explore the problems in science practical lessons in Basic Schools especially pupils from less endowed schools and to address the problem to help their science education in Senior High Schools. Studies have been done on process skills (Gregory, 2013; Loveys et al., 2014; Obiekwe, 2018), but there seems to be little empirical evidence so far on impact of basic school science practical lessons on science education in Senior High Schools in Ghana. Therefore, the study posed this challenge, 'will exposure of pupils in basic science practical lessons affect their performances in Senior High Schools' science education?.

1.2 Objectives of the Study

The primary aim of this study was to examine the impact of science practical lessons in Basic Schools on the secondary school students' academic performance in Integrated

Science in some selected senior high schools in the Old Tafo Municipality. This general aim is expressed in the following specific objectives:

1. To identify science practical equipment available in Basic Schools.
2. To assess students' challenges in teaching Integrated Science practical lessons in Basic Schools.
3. To study the extent of use of science practical equipment in Basic Schools.
4. To study the impacts of Basic Schools' science practical lessons on students' performances in Senior High Schools.

1.3 Hypothesis of the Study

H_o: No differences exist on students' exposure in science practical lessons in Junior High Schools and their performances in Senior High School Science Education.

H_i: Students' pre-exposure in science practical lessons in Junior High Schools impact positively on their performances in their Senior High School science education.

1.4 Research Questions

1. What are the science practical equipment available in Basic Schools?
2. What are some of the challenges students face in integrated science practical lessons?
3. What is the extent of use of science practical equipment in Basic Schools?
4. What is the impact of basic school science practical lessons on students' performances in Senior High Schools?

1.5 Significance of the Study

Considering the present factors responsible for the students' performances in Integrated Science study, the study would lead to practical suggestions on the importance of the practical activities in the Basic Schools. The study will help identify the challenges met in Junior High Schools in science practical lessons and measures needed to address the problem. The study will also educate stakeholders and educationist the need to provide Basic Schools with some of the basic science equipment to help practicalize science lessons. The study will help reduce route learning especially the notion of ''nowadays SHS students cannot solve simple scientific problems''. It will help increase interest in science practical activities in Senior High Schools and science education in general. It will also contribute to problem solving oriented people in the country using hand-on approaches. It is hoped that the findings of this study would also form the basis for further research in the development of science education.

1.6 Limitations

The section shows information on some considered setbacks of the research design and the methodology chosen due to factors such as funding constraints, statistical model constraints, the research design and other factors. The study was restricted to the Old Tafo Municipality and may not provide detailed information on the effect of science practical lessons on all the schools in Ghana, especially schools in the deprived communities. The research tool used was confined to questionnaire that could narrow other observations. Therefore, it was also difficult to ask other question than the general questions that most of the students and the teachers interviewed could understand. In each school, 23 students were selected out of an average school population of 1000 and this may affect the strength of the data and the interpretation of results. Senior High

Schools selected were in the cities and most of the students in such schools were from Junior High Schools within the same community. This might have affected the results of the study as responses by students might be more localized. Replication of this research may not provide the same results since the likelihood of selecting different students may be high and thus may affect responses. Some respondents, especially, teachers may not have provided a true picture of the situation due to their suspected possibility of identifying some of the setbacks of their schools' administration.

1.7 Delimitations

The section talks about the boundaries of this research study based on decisions of what were included or excluded, thus limitations that were consciously set by myself so that the aims and the objectives of the study would be achieved. The study covered only one municipality in the Kumasi Metro, three Senior High Schools and four Basic Schools. Therefore, schools in other communities were not considered owing to resources and time constraints as well as local circumstances such as accessibility issues. The study employed random sampling instead of other probability sampling methods to ensure that all students would have the equal chances of being part of the data taking. However, purposely sampling was adopted to select teachers as only science teachers were needed to help achieve the stated objectives. The study did not cover first and third year students of senior high schools as well as students from basic schools. This is because the study aimed at analysing the results of three end of term examinations of students from Senior High Schools and this automatically excluded first year students who had not written any exams during the time of the administration of the questionnaires. The third-year students were not included due to the assumed pressure on them for the impending WAEC examination.

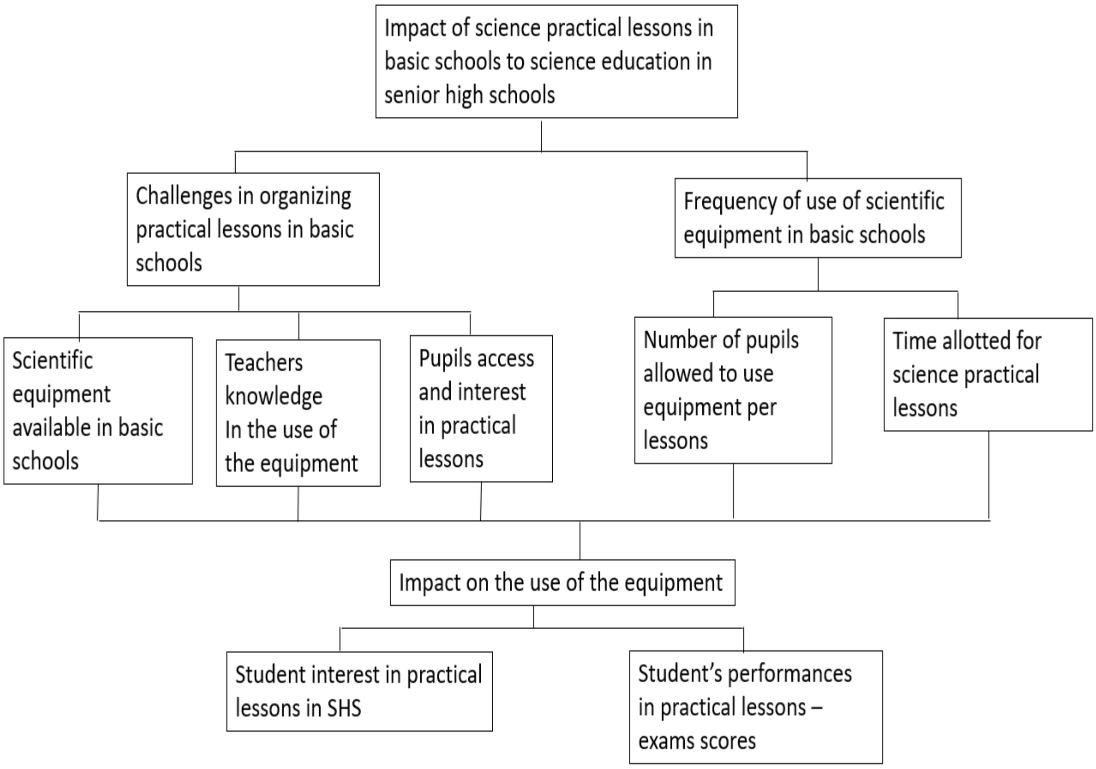
CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section provides background information of the study. The review starts with the conceptual framework and then links it up with the meaning of science education, science education structure, polices and then methods of teaching science in general. The review is then narrowed down to practical activities in science education, challenges and impacts of basic science practical activities on students' career in science and their performances in science education in the higher levels of education.

2.1 Conceptual Framework of the Study



2.2. What is Science Education

“Science is the study of phenomena and events around us through systematic observation and experimentation” (Education Bureau, 2022). The act of teaching and learning of science is science education (Dauda, 2019). The aim of science education is to gain understanding of the established body of scientific knowledge appropriate to the needs, interests, and capacities of students and to develop students understanding of the methods within which this knowledge exists (Millar, 2004). Hodson (1993) indicated that science education has three main components, and these include learning science (acquisition of knowledge in science), learning about science (understanding the interactions between science and society through nature and methods of science) and doing science (practical work to scientific and enquiry and problem solving). Science education enables students to understand the various scientific discoveries, the complex processes in their environment and then the natural system around them. Science education helps students to explain the world around them, understand and interpret scientific theories, investigate into scientific problems, to participate in scientific discussions and then to acquire knowledge needed to solve their everyday problems (Alberts, 2022). Through science education students can develop scientific reasoning and solve daily problems through creativity, critical thinking, and inquiries. Science education may not be to only people who are interested in science but also to the public for them to appreciate the processes surrounding them (Trefel, 2008; Dauda, 2019). The rationale behind science education is to help individuals develop scientific knowledge to help understand the uses and implications of science in the world around them. Science helps people to make sense of the world around them and to appreciate the linkage between science and the society. Through science education people become aware of their environment and then learn to reduce negative impacts on the environment. Students also develop scientific ways of life through curiosity and investigative habits, use scientific concepts and principles to solve problems, get to understand how vulnerable the natural environment is and then to take the necessary precautions to ensure the sustainability of the environment (Ministry of Education, 2007).

2.3 Status of Science Education and Structure

It is believed that science practical work originated around the 17th century (Jeans, 1947). Around 1657, Grand Duke Ferdinand di Medici and his brother Leopold formed a science society as a forum to scientific discussions with the aim of promoting science experimental learning while the first recorded chemical laboratory in 1796 was established by the Dublin Society (Bradley, 2005). These and many activities that followed led to the acceptance of the use of laboratory for scientific research and studies.

Science education is important for nation building in Ghana, the subject area is needed to ensure capacity building geared towards labour force to the local industries (Azure, 2015). As much, the social and the economic transformation of a nation depends on strong science and technological structures (Anamuah-Mensah, 2004) and proper structures put in place in the educational sector will ensure effective science education. According to the Ministry of Education (2019), the new syllabus of Integrated Science education ensures that every learner participates in every learning process as well as enjoying the learning. The curriculum aims at providing the learners the needed foundational skills to function well in the country in order to be critical thinkers and problem solvers. To achieve the main goals of science education, the policy indicates that the science education must be pivoted on learner-centred science teaching and learning approaches that engage learners physically and cognitively in the knowledge acquiring process. Both the basic school and the Senior High School science education syllabuses are organized under five main themes including diversity of matter (diversity of living and non-living things, matter, metals and non-metals etc), cycles (air movement, life cycle of pests and parasites, Crop production etc), systems (the skeletal system, transport, food and nutrition etc), energy (solar energy, photosynthesis, electronics etc) and interaction of matter (ecosystem, magnetism, forces etc) (Ministry of Education, 2007; Ministry of Education 2010). Each theme is divided into units or topics. A total of six periods per week is given for Integrated Science education out of which two periods are for the practical section with a duration of 40-minutes per period. For the Senior High School, a total of five periods is apportioned for Integrated Science while practical lessons take two of the five periods. Like the basic school, time allotted for each period is 40 minutes. Aside the classroom practical sessions, the syllabus also recommends that each school should keep a farm for growing crops as well as rearing of animals such as birds (chicken, ducks and turkey), ruminants (goats, sheep and cattle), other monogastric (rabbits and guinea pigs). Again, schools should plan to visit well established experimental and commercial farms, manufacturing industries, research institutes and other institutions related to science (Ministry of Education 2010). For practical section, the syllabus indicated that some of the skills needed include equipment handling, planning, and designing of experiment, manipulation, classification, measuring and other skills (Ministry of Education 2010). Oliveira and Bonito (2023) indicated that the goal for practical lessons is for students to develop the sense of taste for the study of physical and natural phenomena, while sending students closer to the activities of researchers in the area of knowledge the students acquire through science lessons.

2.4 Policies and Structure of Science Education in Ghana

According to Gbadamosi (1989), science education was initially not the prime focus of the colonial masters as indicated in the 1925 memorandum on education in Ghana. After the independence, Ghana made some frantic efforts to create facilities for the study of science, however, policies on curriculum development for science education was missing. Science teaching started with nature study and hygiene, mainly writing notes for pupils to study and commit to memory. Science was taught as Chemistry, Physics, Biology and Health Sciences at the secondary school while science teaching at the training colleges was rare.

Campaign to teach science at all levels started after the post-secondary independence era, when teachers and other stakeholders were dissatisfied with the old structure indicating that the old structure lacked relevance and was not related to the immediate environment of the children. This led to the setting up of a committee in 1966 by the then Government to review the educational system of Ghana. The review indicated that general science should be taught at the primary and the secondary school levels and up to the school certificate level while those with special interest should be given additional tuition to prepare them for further work in science. This earmarked the introduction of Integrated Science into the Ghana education policy.

Based on other committees formed including teachers, scientists, and psychologists who through series of test trials in some selected schools, developed science education into units and sub-units. Then other materials to enhance teaching including, Teacher's Guide, Pupil's Book, Science Library Series, and Teacher's Background Books were also provided. All the course materials were written based on the environment of the kids and teachers were, as much as possible, supposed to use the environment for science lessons. These materials provided guideline information on procedures in the classroom, individual works outside the school, and how to make simple scientific equipment for experimentation.

The method for teaching Integrated Science was mainly of activity method to provide the platform and adequate materials needed for students to interact actively with teachers. Equipment such as flat and round bottom flasks, funnels, rubber tubing, conical flasks, magnet and many more were initially supplied by the UNICEF grant to help with science teaching in Ghana. Since all schools in Ghana could not get the equipment, teachers were advised to use available equipment in their environment – improvisation for science activities. Such materials included bottles, empty tins, burntout electric bulbs, bamboo, pawpaw stalks, and many more. For example, burnt-out electric bulk filled with water was used to demonstrate the use of hand lens or round bottom flask while empty tins were used as beakers. Handling or construction of equipment such as hammers, hacksaws, screwdrivers, and aquariums were recommended to help teachers appreciate the need to use their own environment for science activities. For materials that could not be improvised, grants were given by the Government to purchase them.

Qualified technicians were attached to science units to assist teachers to construct prototype equipment for science practical activities. In total, the primary science curriculum was designed to make pupils familiar with a variety of biological, physical and man-made phenomena in the world around them. Integrated Science curricular emphasized on activities by the pupils and made use of low-cost, improvised materials from the immediate environment to reduce cost of importation while making science lessons more practical.

2.5 Educational Models

Different types of models are recommended in the educational sector. Some models focus on the making of lesson plan while others also emphasize on the delivery of the content (Kurt, 2016). One of these models is the Dick and Carey model which focuses on the planning of the lesson (Figure 1). The model helps teachers to figure out what to teach and how to teach it. It starts with the identification of instructional goals and then connects other nine steps to the last two steps which are 'developing and conducting formative evaluation' and 'developing and conducting summative evaluation' (Kurt, 2016).

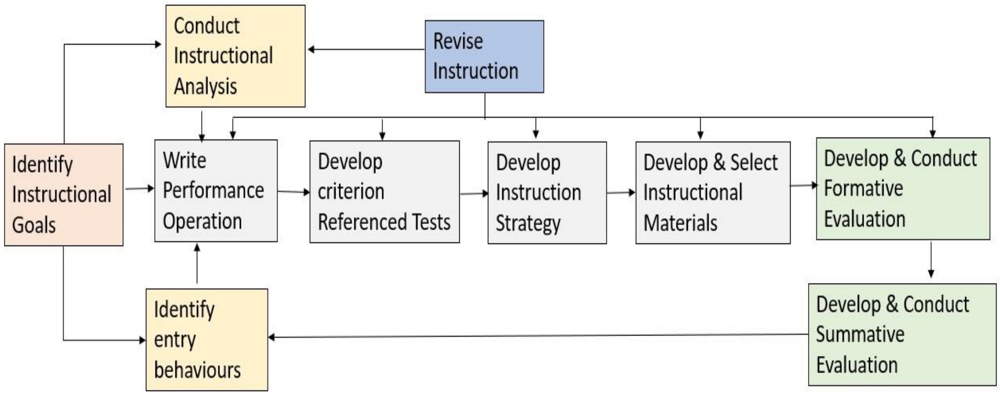


Figure 1: Dick and Carey model.

Source: Kurt, S. (2016). Dick and Carey instructional model. Accessed on 16/07/2023 from https://educationaltechnology.net/dick-and-carey-instructional-model/

These evaluations also give the teacher the background information on the next instructional goals to develop. Dick and Carey model has been confirmed to be very useful for creating science curriculum (Carlton et al., 2000; Akbulut, 2007; Hartman, 2017).

Following the Dick and Carey model, other models have been developed concentrating on student-centred learning models. Examples include the cognitive learning model initiated by Edward Tolman and coined by Jean Piaget in 1936 and which assumes that transfer of learning can be done in different situations through discovery. It emphasizes that learning is facilitated by internal and external factors such as attention, observations, retrieval of information and many more (Bruner, 1990; Yilmaz, 2011). Thus, learning focuses on maximizing the potential of the brain through four main factors including observation, retention, reproduction, and motivation (Fryling et al., 2011; Tennyson and Volk, 2015). For example, a student needs to sit to listen to the teacher for information (observation), the student tries to retain the ideas acquired from the teacher (retention) depending on the internal cognitive process and may reproduce the information in future discussions or for problem solving (reproduction) and then he is motivated to use the information for other discussions or to solve other related problems (motivation). Information can be gathered through experiences, observations, the senses and so forth. Here, the learner is presented with problems and then he is guided to find solutions to the problem without a preview of sequences of materials to solve the problem. This model was criticized for the inefficiency to properly account for individual differences.

The other model is the constructivist approach where people construct their understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Rahman and Chavhan, 2022; Bareiter, 1994). With this model, teachers should access the previous knowledge of the students to build upon new concepts (What is called relevant previous knowledge or simply RPK). There have been many learning cycles based on the constructivism model (Rahman and Chavhan, 2022). These learning cycles started from 3E and now up to 9E (Kaur and Gakkkar 2014; Rahman and Chavhan, 2022). The 7E learning cycle (Eisenkraft, 2003) tends to be the most popular and with which another model called the 7E-Inquiry Integrated Module (7IIM) was designed (Libata et al., 2021). The model has seven instructional phases including 'elicit', 'engage', 'explore', 'elaborate', 'explain', 'evaluate' and 'extend'. This model is designed to meet the challenges of poor performances in science as well as making classroom activities more learner-centred, activity-oriented, and more problem-solving (Morrison et al., 2019). It allows teachers to present lessons that incorporate inquiry and activities into their curriculum in a cycle that promotes a student-centred classroom activity (Vick, 2018). As the students follow the 7 models, they acquire new knowledge through the understanding of the problems and the phenomena they encounter in the environment.

2.6 Methods of Teaching Science (Practical Approach)

As indicated by Edgeworth and Edgeworth (1811) in Lazarowitz and Tamir (1994), "the knowledge that cannot be immediately applied is quickly forgotten and nothing, but disgust connected with useless labour remains in the pupils mind''. Science lessons along the line became an important part in the training of kids to function well in a society surrounded by scientific phenomena. The emphasis of the science program is to develop students' manipulative skills and attitudes for students to become interested in further exploration on his own, and then identify the skills needed to classify and solve problems by themselves or in collaboration with others (Gbadamosi, 1989). To help achieve this and other aims to impart scientific ideas to pupils, teachers must have theoretical and practical preparations and abilities about science learning and teaching (Klutse, 2020). Ability to plan well by the teacher to meet students' needs rely on teacher's knowledge of students' cognitive potential, developmental level, physical attributes, affective development and motivation. Other considerations include the content and activities that teachers make, their interactions with students, selection of assessments and the habit or minds of teachers (Klutse, 2020). Profile dimension tends to be the central basis of instruction, learning and assessment. It is the psychological unit of describing a learning behaviour – the four learning behaviours being knowledge, understanding, application and process (Ministry of Education. 2007; Klutse, 2020). These learning behaviours, also known as dimensions of knowledge, explain the fundamental behaviours of teaching, learning and assessment (Klutse, 2020). Any method of teaching should factor all the four learning behaviours. In lieu, teaching methods are grouped into four main types – learner-centred method, teacher-centred method, content-focused methods and interactive/participative methods (Rajeet, 2020). For the teacher-centred type, the teacher is seen as the master of the subject while the learners are passive recipients of the ideas, e.g., lecture method. When the teacher tends to be an instructor and a learner as well, then this method becomes the learner-centred type. Examples include discussion methods and discovery methods. For content-based methods, teachers and learners carefully analyse the contents of the discussion without any of them altering the contents. Example is the programmed learning method. The interactive or participative method reflects on the three other methods without laying emphasis on either the learner, the content, or the teacher. The methods base on what is the most appropriate thing to learn or do per the situation of the learners and the teachers (Rajeet, 2020).

Different teaching methods are explained appropriately for the teaching of Integrated Science. Some of these teaching methods include Demonstration method, project method, inquiry method, discovery method, field trip or excursion method, processbased method, laboratory or experimental method, lecture method, co-operative learning method and discussion method. In selecting a method, teachers should understand that they are trying to help students understand the scientific methods or process work practically and how science should impact upon their lives. Choice of a particular method for Integrated Science should be governed by the four types discussed. One method may have advantages and disadvantages and therefore the use of integrated methods may be ideal for Integrated Science base on the situation. By using integrated methods such as classroom discussion, students' pre-knowledge and experiences, repetition, web assisted learning, investigative method and out-door learning, teachers create enabling environment for stimulation and greater academic commitments among students (Ndurya, 2020).

2.7 Practical Work in Science Education – Impacts, Benefits and Effectiveness

Supporting theoretical explanations with actual practical lessons in the laboratory is an important feature of effective science education (Ojediran et al., 2014). Leach and Paulsen, (2008) as well as Millar (2004) explained practical work as "any teaching and learning activity that involves student's science process skills in observing and manipulating real objects and materials". The activity is followed by periods of discussions of observations and measurements made and then the interpretation of similarities or differences existing among the observations (Leach and Paulsen, 2008). Practical work links the domain of real objects and observable things with the domain of ideas of scientific knowledge (Millar, 2004) making lessons more concrete and facts close to students' environments. It aims at getting students to grasp the concept well and apply them effectively. Students learn well when engaged in activities therefore the focal point for science education is the hands-on experience (Hodson, 1993). Science practical work help students to understand the process of scientific investigations and improves engagement and knowledge retention. By having hands on feel of scientific process through practical works, students get deeper understanding of the lesson by finding things for themselves while performing experiments with techniques and methods that have enabled the secrets of human bodies, the environment and the universe (Roberts, 2008). Students tend to have positive attitudes for science that meaningfully imparts on their achievements in science (Okam and Zakari 2017; Hinneh, 2017). Woolnough, (1994) indicated that practical work improves communication skills of students and increasing interaction among students and the interest to learn in groups. For example, students engaging in the need of light for photosynthesis helps them to discuss among themselves the equipment and materials required for the experiment, how to set up the equipment and how to make observations. This ensures teamwork which is important for future career and the job market. These practical works involve actions and reflections making students develop their thinking skills and science process skills (Millar, 2004). An experiment was conducted between two groups of students, one with practical science and the other with the normal teaching, it was identified after pre-test and post-test results that student who had access to the practical feel of the lesson understood the concept better than their other counterparts (Shana and

Abulibdeh, 2020). The researchers then recommended that students be given ample time for practical lessons and school administrators should stock their laboratories with all equipment needed for practical work to be effectively implemented.

Though practical work helps students to learn and do science, many challenges face practical activities in various schools in Ghana. In the following chapter, I try to tackle some of these challenges.

2.8 Challenges of Science Education in Ghana

2.8.1 WAEC Chief Examiners Reports on Students Performances in Science

Teaching of science including practical lessons is meeting many challenges. WAEC examiners report for BECE (2021) indicated among many things that students fumbled with correct scientific units, could not use appropriate scientific formulae and expression, could not distinguish between experimental observation and conclusion, had inadequate knowledge in agricultural concepts and were unable to interpret practical questions well. The report further indicated that majority of the students could not draw reasonable conclusions from the results and observations of experimental setups, could not read units well and could not provide precautions necessary for experiments. For the Senior High School certificate, WAEC (2015) indicated that many students could not add units of measurement while most of the students did not consider the precision of the meter rule. It was also noted that most of the candidates could not identify differences between some diagrams while others could not identify and label some diagrams such as retort stand, thermometer and many more. These problems reflect on inadequate preparation of students for evaluations due to other challenges facing the teaching and learning of science. Among some of these challenges include.

2.8.2 Students Attitude to Science Practical Lessons

One of the most important motives to teach science is to get students motivated to be involved in learning science and feel committed to continue with science in future (Hussain and Akhtar, 2013). Inasmuch as science is very important for nation building, many students continue to show negative attitudes to science especially the practical aspects of science. Many students may not appreciate the practical concepts but may rather take part of lessons in science practical work just because it is a requirement (Reid 2003). The cause might be due to the manner in which such classes are conducted by teachers, which rather de-motivates and restricts students critical thinking instead of inspiring them (Reid 2003). Jenkins and Nelson (2005) identified that students do not show interest in science practical lessons because they don't see it as a career and therefore wouldn't spend so much time on it.

2.8.3 Availability of Equipment

Science lessons become more interesting when students are given the opportunity to have the practical feel of the science concepts. As students see, handle, and manipulate real objects, they can get the feel of the relationships between actions and reactions. Scientific models that are difficult to explain can be done easily with the use of scientific equipment. Using scientific equipment help students to comprehend abstract and complex scientific concepts; students develop problem solving skills through comprehending the nature of science; students also develop special talents through practical experiences they develop when manipulating scientific equipment; and, having a concrete feel of the lessons helps develop students' positive attitude towards science (Kamba et al. 2019; Shana and Abulibdeh, 2020). However, in the Basic Schools where the foundation of science is built, most of the schools lack basic scientific equipment needed to make lessons real. This situation is worse in most of the rural schools in Africa and the problem will surely affect the process of science education (Kamba et al., 2019). The hectic of the teacher asking more students to share an equipment is enough to discourage the interest of students in the lesson and the teacher from conducting extra activities in such dimensions. Again, some students are overshadowed in the case of sharing equipment making them remain silent in classroom participations and discussions (Ahmad, 2021).

2.8.4 The Extent of Use of Science Practical Equipment in Basic Schools

In a situation where they are available, the extend of use of the equipment is also a factor to defeat the objectives of science education. Some school administrators may try to keep the equipment safely than to release them for practical lessons – thus preventing them from being scolded by superiors or auditors when not in good shape. Also, when the time allotted for science lessons are not enough, teachers may not have ample time to teach the theory, lead practical activities, and assess the pupils. This makes the teachers to haste the pupils through the topics (Quansah et al., 2020).

2.8.5 Teachers' Knowledge with the Use of the Equipment

Teachers are the forces behind the implementation of educational objectives and policies. Therefore, teachers' competency and motivation are very important in science education. When teachers lack the confidence of teaching topics outside their area of expertise, it affects lesson preparation, choosing activities for students, answering students' questions, sustaining students' interest in the lesson delivery and then linking the lessons to everyday life situations (Parker et al.2018). The child's ability to grasp the concept of science education also depends on what the teacher believes, knows, and does or does not believe, does not know, and does not do (State et al. 1978; Otarigbo and Oruese. 2013). When teachers' motivation in science lessons are very low, it results inadequate preparation, poor supervision, unwillingness to improvise when equipment are not available, inappropriate selection of instructional materials for teaching and then, poor attitude towards students and lesson delivery as a whole. According to Otarigbo and Oruese (2013), the 'teacher factor' in the problems of achieving the learning objectives in Integrated Science is the inappropriate training background of science teachers. Especially in the Basic Schools where a teacher is supposed to teach all courses, the interest may shift to area of specialization of the teacher at the expense of other courses. Supposing the teacher's area of specialisation is in non-science courses then this will affect the teaching and learning of science as well as the practical sections. As the curriculum may have the right objectives and appropriate suggestions for practical work, the teacher's ability to apply the required methods to teach the course will help achieve the objectives of developing the skills and individual ingenuity of the students (Otarigbo and Oruese, 2013). No or in-adequate in-service training for teachers also makes it difficult for teachers to adjust to new developments in science education (Anderman et al., 2012), in effect, such topics or practical lessons are kept under the carpet while students suffer in this new area of knowledge. It is even reported that some teachers who are intimidated by the challenge of learning new instructional strategies remain adamant to new ideas in their respective instructions (Handelsman et al., 2004; Adu-Gyamfi, 2014). Some teachers may be overloaded with may activities including marking of exercise, other extra-curricular activities and administrative work and wouldn't have enough time to prepare for science practical lessons.

2.8.6 Students Exposure and Interest in Practical Lessons

Pupils interest in science education is also a major factor to the implementation of the objectives of science education (Adu-Gyamfi, 2013; Fensham, 2008; Hallack & Poisson, 2001). Though some students find science practical lessons interesting and to a certain extent important, they are not attracted to it as a career worth pursuing (Hallack & Poisson, 2001; Jenkins and Nelson 2005; Sharpe 2012). Adu-Gyamfi (2013) indicated that low interest of students in science education are due to inadequate practical nature of science lessons and thus making science studies more of knowledge transfer from teachers and science books to students. Students learn best when they have the chance to hear, smell, taste, see and feel (Opara and Etukudo, 2014), and adequate lessons materials give the students chance to use their senses effectively. Not all, procedures of assignments and assessments, types of rewards and punishments for science lessons and students grouping are important to sustain the interest of students for further science education (Anderman et al., 2012; Adu-Gyamfi, 2014). Students who use English language as a second language also find scientific concepts very challenging to understand (Quansah et al., 2020). In the mention, students may try to shy away from science lessons that are full of unfamiliar scientific terms. When student also do not have strong background in the scientific concepts from the basic school, they lose interest in science lessons as concepts get tougher for them to understand in Senior High Schools.

2.8. 7 Cultural and Religious Beliefs

Cultural and religious activities around where the schools are found can also affect the study of science including practical lessons (Cooperman et al., 2016). Cultural and religious beliefs help to shape individuals and their perspectives about education and life in general (Cooperman et al., 2016). Some religious beliefs may have some perceptions about scientific concepts and therefore may also affect practical activities in these concepts (Abdallah et al., 2018). Example, science practical lessons on the identification of parts of some farm animals such as pigs may not be well participated by some religious groups such as the Muslim community. This may affect students understanding on some cultural practices carried in the rearing of such farm animals. Again, some religious groups do not believe in the concept of evolution, therefore students from some religious groups may not be interested in any practical lessons on evolution (Barnes et al., 2020). In Ghana, the Akan community have some animals as symbols or totem and these animals are so sacred that students may fear to do anything about them.

More so, Cultural and religious beliefs often dictate traditional gender roles and some of these roles may discourage girls from actively participating in some science activities (Dicke et al., 2019). For example, science practical lessons on electronics, mechanics and electricity are culturally noted to be more masculine. This gender disparity can lead to limited exposure to practical science skills for girls during their basic education, which may hinder their performance in Senior High Schools. These cultural and religious perceptions about such topics can reduce students' exposure to other related important learning activities.

Not all, cultural and religious selection of some courses in science can also influence students' career in science and in as such, limit their interests to specific science practical lessons (Cooperman et al., 2016; Barnes et al., 2020; Abdallah et al., 2018). When religious groups see evolution as topic against biblical creation, students may not have interests to pursue further education in the area and this can limit their future opportunities in the area.

In an environment where science is not considered a priority, students may face social stigmatization and societal pressure (Nunes et al., 2022; Hurtado et al., 2009). In some of the rural farming communities, parents would want their wards to help in their farming activities as a priority, since they do not see any prospect from science education. Students who decide to go for education may feel isolated for their interest in science.

2.8.8 Scientific and Technological Advances

Advancement in science and in technology have transformed the way science is taught in the classroom (Costley, 2014). Science practical lessons, which encompass hands-on experiments and interactive learning, have been greatly influenced by these advances (Isman et al., 2007). The use of smart phones has made more accessible simulated activities of some of these scientific theories (Twum, 2017; Ubben et al., 2023). However, if teachers leading the activities are not technologically inclined, it affects this science simulated practical activities.

Again, scientific and technological advances have help produced complex scientific equipment that were not available in the past (Isman et al., 2007). But many Basic Schools may not have the enough funds to purchase some of these equipment.

When teachers in Basic Schools take advantages of these scientific and technological advances, it will help students' performances in many dimensions such as deeper understanding of the scientific concepts, enhanced problem-solving skills and critical thinking and then finally prepares students for future scientific careers.

2.8.9 Opposing Positions on Impact of Science Practical Lessons in Basic Schools on Senior High School Science Education.

Though science education including practical lessons in Basic Schools may have strong impacts on students' performances in Senior High Schools, there are some levels of opposing views about the stated hypothesis (Abrahams and Millar, 2008).

There are groups of people who think that the theory aspect of science is more important than the practical lessons. They think that once the concept is understood through the traditional teaching, students can apply the concepts in their daily lives to solve practical problems when the situation demands. Hodson (1991), and Osborne (1993) for example, indicated that as practiced in many schools, practical work is ill-conceived, confused and unproductive, and as such the need of alternatives to practical work. For many children, what goes on in the laboratory contributes little to their learning of sciences. Wellington (1998) suggested reappraisal of the role of practical work in the teaching and learning of science.

Again, some teachers think that science practical activities are time consuming (Oliveira and Bonito, 2023). Therefore, if the syllabus should be completed within a time limit, then practical lessons should be silent.

The hypothesis of this study could also be argued from the view point that students' performances in science in further education may not be due to their exposure to science practical lessons in Basic Schools but by a result of multitude of factors which may include the teaching quality, pressure from home, peer influence, students' perspectives and motivation (Shana et al. 2020). Though students might have been exposed to practical activities in the basic science education, their internal and external motivational factors may either enhance or reduce their interests in science education in Senior High Schools and as such affecting their practical activities.

It is again noted that over-emphasis on practical lesson might lead to a low tone of the theoretical knowledge. Without a strong theoretical foundation, students could struggle in Senior High School when facing more complex topics that demand a solid understanding of scientific principles.

Also, some science practical activities favouring some cultural or religious beliefs at the expense of others may create cultural divides within the classroom (Cooperman et al., 2016; Abdallah et al., 2018; Barnes et al., 2020). Students from the other cultural or religious groups may see themselves to be disadvantaged and that may create a bad environment for science studies.

Again, some intercultural activities view the preservation of the traditional knowledge of science instead of the book knowledge (noted the Whiteman's concept). This can cause oppositions to solving practical activities that are not familiar with the immediate cultural activities of where the school is located.

When resources are limited to purchase science practical equipment, allocating time and resources to practical lessons might cause other subject areas to suffer and this may create the notion of "some subjects being more important than others'' syndrome (Shana et al., 2020). When this happens, some teachers and students who have interest in other subject areas will develop hatred for science activities and wouldn't want to take part in any science practical lessons. As we continue to promote science education including effective practical activities, we should also make sure not to underscore the importance of other subject areas (Bosibori et al, 2015).

2.9 Addressing Challenges in Science Education

To address the challenges in science education, a solid lesson plan by the teacher must be followed by understanding and applying the 7E models of learning – elicit, engage, explore, elaborate, explain, evaluate, and extend. It has been suggested that practical lessons improve students' science achievement and increases students' motivation for further studies in science even beyond their Senior High School level (Hussain and Akhtar, 2013; Odom et al., 2007). The state of the practical activity indicates getting students active in the classroom teaching where students can us their manipulative skills in learning the science concepts (Agbo et al., 2016). To help students to develop positive attitude to science, practical works should be properly developed, designed, and structured (Hofstein and Mamlok-Naaman, 2011). Students should be given the chance to handle scientific equipment and should also be allowed to work with the equipment without external pressure.

On the side of the teachers, Parker et al. (2018) elaborated that frequent in-service training should be organized for teachers to help them abreast with the new development in science and the use of some of the scientific equipment that are not in their expertise. Again, content knowledge should be transformed by teachers into suitable activities, demonstrations and simulations and then adapt them to different students' abilities (Parker et al., 2018). Where equipment are not available teachers can leverage on locally made equipment as improvisation (Gbadamosi, 1989). Again, teachers and students can visit nearby science centres, research institutes to get science concepts in their applicable forms (Behrendt, 2014; Tytler, 2007). When students participate in educational trips, they generate a more positive attitudes towards science (Behrendt, 2014) and appreciate scientific phenomena.

Teaching of science should not be aimed at only passing exams but also to help students to realize the need of science in their daily lives. The state should help provide the needed scientific equipment as possible. Also, more time should be allotted for practical lessons to get even the slow learner students more time to work with the equipment.

2.10 Impacts of Basic Schools' Science Practical Lessons

2.10.1 Students' Performances

When science lessons are organized well in the Basic Schools, it can impart positively on the students' performances in Higher education. With effective science lessons, students get strong foundation by gaining hands-on experiences, which re-enforces theoretical knowledge and enhances comprehension (Millar, 2004). When students are engaged in practical lessons, it motivates then to explore deeper into scientific topics and theories. This makes them to perform better in Senior High Schools (Shana, and Abulibdeh, 2020). Students are encouraged to think critically and then relate their skills in critical thinking to solve real-world problems (Santos, 2017; Snyder and Snyder, 2008). These skills can be transferred to the Senior High School education when complex scientific concepts are studied. It is also noted that science practical lessons enhance long-term retention of knowledge (Custers, 2010). Participating in experiments and seeing the firsthand results ensures retention of ideas and could easily be applied in similar situations in the future. Not all, students become more confident leading to Higher participation discussions of scientific ideas and then enhancing their academic prowess (Abdulabaki, et al., 2018).

2.10.2 Nation Building

The aim of science education is to help train students to function well in the nation and then to assist in problem solving. When students are offered the chance for practical lessons, they understand scientific concepts that are relevant to their daily lives and societal challenges (Shana, and Abulibdeh, 2020). They can make informed decisions as patriotic citizens that will help in decision making in the populace. The skills acquired in science practical lessons can be transferred to workforce and thus contributing to economic growth and development (Fatima and Saleem, 2016). There are many societal challenges such as environmental sustainability, good health service, climate change, food security, and poverty reduction that need scientific interventions. Through practical lessons in science, students learn about these pressing issues and appreciate the need to contribute to the solution of the problems (Erhabor and Don, 2016). Students can also apply their knowledge in science policy and governance by using their expertise and knowledge to hold policy makers accountable and participate in the development of evidence-based policies (Erismann et al., 2021). Science practical lessons are very important to ensure stronger career on the part of the students and formidable nation (Millar. 2004). By fostering scientific curiosity, critical thinking and problem-solving, well-prepared citizens are produced to positively influence their communities and contribute to the progress of the nation.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Research Design and Strategy

This is survey research conducted to explore the impact of science practical lessons in Basic Schools on the performances of students in science lessons in Senior High Schools. The survey research was selected due to its ability to explain features of a large group at a time and to provide a lot of first-hand primary data for the research questions posed. It was to help gain a general knowledge on impacts of practical lessons in Junior High Schools on students' performance in Senior High Schools as well as challenges Basic School science teachers face in conducting science practical lessons. The research was to help provide background information on hindrances to science education and to inform decision makers on implementation of policies to enhance science education in Ghana. The use of questionnaires was employed as a tool to collect data from students and teachers.

3.2 Population

The study targeted all students of Senior High Schools reading Integrated Science Education in Ghana. Due to the huge size of the population, the study was conducted in the Old Tafo Municipality of the Ashanti Region and three Senior High Schools of about a total students' population of 7000 were selected while four Basic Schools of a total teachers' population of about 60 were selected.

3.3 Sampling and Sampling Techniques

In total, 68 Senior High School students and 22 Basic School science teachers were selected for the data collection. Simple Random method was used to select students for the questionnaire whilst purposive sampling technique was used for the selection of Basic School teachers.

Four Basic Schools in the Old Tafo Municipality were selected and in each basic school, five teachers were purposively selected for the questionnaires. Two more teachers were selected in one of the Basic Schools due to their interest to take part of the exercise. Teachers were briefed about the questions before they were allowed to answer them. In the second part of the study, three Senior High Schools in the metropolitan were randomly selected. Twenty-three students from each school (all second-year students) were picked for data collection. Second year students were chosen because they might have gotten at least three terms results to assess their performances in science practical lessons and they would also not be under pressures from West African Examination Council (WAEC) to willingly participate in the study. Number of students selected contained equal proportion of males and females to ensure gender balance in the study. Simple random sampling was used for the selection of students for the data collection. In the simple random sampling, students were sampled from a random table of numbers.

Equal number of inscriptions ‘yes’ and ‘no’ were written on small cards according to the number of the students in the classroom. Male students were called in their turn to pick a card after which the process was repeated for the female students to ensure evenly representation of male and female students in the sample. All students with the ‘yes’ card were selected. The process was repeated until a final 23 students sample size was selected for the questionnaire.

3.4 Data Collection Techniques

Both quantitative and qualitative data collection techniques were employed. Closed ended questionnaire was used to collect the quantitative data (Appendix 3). The technique for the quantitative data was to count the total number of students from different districts and number of students providing a particular response. This was employed to tell how many and how often respondents provided particular responses. Also, average score of three terminal exams by students were treated as quantitative data. The qualitative data was based on the degree of response of candidates showing the levels of impact of practical lessons in Basic Schools and their influence on students' performances in Senior High Schools. For example, selection of 'strongly disagree' shows the least level of the disagreement of the question posed whilst selection of 'strongly agree'' shows the strongest level of agreement to the question asked. The qualitative data was also collected using the closed-ended questionnaire (Appendix 3). Closed-ended questionnaires were used to limit responses to the objectives set and to help group, compare and analyse the data. All the data were collected using in-person questionnaire administrations. All the schools were visited and the questions were distributed to selected respondents to answer. Answering of questionnaires were supervised and further explanations were given when necessary.

3.5 Validity and Reliability

After formulating the questionnaire, piloting was done on about ten students to identify and correct all problems. The exercise was done to check how the questionnaires validly and reliably measure challenges and impacts of science education in Junior High Schools on Senior High Education. All questions that had some levels of ambiguities and also questions that were providing similar responses were removed. After the first testing and all ambiguities were corrected, the questionnaires were given to two scientists who are experts in survey research to read through and make other corrections and inputs. During the main distribution of the questionnaires, simple random sampling was used to reduce biasness in selecting students and to ensure equal representation of diverse student groups and characters. On the other hand, purposive sampling was used to sample teachers since the target was on only science teachers. This is justifiable since it was science teachers who could understand the concept of the research and would be able to give a clear picture of the problem investigated.

All questions were read carefully and explained to respondents before answering. Data was carefully coded and normality was checked before further analysis. A robust statistical analysis software, SPSS version 25 was used for the analysis and chi-square and correlational analysis were done to ensure true reflection of the results to the targeted population.

3.6 Data Analysis

The completed questionnaires were coded and subjected to statistical analysis using SPSS version 25.0. Descriptive statistics of frequency counts and percentages were used to analyse the demographic data of the respondent.

Finally, Chi-square test was used to test the hypothesis stated to identify whether there was an impact of basic school practical lessons on the performances in Integrated Science Education in Senior High Schools.

Pearson correlation test was used to identify the relationship between knowledge in the use of science equipment in Junior High Schools and interest in science practical lessons in Senior High Schools. Data visualisation was done with bar graphs and tables using Microsoft Excel.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

This section provides information on the sample size, sample area, characteristics of the respondents selected for the interview, responses from teachers and students selected for the questionnaire as well as the interpretation of their responses.

4.1.1 Demographic Information

In total, 90 questionnaires were administered to either teachers or students. For the teachers, four Basic Schools in the Old Tafo Municipality, Kumasi were visited while for the students, three Senior High Schools in the Kumasi Metropolitan were visited. In all, 22 teachers and 68 students summing up to 90 respondents were interviewed (Table 1).

Table 1: Demographic information of respondents

Variables	No. of Respondents	Percentage
Position		
Teachers	22	24.4
Students	68	75.6
Sex Males	44	48.9
Females	46	51.1
Age		
a. Students 12 - 15 years	6	6.7
16 - 20 years	63	70
b. Teachers		
21 - 25 years	13	14.4
>25	8	8.9
c. Undeclared	6	6.7
Teachers' Qualification		
Bachelor (B.Ed)	19	86.4
Masters	3	13.6

Out of the 90 respondents, 44 (48.9%) were males while 46 (51.1%) were females. For the 22 basic schoolteachers interviewed, 13 were between 21 to 25 years old while 8 of them were above 25. All the teachers interviewed had attained their first degree with 3 of them having a second degree in addition. Sixty-three of the students interviewed representing 70% were in the 16 – 20 age bracts while 6 of them were below 16 years. All the students selected were in their second year of the Senior High School education. Six respondents in total did not declare their ages.

Table 2: District and regional distribution of Basic Schools of respondents (n=90)

District	**Number of Basic Schools**	**%**	**District**	**Number of Basic Schools**	**%**
Afigya Kwabre	8	8.9	Mamponteng	1	1.1
Ahafo-Ano North	1	1.1	Manso	1	1.1
Amakom district	1	1.1	Obuasi East	3	3.3
Asante-Mampong	1	1.1	Oforikrom	1	1.1
Asokore Mampong	1	1.1	Old Tafo	25	27.8
Atwima Kwanwoma	1	1.1	Sagnirigu	1	1.1
Atwima Nwabiagya	3	3.3	Santasi District	1	1.1
Bekwai	2	2.2	Sekyedumase	1	1.1
Bosomtwe	1	1.1	Suame district	3	3.3
Dabieso	1	1.1	Tanoso District	1	1.1
East- Mamprusi	1	1.1	Tachiman South	1	1.1
Kumasi Metro	1	1.1	Yeji	1	1.1
Kwabre District	1	1.1	Undeclared	22	24.4
Kwabre East	4	4.4	**Total**	**90**	**100**
Kwabre South	1	1.1			
Region	**Number of Basic Schools**	**%**	**Region**	**Number of Basic Schools**	**%**
Ashanti	63	70.0	Western Region	1	1.1
Bono East	2	2.2	Undeclared	21	23.3
North-East Region	1	1.1	**Total**	**90**	**100**
Northern Region	2	2.2			

The Basic Schools attended as well as those taught by the teachers were identified to spread among 27 districts involving five regions in Ghana (Table 2).

Most of the respondents had their basic school education in the Old Tafo Municipality (27.8%) and Afigya Kwabre District (8.9 %) all in the Ashanti region. Twenty-two of the respondents did not provide any information about the Basic Schools they attended.

4.1.2 Availability of Scientific Equipment in Basic Schools

With yes and no responses (yes indicating available and no indicating not available) respondents were asked to identify the scientific equipment available in their Basic Schools (Figure 2).

Meter rule was the most common equipment available in all the schools while rain gauge was the least common equipment. Also, microscopes, petri dish, hand lens, specimen of bones, chemical reagents, Bunsen burner and samples of organisms were not common in the Basic Schools attended by the students. Other equipment such as weighing scale, thermometer, test tubes, measuring cylinder, scientific poster and school gardens were comparatively available in some of the Basic Schools by the students.

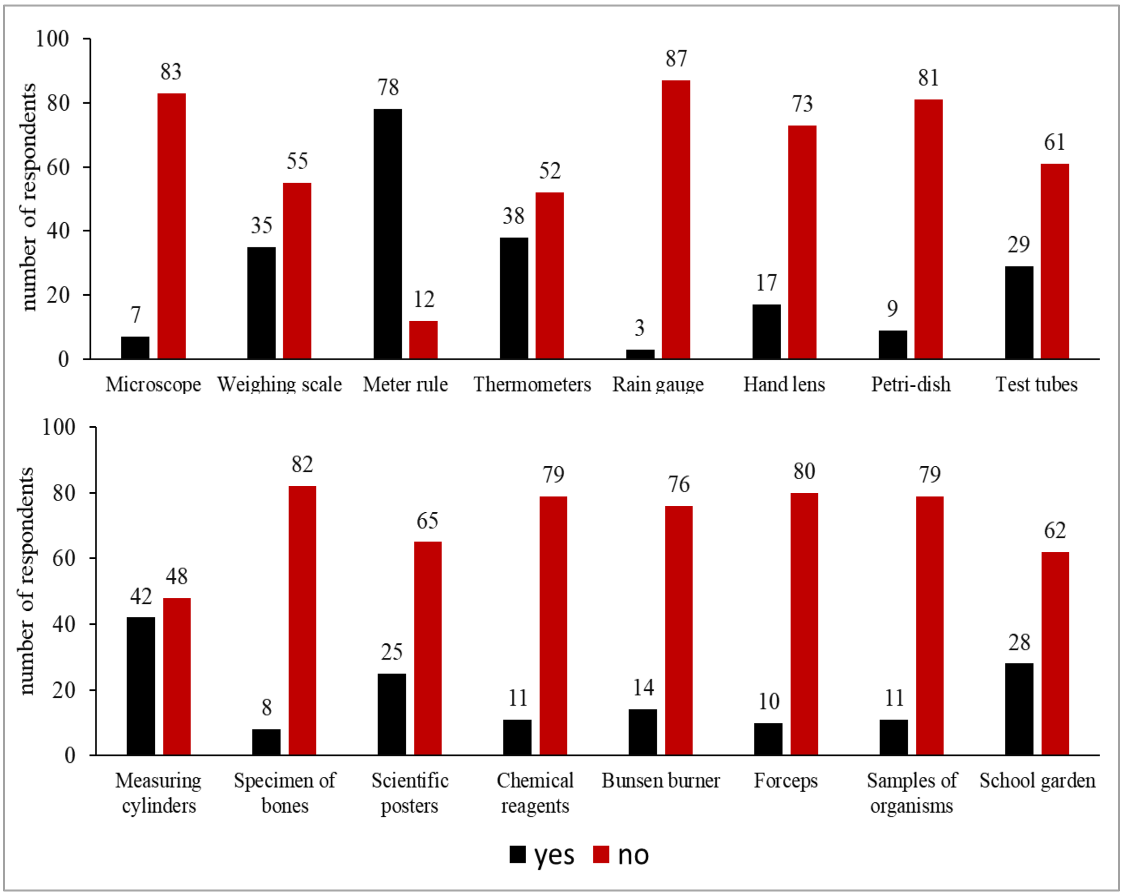


Figure 2: Science practical equipment available in Basic Schools of respondents (n = 90)

4.1.3 Students' Exposure and Challenges of Teaching Science

When students were interviewed based on their interests, exposure, and challenges of Integrated Science lessons, it was identified that majority of the students agreed with the question posed (Figure 3) that they have interest in Integrated Science and the question reflected on their high examination results at the end of the term. Fifty seven out of 68 of the students indicated unavailability of science laboratory in the Basic Schools they attended. In addition, 59 students of the 68 disagreed with the statement that their teachers made them visit scientific institutions to learn about science practical activities. Forty seven out of the 68 disagreed that their science teachers showed them science practical equipment but did not have the chance to handle it while 60 students showed their disapproval of the statement “we visited Senior High Schools in the district for science practical lessons”.

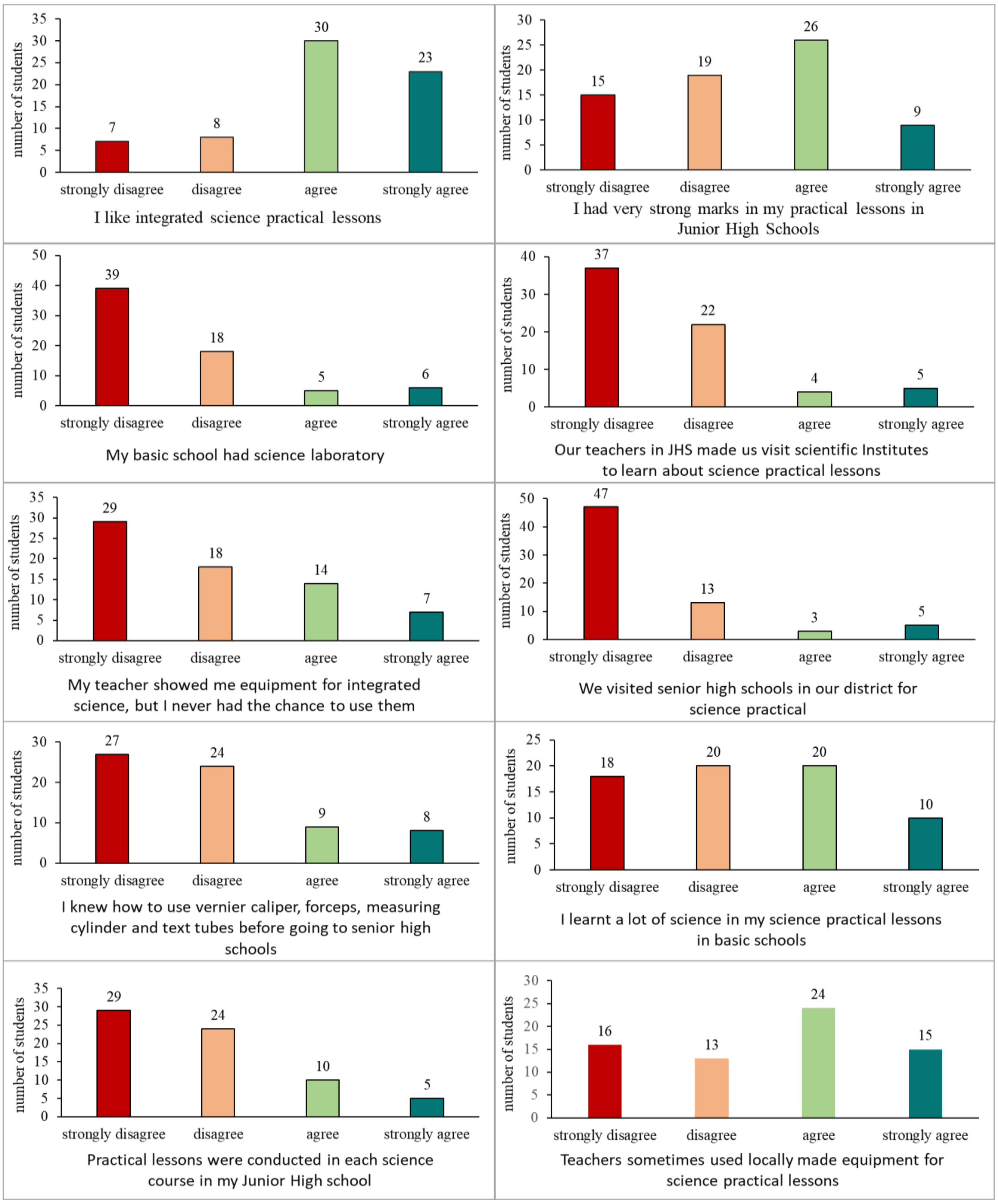


Figure 3: Students’ exposure and challenges in teaching Integrated Science practical lessons in Basic Schools (n = 68)

Only 17 out of the 68 students agreed that they knew how to use some basic scientific equipment such as vernier callipers, forceps, measuring cylinders and test tubes before attending Senior High Schools. Thirty students indicated they learnt a lot of science through the practical section in Basic Schools while 38 disagreed with the statement. Fifteen out of the 68 students confirmed frequency of practical activities during science lessons while 53 students indicated otherwise. On the other hand, 39 students showed their approval of the use of improvised materials by teachers for practical lessons while 29 students were not in agreement with the question posed.

4.1.4 Use of Practical Equipment by Basic Schoolteachers

For the 22 basic school science teachers interviewed, 11 of them indicated their willingness to allow more students to handle science equipment during practical lessons while the other 11 showed otherwise (Figure 4). Seven teachers out of the 22 disclosed that they normally visit nearby Senior High Schools for science practical while 15 of them disagreed with the statement. In terms of field trips, more than half of the teachers interviewed confirmed visitation to science-related industries through field trips. About 14 teachers disagreed that they seldomly use science laboratory resources in their schools. In terms of availability of science practical textbooks, 15 of the teachers indicated insufficiency of the materials. Almost all the teachers agreed that the use of hand-on science exercises increases students' interest in science. In terms of the use of improvisation for science practical lessons, 14 teachers testified the use of improvised materials while 8 disagreed.

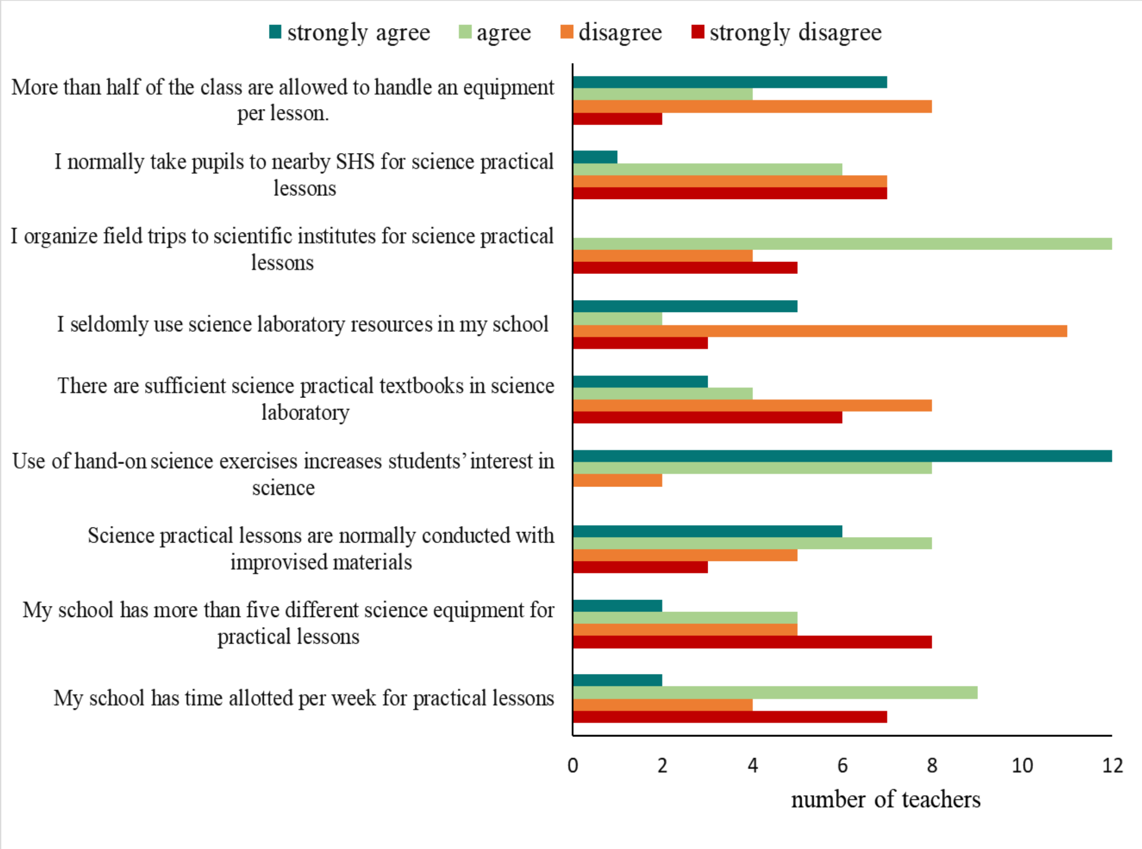


Figure 4: Extent of use of science practical equipment in Basic Schools by the teachers (n = 22)

Only seven out of the 22 teachers could assert of more than five science equipment in their schools. In terms of time allotted for science practical lessons on the timetable, responses were at par with 11 teachers agreeing with the statement while the other 11 did not agree.

4.1.5 Impact of Basic School Science Practical Lessons on Student performances in Senior High Schools

Frequency and percentage test indicated almost all students interviewed showing interest in science careers (Figure 5). Moreso, a significant effect (P = 0.048) existed between practical lessons conducted in each science course in Junior High Schools (JHS) and preference to use scientific equipment in the future career (Appendix 1).

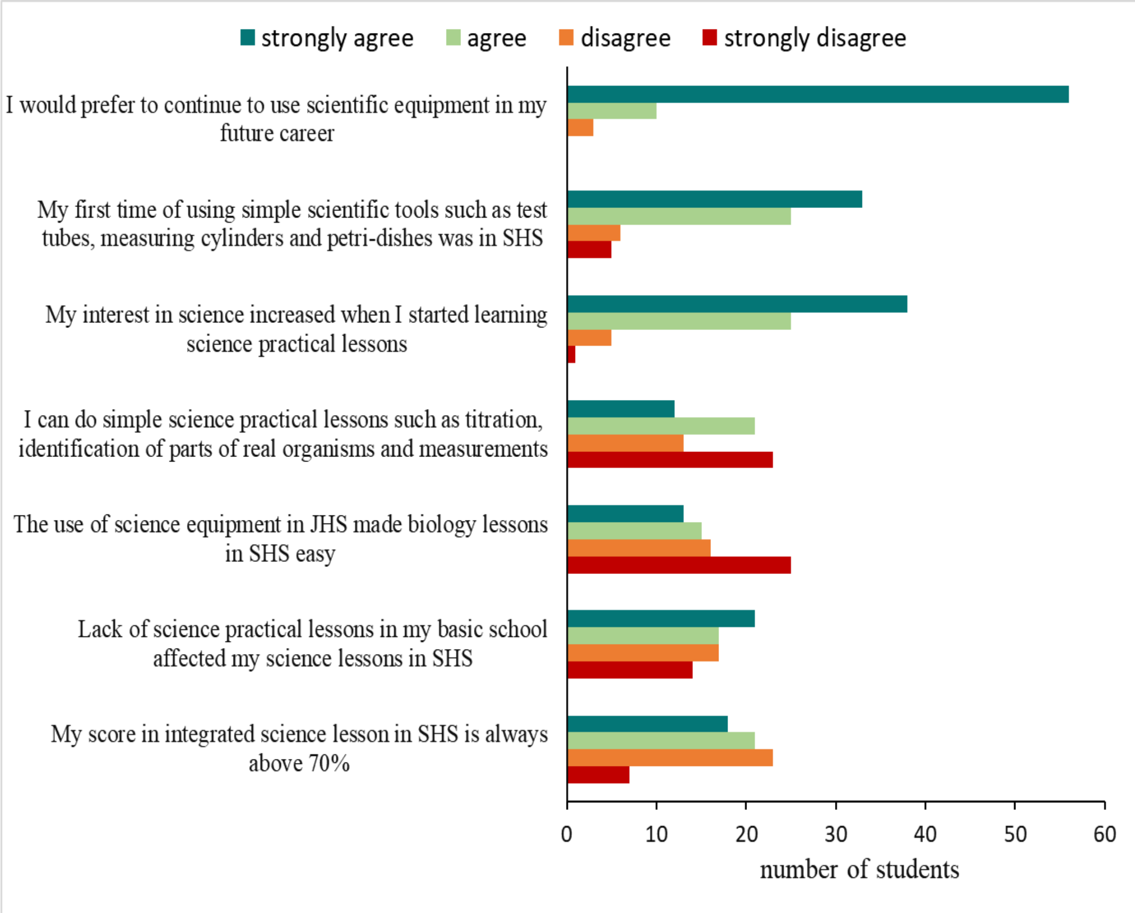


Figure 5: Impacts of Basic Schools' science practical lessons on students' performances in Senior High Schools (n = 68)

Fifty-eight students handled science equipment first time in Senior High Schools (SHS). Again, 63 out of the 68 students had their interest in science increasing when they could handle science equipment. However, 33 students of the 68 could do simple science practical activities such as titration, measurements, and identification of parts of organisms. On the other hand, the chi-square test showed a High significant effect (P = 0.006) of the impact of practical lessons conducted in Junior High Schools on the ability of students to do simple science practical activities such as titration, identification of parts of real organisms and measurements in Senior High Schools (Table 3).

Table 3: Chi-Square test showing significant effects of practical lessons conducted in science course in JHS and ability of students to do science practical activities such as titration, identification of parts of organisms and measurements in Senior High Schools. The symbols ** and * indicate significant levels**

Cross Tab Chi-Square test	**Value**	**df**	**Significant level (P<0.05)**
Pearson Chi-Square	22. 994	9	0.006**
Likelihood Ratio	24.556	9	0.004**
Linear-by-Linear Association	11.583	1	0.001**
Number of Students	68		
Cross Tab Correlation test	**Value**	**Asyp. Std Error**	**Significant level (P<0.05)**
Nominal Phi	0.582		0.006**
Nominal Cramer's V	0.336		0.006**
Pearson's R	0.416	0.096	0.000***
Spearman Correlation	0.398	0.107	0.001**
Number of Students	68		

Forty-one students disagreed that science practical lessons in JHS made science lessons in SHS easy while the other 27 could transfer their interest from JHS practical lessons. Thirty-eight students confirmed that lack of science practical lessons affected their science lessons in SHS while 30 of the students showed otherwise and this is replicated in their scores during end of term exams as 37 students showed their higher marks above 70% and 31 struggled below the pegged mark. Using a bivariate analysis, a correlation (Correlation co-efficient = 0.25; P = 0.038) existed between knowledge in the use of science practical equipment in Junior High Schools and interest in science practical lessons in Senior High Schools which was significant at the 0.05 probability level (Appendix 2).

4.2 Discussion

Science practical lessons are very important to help bring abstract lessons closer to the child's environment. When students handle or manipulate scientific equipment, they get concrete understanding of the scientific facts, and it also enhances their psychomotor, affective, and cognitive domains. Though, teachers and students were sampled from one district in Ashanti region in Ghana, the result from the research reflects the larger domain and it provides a concrete information on the status of science practical lessons in the various Basic Schools in Ghana.

4.2.1 Science Practical Equipment Available in Basic Schools

Using scientific equipment help students to comprehend abstract and complex scientific concepts. As scientific equipment makes teaching and learning of science easier, many Basic Schools do not have access to basic science equipment. Rain gauge is important for students to appreciate climate variability as well as the seasons. Ghana mostly relies on rainfed agriculture and teaching kids about the measurement of rainfall will make them appreciate seasonality and rainfall patterns. However, 3 respondents representing 3.3% of the sample size confirmed availability of rain gauge in their schools. Meter rule was common in the Basic Schools possibly because of easy access and the use of it for other subjects, such as mathematics and pre-technical skills. It was expected that pupils at the Basic Schools would be introduced to identification of specimens, use microscopes and hand lens to view small objects and also, to understand the chemical nature of the world they find themselves within but concrete evidence to prove these scientific phenomena are lacking in the Basic Schools. In this situation, teachers may resort to theoretical teaching which makes lessons more abstract, uninteresting, and easy to forget. Earlier reports indicate that low interest of students in science education are due to inadequate practical nature of science lessons making science studies more of knowledge transfer from teachers and science books to students (Adu-Gyamfi, 2013). Kamba et al. (2019) reported that students develop problem solving skills through comprehending the nature of science. Not all, the researchers further indicated that students develop special talents through practical experiences they develop when manipulating scientific equipment. Having a concrete feel of the lessons helps develop students' positive attitude towards science (Shana and Abulibdeh, 2020) and career target. Therefore, educational policy makers in various districts as well as opinion leaders must help to provide at least the basic equipment to improve upon science education in Ghana.

4.2.2 Students' Exposure and Challenges of Teaching Science

Teaching Integrated Science has many constraints in Ghana. Many of the students interviewed showed their interests in science and perhaps a career in science related fields. However, responses from the students showed numerous challenges encountered during their basic science education. The challenges span from unavailability of science laboratory, inadequate visitation to research institutes, and low practical activities. In terms of field trips, responses from students differed from that of the teachers. While most of the students disagreed that teachers organized field trips for them, the responses from the teachers indicated otherwise. The disparity could be due to the different schools attended by sampled students and those schools taught by teachers. Further reason could be due to inadequacy of the field trips on the side of the students. While many science-related industries and research institutes are available in the country as well as most of the Senior High Schools having science laboratories, teachers should be encouraged to organize field trips around these centres. Students learn best when they have the chance to hear, smell, taste, see and feel, (Opara and Etukudo, 2014) and field trips give students the chance to use their senses to make concepts closer to their domains. School administrators should also provide the necessary logistics and remove all hindrances that may prevent the organization of these trips. In such visitations, students should be tasked to write reports of what they see and then make presentations afterwards for further awards. In the science related industries and institutes, student will appreciate science in the natural context. They will be able to see evidence of what is taught in the classroom, and it will increase processing of information in their longterm memory. When these exposures are given to students right from the Basic Schools, it gives them a strong background in the scientific concepts from the primary school and this builds their interest in the Senior High Schools even beyond their Senior High School levels (Hussain and Akhtar, 2013; Odom et al., 2007).

While it was expected that majority of the basic school graduates would know how to use simple scientific equipment such as measuring cylinders for measuring fluids, test tubes to handle fluids, forceps to handle specimen and vernier callipers to take diameter measurements of objects, only 17 out of the 68 students sampled could show some levels of confidence in the activities providing evidence of inadequate science practical lessons in Basic Schools. It is therefore not surprise that WAEC examiners report for BECE (2021) indicated among many things that students fumbled with correct scientific units, could not use appropriate scientific formulae and expression, could not interpret practical questions well and could not draw reasonable conclusions from the results and observations of experimental set-ups. Measuring cylinders, test tubes, forceps and vernier callipers are very basic and can be manufactured locally or improvised for practical lessons. These sets of equipment also provide scientific bases for measurements which are important for science career, but JHS graduates have inadequate knowledge in the use of such equipment, and this may make science lessons tougher in the SHS schools. The problem is again evidence of the WAEC report (2015) that final year Senior High School Candidates could not add units of measurement while most of them also did not consider the precision of the meter rule. These reports from WAEC show the weakness of science practical lessons in Junior High Schools and the effects on science education in Senior High Schools. Measures are needed to increase science practical lessons in Basic Schools to help build a science related economy.

4.2.3 Extent of Use of Science Practical Equipment in Basic Schools

Extend of use of science practical equipment is very important for science education. As reported by Ojediran et al., (2014), supporting theoretical explanations with actual practical lessons in the laboratory is an important feature of effective science education. Leach and Paulsen, (2008) and Millar (2004) indicated that practical work involves student's science process skills in observing and manipulating real objects and materials. However, extent of use of science practical equipment is limited due to a cascade of factors. Some of these factors include short time for science lessons, few set of science equipment and low teacher's motivation to science lessons. One of the most important motives to teach science is to get students motivated to be involved in learning science and feel committed to continue with science in future (Hussain and Akhtar, 2013), However, about 50% of the teachers interviewed indicated most of the students not getting access to practical equipment during science practical. The hectic of the teacher asking more students to share an equipment is enough to discourage the interest of students in the lesson and the teacher from conducting extra activities in such dimensions (Ahmad, 2021). Again, some students are overshadowed in the case of sharing equipment making them remain silent in classroom participations and discussions (Ahmad, 2021). In science education, individual achievement is very important through equitable share of resources. As such, scientific equipment should be enough to give all students equal chances to handle them. This will help to develop individual students' manipulative skills and the attitude to become interested in further exploration on their own, and then identify the skills needed to solve problems by their own or in collaboration with others (Gbadamosi,1989).

Students' responses on availability of equipment indicate more Basic Schools not having science laboratories, however, 14 out of the 22 teachers showed use of science laboratory for science practical lessons in Basic Schools. It is possible that the schools where the teachers were sampled from have the mobile science laboratories where the equipment are sent to the classroom for science practical lessons and then are sent back to store houses after the lesson. The responses from the students indicate that only few Basic Schools may have this mobile equipment making them have advantage over their other colleagues. Teachers in schools without the mobile laboratory must therefore frequent science resource centres in nearby Senior High Schools for practical lessons.

Teachers' attitude towards science may also serve as contributing factors to the use of science equipment for practical lessons. Parker et al. (2018) reported that teachers' competency and motivation are very important in science education and when teachers lack the confidence of teaching topics outside their area of expertise, it affects choosing activities for students and sustaining students interests in the lesson delivery. In some Basic Schools, teachers without science background may be tasked to teach science especially when the staff does not have enough science teachers. In such situations, weak background of the teacher may demotivate him to organize science practical lessons around topics which the teacher may not be familiar with. To help solve this problem and to achieve other aims of imparting scientific ideas to pupils, teachers must have theoretical and practical preparations and abilities about science learning and teaching (Klutse, 2020) through in-service training and peer teaching. it is advisable that in-service trainings are organized frequently to help abridge teachers' knowledge while teachers can also invite their colleague teachers from other nearby schools to assist with some aspects and set-ups.

It was also noted that even if the sets of equipment are available, guidebooks may not be available to assist teachers on the set-ups of such equipment for practical studies. This was evident when 15 teachers representing 68% of the sample size agreed that textbooks for science lessons were not sufficient. School administrators need to find alternative means of getting enough laboratory guide books and other manuals for teachers. This can be through photocopying them from available sources, downloading them from the internet or making request to the government.

4.2.4 Impacts of Basic Schools' Science Practical Lessons on Students' Performances in Senior High Schools

When science lessons are effective, students can get strong foundation by gaining hands-on experiences and this re-enforces theoretical knowledge for real world application and other further studies (Millar, 2004). Most of the students did not hide their feelings of seeing science practical lessons very interesting. With effective basic school science practical lessons, students are motivated to explore into deeper scientific concepts and thus, makes them to perform better in Senior High Schools (Shana and Abulibdeh, 2020). Low science practical lessons narrow students' exposure to science activities and make majority of students unable to perform some basic practical activities such as titration, measurements, and identification of parts of organisms. If students are pre-exposed to science practical lessons in their basic school education, they will have some levels of skills in practical concepts in science which can be transferred to the Senior High School levels (Santos, 2017; Snyder and Snyder, 2008). Custers (2010) showed that participating in experiments and seeing the first-hand results ensures retention of ideas and could easily be applied in similar situations in the future.

Some students testified that lack of effective science practical lessons affected their science activities in Senior High Schools. In situations like this, if the teachers in the Senior High Schools do not start from the basics, affected students will continue to lose interest in science and that may affect their future decisions in career developments. The more the students are exposed to practical lessons in the Basic Schools, it encourages them to think critically and then relate the skills to solve real-world problems and or other similar problems (Santos, 2017; Snyder and Snyder, 2008). In this wise, students must be given the chance to hear, smell, taste, see and feel science lessons (Opara and Etukudo, 2014) right from the Basic Schools to increase confidence and proper adjustments in the Senior High School education. This can be done through the seven E model where students are allowed to elicit, engage, explore, elaborate, explain, evaluate and then finally extend their knowledge to similar situations (Libata et al., 2021). This makes classroom activities more learner-centred, activity-oriented, and problem-solving oriented (Morrison et al., 2019). Through the model, students can acquire more insights into scientific concepts and will relate them well in future endeavours.

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATIONS, AND CONCLUSION

5.1 Introduction

Science practical activities are important in science education to help make science lessons real and interesting. This chapter provides information on summary of findings, recommendations or policy implications and future research directions.

5.2 Summary of Findings

The study has shown that most of the Basic Schools in Ghana do not have enough scientific equipment for science education. Guidebooks or science practical activity manuals are also not easily accessible to support teachers for the set-up of some of these scientific equipment. Aside unavailability of equipment for science practical lessons, some challenges students indicated include inadequate visitation to science related institutes, low accessibility to the few available scientific equipment thus inability to use some of the basic scientific equipment. Other problems included limited time allotted for science practical lessons, science lessons being mostly from teacher’s notes to students without practical activities.

Teachers’ responses for science practical activities also indicated insufficiency of science textbooks and guidebooks as well as inadequate science practical equipment. In case where practical lessons are organized, large class size reduces number of individual students that handle an equipment per time. It was identified that the competency of the teachers in the subject area contributes to topics to teach and the instructional methods to select. Teachers who are very confident in practical topics would be motivated to teach such topics even with improvisation. Other teachers may dodge some topics or some practical activities if they do not have a strong background in the field.

The study also revealed that basic science practical lessons have strong impacts on students' performances and their future interest for science related career. Students testified that lack of science practical lessons in the Basic Schools affected their Senior High School science education. When students are exposed to science practical lessons in Basic Schools, they carry the skills forward to Senior High School. Students then adapt easily to the different lessons of science concepts and then grasps such concepts with ease.

5.3 Recommendations and Policy Implications

Educational stakeholders, including the government and other school administrators need to supply enough equipment for Basic School science practical lessons to help students adjust well to science education in the Senior High Schools. Again, community science laboratory centres can be built next to regional, district and local libraries to help students frequent these places after school hours. Teachers in Basic Schools can also arrange with their students to visit such laboratory centres for science lessons.

5.4 Future Research Directions

Due to insufficient funds and lack of resources, this research was focused on one district in the Ashanti Region of Ghana. Further research is needed to expand the data taking to three or more districts for a clear picture of the problem.

Again, further research is needed on the equitable distribution of the science equipment in Basic Schools – thus between private schools and government schools and then between schools in the urban areas and in the rural areas.

5.5 Conclusion

Inasmuch as the world is advancing in technology, practical activities in science are very important for the African student to compete equally with students from other continents. Building the basics will increase the interests and the impacts of science education at the higher levels. The research has shown that most of the Basic Schools in the country lack some of the basic science equipment and making science study more of the theory base. As there is a high impact of basic science practical lessons on students' performances in Senior High Schools, intensification of practical activities is needed to build a better economy and to achieve most of the developmental goals.

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APPENDICES

Appendix One

Practical lessons conducted in each science course in JHS verses preference to use scientific equipment in the future career.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.679[a]	6	.048
Likelihood Ratio	12.137	6	.059
Linear-by-Linear Association	1.665	1	.197
N of Valid Cases	68		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .22.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.432			.048
	Cramer's V	.305			.048
Interval by Interval	Pearson's R	-.158	.120	-1.297	.199[c]
Ordinal by Ordinal	Spearman Correlation	-.198	.116	-1.643	.105[c]
N of Valid Cases		68			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Appendix Two

Knowledge on how to use science equipment in JHS verses interest in science increasing in SHS

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.063[a]	9	.271
Likelihood Ratio	14.835	9	.096
Linear-by-Linear Association	4.250	1	.039
N of Valid Cases	68		

a. 12 cells (75.0%) have expected count less than 5. The minimum expected count is .12.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.403			.271
	Cramer's V	.233			.271
Interval by Interval	Pearson's R	.252	.089	2.114	.038[c]
Ordinal by Ordinal	Spearman Correlation	.191	.113	1.578	.119[c]
N of Valid Cases		68			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Appendix Three

Questionnaire Structure Used

Section A - Demographic Information

1. Name of Senior High School ……………………………………………..........
2. Name of Junior High School …………………………………………………
3. Name of the town in which the Junior High School is located…………………
4. Name of the district in which the Junior High School is located………………
5. Name of the region in which the Junior High School is located………………
6. Position
    a. Student
    b. teacher
7. Sex
    a. Male
    b. Female
8. Class (for students)
    a. SS1
    b. SS2
    c. SS3
9. Age range
    a. 12 – 15 years
    b. 16 – 20 years
    c. 21 - 25
    d. Other (Please write the age here………………………………………….)

For teachers only – Highest qualification

a. Diploma
b. BSc.
c. B.Ed
d. PGDE
e. MSc/MEd/MPhil
f. PhD
g. Other (Please write it here ………………………………………………….)

Section B – Equipment Available

Science practical equipment available in the Junior High School attended (In the case of teachers, kindly tick equipment available in the 'yes' column)

This practical equipment were in the Junior High School attended/taught	Yes	No
a. Microscope		
b. Weighing scale		
c. Meter rule		
d. Thermometers		
e. Rain gauge		
f. Hand lens		
g. Petri-dish		
h. Test tubes		
i. Measuring cylinders		
j. Specimen of bones		

k. Scientific posters		
l. Chemical reagents		
m. Bunsen burner		
n. Forceps		
o. Samples of life or dead organisms		

Section C – Students Exposure and Impacts

Indicate your level of agreement or disagreement by ticking the appropriate column

S/N	Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
	Students' exposure to science practical lessons in Junior High Schools (for students only)				
1	I like Integrated Science practical lessons.				
2	My basic school had science Laboratory.				
4	My teacher showed me school equipment for biology, but I never had the chance to use them.				
5	I knew how to use vernier caliper, forceps, measuring cylinder and text tubes before going to Senior High Schools.				

6	Practical lessons were conducted in each science course in my Junior High School.				
7	I had very strong marks in my practical lessons in Junior High School.				
8	Our teachers in JHS made us visit scientific Institutes to learn about science practical lessons.				
9	We visited Senior High Schools in our district for science practical.				
10	I learnt a lot of science in my science practical lessons in Basic Schools.				
11	Teachers sometimes used locally made equipment for science practical lessons.				
	Extent of use of science laboratory resources among teachers (for teachers only).				
12	My school has time allotted per week for practical lessons (Kindly state number of periods per week………………………………..**)**				

13	My school has more than five different science equipment for practical lessons. Kindly list five of them 1……………………………………, 2……………………………………, 3……………………………………, 4……………………………………, 5……………………………………				
14	Science practical lessons are normally conducted even without sophisticated equipment.				
15	Use of hand-on science exercises increases students' interest in science				
16	There are sufficient science practical textbooks in science laboratory				
17	I seldom use science laboratory resources in my school.				
18	I sometimes use locally made materials when the required materials are not available.				
19	I organize field trips to scientific institutes for science practical lessons				

20	I normally take pupils to nearby SHS for science practical lessons.				
21	More than half of the class are allowed to handle an equipment per lesson. Kindly state, on average, number of pupils allowed to handle an equipment per lesson (number...……)				
	Impact of science practical lessons in JHS on performances in biology education in SHS (for students only)				
22	My score in Integrated Science lesson in SHS is always above 70% **Exam marks** for 3 terms **………., ………, ……….**				
23	Lack of science practical lessons in my basic school affected my Integrated Science lessons in SHS.				
24	The use of science equipment in JHS made biology lessons in SHS easy.				
25	I can do simple science practical lessons such as titration, identification of parts of real organisms.				

26	My interest in science increased when I started learning science practical lessons.				
27	My first time of using simple science tools such as test tubes, measuring cylinders and petri-dishes was in SHS				
28	I would prefer to continue to use scientific equipment in my future career.				