UNIVERSITY OF EDUCATION, WINNEBA

INTEGRATING INDIGENOUS KNOWLEDGE IN SCIENCE INSTRUCTION AND ITS EFFECT ON STUDENTS' PERFORMANCE AND ATTITUDES IN SELECTED INTEGRATED SCIENCE TOPICS

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of the requirements for award of the degree of Master of Philosophy (Science Education) in the University of Education, Winneba.

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DECLARATION

Candidate's Declaration

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

CANDIDATE"S SIGNATURE: ……………………………………

DATE**: ……………………………………**

Supervisors' Declaration

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

Name of Supervisor: Dr. James Awuni Azure

Signature of Supervisor: ……………………….

Date: …………………………………

DEDICATION

To my father and mother, Rev. Francis Achare and Mrs. Esther Achare

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LIST OF ACRONYMS AND ABBREVIATIONS

SHS – Senior High School

IK – Indigenous Knowledge

GES – Ghana Education Service

WS - Western Science

2GAA – 2 General Art A

2GAB – 2 General Art B

2GAC – 2 General Art C

NASTECH – Namong Senior High Technical School

WAEC – West African Examination Council

NaCCA – National Council on Curriculum and Assessment

WASSCE – West African Senior School Certificate Examination

ABSTRACT

The importance of indigenous knowledge in the classroom is gaining relevance among researchers and teachers yet little research has examined its effect on students‟ performance and attitudes in integrated science. The aim of the study was to investigate the effect of indigenous knowledge on students‟ performance and attitudes on selected topics in integrated science. The research was action research specifically designed to answer the three research questions that guided the study. The population of the study comprised all the students in Namong Senior High School with a purposively selected intact class of 52 students as the sample. Two instruments namely the Science Achievement tests and Questionnaire were used to gather the data for the study. The data gathered from instruments were analyzed using descriptive statistics. The findings revealed that participants of the study generally demonstrate more positive attitudes coupled with increase in performance after the intervention. The findings of the study provide some insights and recommendations to Namong Senior High School teachers on integrating indigenous knowledge into science instruction to promote effective teaching and learning coupled with positive attitudes and enhanced performance in science.

CHAPTER ONE

INTRODUCTION

1.0 Overview

In this chapter, the following are discussed; Background to the study, Statement of the problem, Purpose of the study, Objectives of the study, Research questions, Significance of the study, Delimitations of the study, Limitations of the study and the Chapter Organisation of the study.

1.1 Background to the Study

Kasanda, Lubben, Gaoseb, Kandjeo-Marenga, Kapenda, Hileni and Campbell (2005) described indigenous knowledge is a comprehensive body of knowledge made up of practices used by local people as a result of their long association with the environment for adaptation and survival. It is a shared knowledge of experience that has been passed on from generation to generation and made up of knowledge generated from long associations with a particular geographical area. Ezeanya-Esiobu (2019) asserts that indigenous knowledge evolves as more information about survival and adaptation to the environment continuous in fields that include medicine, leadership, moral development, pharmacology, geography and agriculture. According to Materer, Valdivia and Gilles (2002), as a result of behavioural dynamics of human‟s association with the environment, indigenous knowledge is more flexible and mostly transmitted orally. This knowledge is enrooted in the cultural practices of the local people such as cultural festivals, taboos, folklore, proverbs, myths and so on.

In Ghana entering some specific forests, catching certain species of fish in some rivers, singing while bathing, going to the farm on certain days (varies from one ethnic group to the other) to mention a few were some of the beliefs and taboos developed from indigenous knowledge.

The western world perceives indigenous knowledge as "crude", "unscientific" and "uncivilized" because of its lack of "generalizability" and" universality" (Kiggundu, 2007). However, its role in the teaching and learning of science is very vital for the holistic development of learners.

Indigenous knowledge creatively involves the learner‟s cultural background, perspective and relevant previous knowledge he or she has gained from the environment prior to being exposed to the science curricula. As a result, learners‟ involvement in science lessons increase (Brown, Muzirambi & Pabale, 2006) which can lead to personalised and relevant learning coupled with intrinsic motivation (Keane, 2006; Webb, 2013). It also encourages diversity in ways of knowing, while shedding light on its value and being a vital resource for learning in the classroom (Chinn, 2007).

According to the Merriam-Webster dictionary, science is "knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through the scientific method". The word "science" originated from Latin *scientia*, which means knowledge. The knowledge gained from science is both a product and process i.e. body of knowledge and the process by which that knowledge is produced (Carpi & Egger, 2011). The factual aura around scientific knowledge is as a result of the process that leads to its accumulation called the „scientific process‟. The scientific process is a way of building knowledge that leads to the making of predictions about the world that are tentative and can be tested (Carpi & Egger, 2011). For example, the question of whether vision occurs as a result of reflection of light from the eyes or from the object being viewed at that particular time can be put into a test, studied and evaluated by identifying the problem, developing a research plan, conducting the study, analysing and evaluating the data, communicating the results and generating new ideas.

The evidence, application and use of scientific knowledge is very important both in the classroom and in day-to day life activities. Scientific knowledge helps to obtain more knowledge about the cure, causes, effects and prevention for a wide range of diseases. It also leads to the manufacture of machines and gadgets that makes life much easier and faster through communication, transport, construction, photography, etc. In Agriculture, scientific knowledge has brought about the invention of machines that can efficiently aid in sowing, irrigation, harvesting and the production of fertilizers and weedicides that promote high crop yields (Vedantu, n.d).

Even though the pros of scientific knowledge highly outweigh its cons, over the past decade, many of the scientific findings that had been taken as fact have been retracted due to either error or fraud (Brainard & You, 2018). Some of the disadvantages of science includes restriction of science by depth of existing knowledge, experiments for testing being limited to observations which are subjective, ethical and legal considerations (i.e. dissections and the use of certain scientific experiments in the quest to know more can be questionable e.g. use of captive animals in experiments, abortion, genetically modified organisms (GMO), cloning, freezing of human sperm and embryos etc).

Sherman and Sherman (2004) opined that, quality teaching and learning can only be achieved when it revolves around the learners‟ previous knowledge. Learners build up knowledge and understanding of concepts through their constant association and interactions with their community and environment. When such community experiences are integrated in science teaching, it promotes individualized and conceptualised learning which leads to an improvement in their performance. Educators are therefore encouraged to build upon the community experiences of learners when teaching. It is also the responsibility of teachers to use ways that welcome both western and indigenous knowledge in practices that foster importance, a sense of dignity and national pride among learners.

Irrespective of the many benefits of indigenous knowledge incorporation in the science curricula, there are numerous challenges to its implementation. The amalgamation of traditional with formal western education models which can prove difficult because it takes a different form as compared to western science (Handayani, Wilujeng & Prasetyo, 2018). It is unstructured and less formal which makes teachers have difficulty crossing cultural borders to implement indigenous knowledge in their classrooms (Jegede & Aikenhead, 1999). Also, due to the unstructured nature of indigenous knowledge, teachers" lack instructional methods and pedagogical content knowledge (Ogunniyi, 2007) which leads to their fear that they will be teaching pseudoscience (De Beer & Whitlock, 2009). Another challenge to integration of indigenous knowledge in formal education arise from teachers" lack of belief about the actual relevance of indigenous knowledge and how it can contribute significantly in addressing the socio-economic needs of the country (Dei, 2002; Gachanga, 2007; Mwenda, 2003; Semali, 1999). Teachers therefore need to re-examine their methodologies and develop new appropriate avenues to engage and legitimise indigenous knowledge forms in classroom science. The researcher in respect of this aimed to find out the effect of indigenous knowledge incorporation on students" performance in selected concepts in science.

1.2 Statement of the Problem

It has been observed that students" academic performance in science in the senior high school certificate examination between 2017 and 2019 had been persistently poor (Chief Examiner"s Report, WASSCE,2019) and the poor performance is connected with the notion that science is broad and demands a lot of reading and practical work. Science, though practiced unknowingly in the everyday life of the people, is isolated from the school curriculum. The students" life experiences are neither integrated into classroom practice nor linked with concepts in integrated science. The traditional knowledge and experiences are abandoned for modern science. The cultural practices of local communities in which our schools are located are not part of the senior high school curriculum. Consequently, science is not valued and becomes difficult to understand by the few who study it.

Another problem to the proper exploitation of science in our nation is the narrow view of science as western subjected thereby alienating indigenous knowledge and know-how existing in our countries to the classrooms which constitute science (Anamuah-Mensah & Asabere-Ameyaw, 2004). In this 21st century, there happens to be a gradual shift of some developing countries from focusing solely on western science to adjusting their curricula to suit the educational and developmental needs of their countries. In Ghana, substantial literature that constitute the performance and conceptual understanding towards indigenous knowledge incorporation, its significance, challenges and effects on students" performance and attitudes is barely existent. Abandoning of indigenous knowledge and practices of our Ghanaian communities for academic ways of teaching and learning makes the study of science abstract and un-attractive to students today.

This study, therefore, was to determine the effect of indigenous knowledge integration in integrated science teaching on the performance and attitudes of students in selected topics in science.

1.3 Purpose of the Study

The purpose of the study was to investigate the effect of integrating indigenous knowledge in integrated science instruction on students" performance and attitudes towards selected topics in integrated science.

1.4 Objectives of the Study

The objectives of the study were to:

1. Investigate the knowledge level of SHS form two students on selected topics in integrated science.
2. Ascertain the effect of indigenous knowledge integration in integrated science instruction on the performance of students in selected integrated science topics.
3. Assess the attitude of students towards the integration of indigenous knowledge in integrated science instruction on selected topics in integrated science.

1.5 Research Questions

1. What is the knowledge level of SHS form two students on selected topics in integrated science?
2. What is the effect of indigenous knowledge integration in integrated science instruction on students" performance in selected topics in integrated science?

3. What is the attitude of students towards the integration of indigenous knowledge in integrated science instruction on selected topics in integrated science?

1.6 Null Hypothesis

H_o: There is no statistically significant difference in the academic performance of students before and after integrating indigenous knowledge in teaching selected integrated science topics.

1.7 Significance of the Study

The findings of the study will be of great importance to teachers, learners and curriculum developers such that it will expose teachers to the benefit of integrating indigenous knowledge in teaching some selected topics in science. It will reduce a lot of stress on teachers both on the activities to be carried out and on the collection of instructional materials as some of the students might even explain some concepts better using some indigenous knowledge and practices and also help in the gathering of teaching and learning resources from the locality. It will help teachers and students to gain respect from the people in the community because some of them will be involved in leading students and their teachers to preserved species around the area.

In addition, this will help mostly science teachers to improve on their instructional approach towards the teaching and learning of selected topics in Ghanaian science classrooms. It will also serve as an avenue for teachers to realise another path that leads to improving the conceptual understanding and performance of students in science.

The study findings will also inform developers of the curriculum on including indigenous knowledge and practices into the science curriculum for the senior high schools. Lastly, the findings of this research will inform administrators of senior high schools on how to provide in-service training for teachers on the best ways to integrate indigenous knowledge into the teaching and learning of science while also serving as an add-on to existing literature.

1.8 Delimitations of the Study

1. This research involved only one form two class in the selected school.
2. The research was delimited to few selected topics in the Ghana Education Service Science syllabus.

1.9 Limitations of the Study

1. Absenteeism in day students could affect the results
2. The recent presence of the pandemic increased the reluctance level of students" participation with regards to the tests and questionnaires

1.9.0 Chapter Organisation of the Study

The study made up of six chapters. Each chapter begins with an overview and made up of subheadings that constitute it.

The background to the study, statement of the problem, purpose of the study, objectives and research questions of the study, null hypothesis, significance of the study, delimitations, limitations and definition of terms constitute the first chapter.

The second chapter constitute the literature review made up of subheadings for each area of related research. Chapter three is made up of the methodology and data collection, which constitutes the research design, study population, sampling and sampling procedures, instrumentations, and data collection procedure and data analysis.

Chapter four is made up of the analysis and presentation of the data collected, chapter five discusses the results and chapter six is made up of the summary of the study, main conclusions, recommendations and suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter is made up of the essential literature by researchers in related fields which have been reviewed for the study. Premier issues reviewed include the theoretical and conceptual frameworks of the study. The theoretical framework is hinged on the theories of Albert Bandura and Lev Vygotsky. Empirical review on the incorporation of indigenous knowledge on students" understanding and performance in integrated science is also discussed.

2.1 Theoretical framework of the study

The theoretical framework within which the study was situated included Albert Bandura"s Social Learning theory and Lev Vygotsky"s social constructivism theory. Albert Bandura"s social learning theory is based on the idea that children learn from their interactions with others through observation and imitation in a social context where the basic reproduction of motor activities is as a result of imitation (Bandura, 1977). Even though Bandura"s theory is believed to be the bridge between the behaviourist and constructivist theories because it includes attention, memory and retention (Muro & Jeffrey 2008), he added a social element by debating that, children can gain and learn information by observing other people and that learning may or may not result in a behaviour change (Bandura, 2006). There are three general principles from learning from one another according to the social learning theory which are: Observation, Imitation and Modeling.

Bandura supported by Newman and Newman (2007) opined that, the people who are being observed are called models and the process of learning is called modeling where the rest of the stages of the social learning theory will only occur if a positive behaviour is observed in the first stage – Observation.

According to Bandura (2006), a huge percentage of behaviours either positive or negative have been observed to be learned through modeling.eg. students can watch parents read and watch the demonstrations of mathematics problems. Also, learning includes moral judgments regarding right and wrong which can in part, develop through modeling. Therefore, some practices and skills are learned by students prior to their exposure to classroom science through modelling from parents or significant elders in their society like telling time using the sun or shadows, water and soil conservation techniques in agriculture (mixed cropping, cover cropping, crop rotation, manuring), measuring plot sizes using the foot or ropes, and so on.

Vygotsky (1978) however had the view that social learning precedes development. According to him, a child"s cultural and overall development is evident firstly between people (inter-psychological) and then eventually inside the child (intra-psychological). To Vygotsky, children have the potential to perform higher intellectual levels when asked to work in collaborative situations than individually. He also believed that students could better develop complex understanding of concepts and skills when assisted by an expert or a more knowledgeable other. Learning according to Vygotsky occurs within the zone of proximal development which tends to extend when assisted by a knowledgeable other. Thus, with Vygotsky, children are capable of constructing their own knowledge through collaboration or assistance of an expert; children are socially engaged in constructing their own knowledge. This is what has been termed as „social constructivism".

Constructivism as a learning theory in psychology tries to explain how individuals make sense of their experiences by constructing knowledge and meaning from them. Constructivism, according to Elliott, Kratochwill, Littlefield, Cook and Travers (2000), is "a learning method that maintains that people actively create or make their own knowledge and that reality is defined by the learner's experiences".

Constructivism is founded on the idea that knowledge is created rather than intrinsic or acquired passively. The core principle of constructivism is that human learning is created, and that learners build new information on top of past knowledge. This past information has an impact on what new or modified knowledge an individual will develop in order to create new learning experiences (Phillips, 1995). During the learning process, learners evaluate new information in light of prior knowledge. They may also adjust old knowledge to fit new information if there are discrepancies. Constructivism rejects the notion that new information is written on a blank slate and assumes that learners have past experiences and knowledge that may be used to generate new knowledge (Olusegun, 2015)

The second tenet of constructivism is that learning is an active rather than passive process. Learners are engaged throughout the learning process; they apply past information, take note of important features in new learning situations, assess the consistency of prior and developing knowledge, and adjust knowledge depending on that evaluation (Phillips, 1995).

The third basic concept of constructivism, according to McLeod (2019), is that all knowledge is socially produced. In a similar spirit, Dewey proposed that learning is viewed as a social activity; rather than an abstract idea, it is something we do together, in connection with one another (McLeod, 2019). According to McLeod

(2019), children and their partners co-construct knowledge as a result of social interactions through directed learning within the zone of proximal development. He emphasized that the environment in which children grow has an impact on how and what they think about.

In constructivism, two essential notions related with the development of new knowledge are accommodation and assimilation. Assimilation is the merging of new experiences into previous experiences, whereas accommodation is the reorganization or change of current information to comply with new knowledge obtained. Both processes are critical in knowledge production because they aid in the integration of new information and experiences into established schemas and assure consistency (McLeod,2019).

Children learn best when they engage with their surroundings and are actively involved in the school curriculum that is based on their existing cognitive structures (McLeod, 2019). As a result, learning is dependent on the learner's cognitive development stage. The intellectual Children learn best when they engage with their surroundings and are actively involved in the school curriculum (McLeod, 2019). Constructivism is the foundation of several student-centered educational strategies such as the learning cycle, collaborative learning, and cooperative approach (Bernard, Borokhovski, Schmid, Waddington & Pickup, 2019).

While the instructor serves as a facilitator or guide, constructivism allows students to assume complete responsibility for their own learning. Students will feel more empowered as a result of this. The immediate learning environment, in combination with past information, has a collaborative influence on the creation of knowledge during the learning process. As a result, learning is dependent on the learner's cognitive development stage.

Students actively develop their own understandings based on earlier experiences, according to constructivism. This is in stark contrast to traditional education approaches, which treat the instructor as the sole source of information. Constructivism's profound and unique observation of human learning has resulted in a considerable shift in traditional teaching perspectives (Yanchun, 2002). Constructivists acknowledge that learning is pointless without students' initiative and active engagement. Constructivism values instructors' facilitative role in assisting pupils in efficiently learning knowledge. Constructivism emphasizes cooperation and communication, as well as cooperative awareness in students. Cooperation between professors and students, as well as among students, is disregarded in traditional teaching (Darling-Hammond, Flook, Cook-Harvey, Baron, Osher, 2020). Knowledge, according to constructivists, is the social production of persons and others via negotiation. As a result, in order to generate knowledge, students must collaborate and interact with one another (McLeod, 2019).

Instead of passively collecting knowledge, students may broaden their perspectives in a collaborative learning environment. It also aids in the development of their own knowledge system, as well as the development of their inventive spirit and problem-solving abilities. Students' prior information, experiences, thinking style, learning habits, and methodologies, according to constructivists, are significant foundations in the development of new knowledge.

Learning, according to modern cognitive psychologists, is an interactive process of new and old knowledge. Internal conditions for generating study activities include previous knowledge and techniques stored in the memory system. Learning is a process that pupils initiate based on their prior knowledge and experiences. As a result, students should be guided to create new information and experiences from old ones, resulting in the reciprocal linkage of new and old knowledge.

Individuals are active participants in the development of their own knowledge, according to social constructivism, a social learning theory created by Russian psychologist Lev Vygotsky (1978), Learning, occurs primarily in social and cultural circumstances rather than entirely within the person (Schreiber & Valle, 2013). The social constructivism approach places a strong emphasis on dyads and small groups (Johnson & Bradbury, 2015). Students, for example, learn mostly through interactions with their classmates, teachers, and parents, whereas teachers promote and facilitate discourse in the classroom by utilizing the natural flow of speech (Powell & Kalina, 2009). Successful teaching and learning, according to social constructivism, is primarily reliant on interpersonal contact and conversation, with the major focus on the students' interpretation of the topic (Prawat, 1992).

Vygotsky's theories emphasise the importance of social contact in the formation of cognition (Vygotsky, 1978), since he strongly believed that community plays an important role in the process of "creating meaning."

He claimed that all cognitive functions emerge from (and must be accounted as products of) social interactions, and that learning was more than just the assimilation and accommodation of new knowledge by learners; it was also the process by which learners were integrated into a knowledge community.

Vygotsky accepted innate growth, but claimed that the highest level of cognitive thought is elicited by language, texts, and conceptions coming from culture (Crain, 2005).

The two theoretical frameworks above were relevant in informing the study on how community experiences and culture has a huge role in the construction of knowledge typically, science experienced in the environment and its relevance in the classroom. The two theories above provided the basis for how indigenous knowledge influence students‟ performance in integrated science through students‟ knowledge gained through social interactions and observation and imitation from their society which could lead to effective accommodation and assimilation in the integrated science classroom.

2.2 The current mode of science instruction in the Ghanaian classroom

The right to education and a system of quality education that expresses the worth of the child‟s culture, community, language and access to schooling and involvement without fear or fervour is the right of every child, meanwhile in Ghana, the bridge between culture and community experiences and the classroom is very narrow. At any level of education, the main aim of teaching is to bring an essential change in the learner (Tebabal & Kahssay,2011). In order to fast-track the gradual process of knowledge transmission, teachers should apply and adapt appropriate teaching methods and measures that best suit specific objectives set for each lesson. In the traditional era, many teachers and educators commonly used teacher-centred methods to transmit information and knowledge to learners as compared to student -centred methods.

In recent years, the effect of teaching methods on student learning and behaviour change have consistently been taken keen notice of in the thematic field of educational research (Hightower,2011). Also, improvement in student learning and growth is enhanced with research on teaching methods.

According to Adunola (2011), poor academic performance by majority of students is basically linked to the use of ineffective teaching methods by teachers to teach learners. The effectiveness of teaching methods as proven by substantial research denotes that the quality of teaching is often reflected by the achievements of learners. Teaching involves bringing about desirable changes in learners so as to achieve specific outcomes (Ayeni, 2011).

In the Ghanaian senior high schools, every student in any course or programme of study take the integrated science subject as a core over a span of three years. The integrated science syllabus has been structured over a three-year programme with five main themes namely; Diversity of Matter, Cycles, Systems, Energy and Interaction of Matter. The five themes form the five sections of the syllabus for each of the three years‟ work. Each year‟s work consists of a number of sections with each session comprising of a number of units.

The first theme discusses topics and subtopics under Measurement, Diversity of Living and Non-living things, Matter, Cells and cell division, Soil and water conservation and other relevant topics spanning through the three-year programme about Diversity of Matter which has the aim to allow students to appreciate importance of diversity and the necessity of maintaining it and the interconnectedness among living and non-living things necessary to create harmony in nature. Theme two called Cycles is made up of topics such as Hydrological Cycle, General principles of farm animal production, Air Movement, Crop Production etc. This theme also has topics that span through all the years of study in school and aims to enable students recognize the repeated patterns of change in nature and understand how these patterns arise. Reproduction and growth in Plants, Respiratory System, Food and Nutrition, Dentition, Feeding and Digestion in mammals, Transport-Diffusion, Osmosis and Plasmolysis and many others make up the third theme. The study of systems would enable students to recognize that a system is a whole consisting of parts that work together to perform a function. Theme four is also made up of Forms of Energy and Energy Transformation, Solar Energy, Photosynthesis, Electronics e. t. c...

The study of energy enables students to appreciate that energy affects both living and non-living things. The study of this theme aims to allow students to appreciate the importance and uses of energy and the need to explore and conserve it. Theme five which sums up the organization of the syllabus is also made up to topics such as Ecosystem, Atmosphere and Climate Change, Infections and diseases, Safety in the Community which aims to enable students to appreciate that the interactions between and within systems helps humans to better understand the environment and their role in it (NaCCA, 2015).

At the end of the three-year programme, the students write a national final examination made up of paper one, two and three. Paper three is a practical paper on test of practical work while paper one and two is a composite paper are usually taken at one sitting made up of multiple choice and essay type questions. Paper two and one measure the student‟s ability to recall simple concepts, principles and laws, apply them and also exhibit some level of knowledge in formula work where necessary. It is therefore essential for students to have in-depth understanding of the subject matter.

According to a report on the trends in poor performance of WASSCE candidates in science and math in Ghana by Abreh, Owusu and Amedahe (2018), it was indicated that some perceived factors include the professional qualification of teachers, inability to complete the syllabus, lateness of admission of first years coupled with their early completion in third year, lack of teaching and learning materials and most importantly inappropriate teaching methods.

Additionally, O"Connor (2002) also in a study revealed some factors that contribute to the poor achievement of students in science one of which is the teaching method used. The teachers make minimal efforts in linking the concepts in the classroom environment to real life situations within the context of students" own lives and environment. This has a negative effect on students' interest and motivation to study science subjects (Azure, 2015). Also, as a result of inadequate teaching and learning aids, teachers are forced to use traditional lecture methods in teaching which affects students" conceptual understanding and performance.

O"Connor, (2002) indicated that teachers favour teacher-centred, knowledge-based teaching methods that leave little room for learners' participation. The teaching methods that are used mostly at the secondary levels have been found to be lecturing; question and answer; explanations of procedures and note giving, in that order.

Hussain, Azeem and Shakoor on the other hand (2011) do take keen interest in the traditional method of teaching irrespective of its many demerits because it promotes easy classroom management while also being a safety net for new teachers who may be unfamiliar with other methods. It is also a more preferred method of instruction when a large amount of information is to be given out effectively. In spite of these, the traditional method is less preferred to other methods such as scientific enquiry due to how best and with ease students are able to apply science concepts to real life situations when taught with the latter (Hussain, Azeem, & Shakoor, 2011). This suggests how inevitable it is to replace the traditional methods with new, interactive ones if better student achievement and conceptual understanding is expected. However, its negative effects cannot be exchanged with its merits outlined by researchers.

According to Boud and Feletti (1999), Teacher–centred approach means students are spoon-fed information from the teacher without being engaged in the subject being taught through activities. This approach is hardly practical or engaging but more theoretical and requires more memorizing (Teo & Wong, 2000). Application of knowledge to real life situations is non-existent. The teacher controls the transmission and sharing of knowledge and always attempts to maximize the delivery of information while minimizing time and effort. As a result, both interest and understanding of students may get lost. To address such shortfalls, Zakaria, Chin and Daud (2010) specified that teaching should not only depend on dispensing rules, definitions and methods for students to memorize, but should also actively engage students as primary participants in activities.

2.3 Prior Knowledge

Background knowledge is the raw material that conditions learning; it serves as mental hooks for storing new information and is the fundamental building block of content and skill knowledge. Prior knowledge, according to some authors, is what a person already knows about a topic (Marzano, 2004; Stevens, 1980). Learners have formed informal conceptions about how things function, about themselves, and about others by the time they join school (Bransford, Brown & Cocking, 2001; Carey &

Gelman 1991; Donovan & Bransford, 2005; Gardner, 1996). Learners construct knowledge, according to cognitivist experts, and the knowledge they already have affects their ability to learn new knowledge.

If new knowledge clashes with old knowledge, the learner will be unable to comprehend anything. As a result, when preparing to teach, teachers must take into account students' prejudices. Most instructors place a great deal of emphasis on the topic to be taught, ignoring what the students bring to the table during teaching and learning. Pre-existing information is frequently accessed with little preparation and instructional time. This error could have far-reaching consequences. Turning a blind eye to students' past knowledge almost certainly means that the teacher's intended message will be misunderstood by the students. The teacher's and students' engagement with the teaching and learning materials should be influenced by their prior knowledge. The primary goal of education is to correct students' misconceptions and provide appropriate solutions.

According to Strongman and Hall (2004), one of the fundamental goals of education is to correct pupils' erroneous beliefs. It will be easier for the teacher to put measures in place to remedy the situation if the teacher is aware of what the students bring to the learning environment. According to the American Association of Advancement of Science (1990), prior to the teaching and learning of any new knowledge, students' existing ideas lay the groundwork for the construction of the new knowledge. As a result, learners acquire new knowledge by establishing a relationship between new and existing knowledge or by reorganizing new and existing knowledge.

Prior knowledge is a frame of organization that kids bring from home and use to build meaningful connections between concepts, facts, and procedures that must be understood before they engage in education (Okanlawon, 2012). These abilities and experiences might be from prior grades or social contacts that the students bring into the classroom. It is the information that students get through their immediate surroundings, classmates, parents, and teachers preceding lessons (Kuhlane, 2011).

Graven and Schafer (2013) argue that knowing what the learners already know is critical since new information is acquired by connecting it to what they already know. Because when a familiar topic is offered, prior knowledge piques the learners' attention. It encourages learners to participate more actively in conversations during social encounters (Sedlacek & Sedova, 2017; Vygotsky, 1978). When instructors examine their students' past knowledge, they are honouring their socio-cultural backgrounds (Mavuru & Ramnarain, 2017; Stears, Malcolm & Kowlas, 2003). Prior knowledge also according to Stears, Malcolm, & Kowlas (2003), provides stronger connection to the materials taught, deepening the level of interaction between learners and the teacher. As shown, prior information has an impact on how people create knowledge (Vygotsky, 1978). It allows the instructor to see what the students already know, allowing them to avoid repeating information they already know (Moore & Van Rooyen, 2002), as well as clearing up any misconceptions they may have.

Prior knowledge aids learners' cognitive growth by allowing them to distinguish between what they already know and what they need to acquire. As a result, classroom learning must include, build on, expand, and challenge students' past knowledge and experience (Physical Science Syllabus, Ministry of Education, 2015).

Also, According to Stears, et. al. (2003), When teaching the scientific curriculum, it is helpful to have prior knowledge of the students in the process of linking the information to issues they face on a daily basis. Ignoring learners' past knowledge restricts their reasoning. Stears et al. (2003) go on to say that when students are interested in science, they learn well and embrace it. The teaching and learning process include everyday events. As a result, in order to attain the effective learning in students, teachers must integrate the learners' existing knowledge into their instruction (Nyambe,2008). IK can be utilized in this circumstance. Using past knowledge of students to enhance scientific instruction (Kibirige & Van Rooyen, 2006) as well as to counteract the problems given by Western science (Mukwambo, Ngcoza, & Chikunda, 2014).

Many academic sources advocate for the integration of indigenous knowledge (IK) in science education (Erinosho, 2013; Le Grange, 2007; Nyika, 2017; Shizha, 2007). These researchers opined that integrating IK into scientific learning improves students. It helps to contextualize science by involving learners (Sedlacek & Sedova, 2017). Different definitions of IK originate from the writings of various researchers. IK is a type of place-based knowledge that is anchored in local cultures and is most commonly linked with long-established communities that have strong links to their natural environment (Orlove, Roncoli, Kabugu, & Matagu, 2010).

It's a manner of understanding and interpreting events that are unique or intrinsic to a person"s cultural collective (Ogunniyi, 2007b).

There are several advantages to integrating IK into scientific education. The usage of IK in the classroom has been shown to improve student engagement in scientific classes (Erinosho, 2013; Sedlacek & Sedova, 2017). According to Sedlacek and Sedova (2017), the learners' engagement in the quality of the teaching and learning process is determined by the lesson. As a result, the involvement of when students recognize the link between ordinary activities and what they are learning in class, they will be more engaged as well as what is taught in the classroom. When students are exposed to ordinary classroom activities, they are more likely to grasp what they are studying, which may lead to more involvement. It also allows students to interact socially.

According to Vygotsky (1978) in order for them to be able to communicate their experiences, it is expected that during social gatherings, learners hone their IK and get clarity on the knowledge they have acquired through interactions from their own house. Furthermore, IK contextualizes science so that students do not experience science as alien (Aikenhead & Jegede,1999). It encourages the learners to engage with materials that are familiar to them as they are exposed to scientific concepts. IK makes science more local and accessible contextualized within the socio-cultural settings of the students (Mavuru & Ramnarain, 2017). This argues that integrating IK into classes might be a good place to start when teaching concepts in science (Simasiku, Ngcoza & Mandikonza, 2017). Shava (2000) also suggests that educational pedagogics can be contextualized in order to motivate students to talk about their experiences. Using IK to contextualize science allows learners' prior knowledge to be utilized (Erinosho, 2013; Oloruntegbe & Ikpe, 2011) during teaching and learning (Erinosho, 2013; Oloruntegbe & Ikpe, 2011). This could be accomplished by Africanizing the science curriculum and adopting teaching and learning methods and approaches that are relevant to the African context (Mukwambo, et al., 2014). Learners' attention is piqued by context-based instruction, (Sheldrake et al., 2017; & Ramnarain, 2017) as a result, Hofstein and Mamlok-Naaman (2011) claim that if learners are not engaged in science, they will not make an attempt to study and comprehend scientific ideas. When students use materials from their own culture, they are more likely to succeed and might be able to see how these materials contain some science features in the environment as they are gaining knowledge in their classes.

According to Mukwambo et al. (2014), indigenous traditions are entrenched in western science as the epigraph above emphasizes. As a result, teachers must examine the context of the lesson and consider learners when spreading the material of the scientific curriculum.

The learners may see how western science is embedded in their cultural traditions, as well as the similarities between western science and IK. Therefore, IK and western science should not be viewed as competitors, but rather as partners complementary to each other (Ngcoza, 2017). When utilized in the classroom, IK can help to consolidate a link between the learners' daily lives (prior knowledge) and the scientific world (Shizha, 2006).

IK may also be used to describe how things are done and can be supplemented by western science, therefore integrating these two bodies of information, learners may be able to clearly express themselves grasp the science that was taught in class and allow students to connect science to their everyday lives. It may also be simpler for the students to comprehend when they are linking scientific information to their daily understanding, since this is what they are doing.

Additionally, learners are more inclined to participate in schooling that emphasizes their cultural identities (Mukwambo et al., 2014). When learners have a foundation on which to build, it may be simpler for them to absorb new information (Simasiku, 2017).

Students may develop unfavourable attitudes about science when they have the inability to comprehend material presented to them. On the other hand, once students demonstrate a good attitude toward science, they may be encouraged to pursue it further. Their interest in learning science may be piqued as a result of their studies (Hofstein & Mamlok-Naaman, 2011).

Lemke (2001) adds that when participants' cultural resources are integrated in science teaching and learning, learning becomes more successful. Cultural engagement is also created by taking into account learners' cultural ideas or everyday experiences among other ethnic groups and gives students insight on how to appreciate their own cultural heritage as well as the legacy of others (Cocks, Alexander & Dold, 2012; Hewson, Javu & Holtman, 2009). This may make students proud of their culture since it is acknowledged in the classroom in conjunction with western science. IK with western science establishes a person's identity and creates a relationship with them by promoting self-assurance (Taylor, 1999). To put it another way, IK serves as a link between every day and classroom information.

Aikenhead and Jegede (1999) state that the degree of cultural influence on scientific learning determines success variations in how well the student transitions between ordinary life and science classroom, as well as the support provided to the student to ease the transition and therefore teachers should not disregard students' past knowledge because their learning is integrated in their prior knowledge (Le Grange, 2007).

Mavuru and Ramnarain (2017) identified the socio-cultural environment as a key factor in learning. In the classroom, there is a lot of science. It is the teacher's job to make the transition from one level to the next a lot simpler to go from everyday science to classroom science (Aikenhead & Jegede, 1999; Mavuru & Ramnarain, 2017). The instructor should also assist the students in seeing the connection between their daily science and the classroom science.

Linking prior knowledge to indigenous knowledge

Indigenous Knowledge (IK) can be an effective teaching tool in a classroom setting. In many nations, however, traditional curricula and achievement examinations do not promote kids' learning based on their IK. Learning environments must be modified to allow students to build on the knowledge of their indigenous cultures while also taking into account their culture and value systems. However, students' experiential knowledge can be looked of as prior knowledge. They are numerous types of knowledge that students acquire as a result of living and working in their towns and families, as well as participating in other local activities. Students' ability to understand material presented to them improves when teaching is reinforced by past knowledge, according to educational studies. Furthermore, pupils are more likely to remember information when they feel personal meaning in the material they are studying. As a result, the recognition of pupils' prior knowledge, also known as their IK, is the first crucial instructional method.

Educators might avoid using "cookbook techniques" in their classrooms and instead enable students to "build" their knowledge using existing information. Educators might, for example, provide challenges that are relevant to students and appreciate their perspectives, i.e., respect the culture, tradition, and identity that students bring to the classroom. Educators can also build on and teach new concepts by using students' past knowledge as a foundation. This is known as constructivist learning. This method of learning produces a "step-by-step" learning process that allows pupils to correctly acquire a topic over time. This also avoids the formation of alternate concepts, which frequently occurs when pupils are required to jump from zero to a notion.

2.4 Performance and achievement in science

Promoting students' academic performance in science has long been a major objective of scientific education at all levels of education (Biggie & Hunt, 1980). Examinations, quizzes, assignments, group work, and other forms of ongoing evaluation are routinely used to assess students' academic progress (Tomporowski, Davis, Miller & Naglieri, 2008). Students' academic achievements are measured by their scores in classroom exercises, assignments, tests, and examinations and they provide teachers with useful insight on their learning progress. It also enables teachers to assess the extent to which students have acquired knowledge and skills (Sukola, 2015).

Cognitive characteristics such as formal reasoning ability, prior knowledge, and learning orientation have been shown to have a major impact on students' science proficiency.

Students' science achievement is heavily influenced by formal reasoning ability, learning orientation, and prior knowledge, among other cognitive characteristics. The function of formal reasoning in students' science proficiency has garnered the greatest attention of all the cognitive variables (Dogru-Atay & Tekkaya, 2008). Rips (2004) defines reasoning as a mental process that allows people to create new representations based on previously acquired information. It includes problem-solving cognitive processing that involves generating conclusions based on logical rules or rational procedures (Mayer & Wittrock, 2006).

2.5 Indigenous knowledge systems and their scientific implications in Africa

According to Simpson and Weiner (2018), Knowledge is defined as an awareness or understanding of a particular subject, situation, place or skill. It is a deep familiarity about anything mostly known to be the justified truth about something. Before the intrusion of an unfamiliar to what is already present, knowledge that is aboriginal to a particular area is known to be indigenous.

Indigenous knowledge is therefore native knowledge that is developed from experience as a result of long associations with a particular region or area. Ocholla and Onyancha (2005) also defined it as the knowledge, skills and attitudes that emanate from personal and community experiences of a particular area. Such knowledge is always affected by internal creativity and changes as a result of contact with external systems though it is peculiar to a specific culture or society. Nakashima (2000) also opined this about indigenous knowledge;

"Indigenous or local knowledge refers to a complete body of knowledge, know-how and practices maintained and developed by people, generally in rural areas, who have extended histories of interaction with the natural environment. These sets of understandings, interpretations and meanings are part of a cultural complex that encompasses language, naming and classification systems, practices for using resources, rituals, spirituality and world view. It provides the basis for local-level decision-making about many fundamental aspects of day-to-day life; for example, hunting, fishing, gathering, agriculture and husbandry; food production; water; health; and adaptation to environmental and social change".

Education produces knowledge as an end product; it is made up of sets of information, facts, ideas, skills, expertise, and awareness or familiarity accumulated by a person through education or experience for the theoretical or practical understanding of a subject (Simpson & Weiner, 2017). Quality education is only said to have been achieved when it is not only relevant to the needs of the people concerned but equally appropriate to the social and material environments in which it is pursued (Hanushek & Ludger, 2007). It must be adaptable and be sensitive to meaningful situations to members of the society taking into account their aspirations and concepts of development. The development of indigenous knowledge is a by-product of efforts to master the environment and has been a matter of survival to communities.

For a few decades now, there has been the constant rise in the comparison of indigenous knowledge with scientific knowledge or western science in a way that largely favours western science because of its universality and generalizability. The rise of scientific knowledge which was constituted in the early centuries absorbed some western folk knowledge and practices. Therefore a comparison of indigenous knowledge with western science places the latter on a higher pedestal of privilege because of its universality even though the comparison between the two is not necessary, as the baseline of universal reason exist in all traditions, enforced by shared human economic need and cognitive processes, although "activated and expressed in different cultural contexts" (Oguamanam, 2006).

Science may be described as a discipline of knowledge that uses experiments and observations to offer explanations for natural occurrences and processes (Hayfron-Benjamin, 2008). Physics, chemistry, biology, and agriculture are all part of the integrated scientific curriculum in Ghanaian schools. Students can learn about natural occurrences and processes, as well as the behaviour of materials and objects in the environment, through science (Erinosho, 2008). Science is taught in schools for a variety of reasons. The following are some of the benefits of scientific literacy:

1. Science knowledge helps pupils develop a wide range of skills and cognitive abilities. To make sense of the environment, certain abilities are required, which include performing investigations, giving empirical data, and making reasoned judgements.
2. Scientific literacy is required for citizens to make informed decisions and reasoned judgements on public-interest issues like as health and nutrition, malaria, HIV/AIDS, environmental degradation, and so on (Erinosho, 2008).
3. A basic understanding of science offers the framework for vocations in medicine, nursing, agriculture, pharmacy, science education, and other disciplines. For Science to be beneficial to students, the teacher must utilize pedagogical tactics that encourage all students to learn scientific abilities, engage in varied reasoning, and apply their knowledge.

Western science or indigenous knowledge are single distinct entities that could both complement each other irrespective of the discrepancies in socio-cultural processes and worldviews. Some differences between the two are highlighted by Oguamanam (2006) as follows:

1. The pass on of indigenous knowledge from generation to generation is mostly oral, through folklores and legends, or through imitation and demonstrations while Western science transmits knowledge through writing.
2. Indigenous knowledge is gained by observing and participating in simulations, real-life experiences and trial and error whereas Western knowledge is taught and imbibed in abstraction.

3. Indigenous knowledge is founded on the notion that the world and everything it comprises has a life force and are infused with spirit, and made up of both the animate and inanimate objects such as fire and trees. Western knowledge severs the animate from the inanimate and treats all as physical entities.
4. Indigenous knowledge views the world as interrelated; it does not necessarily subordinate all other life forms to mankind as they are all interrelated and interdependent parts of one ecosystem. Western science views mankind as superior to nature and "authorized" to exploit it maximally.
5. Indigenous knowledge is integrative and holistic in nature, rooted in a culture of kinship between the natural and supernatural. Western science is "reductionist and fragmentary, reducing and delineating boundaries to the extent that every relationship is treated as a distinct whole."
6. Indigenous knowledge values intuition, emphasises emotional involvement and subjective certainty in perception. Western science thrives on logic and analysis, abstracted from the observer, and the replication of measurement to determine results.
7. Indigenous knowledge is based on a long period of close interactions with the natural environment and phenomena. Western knowledge thrives on the mathematical and quantitative ways of gathering information.

Jones and Hunter (2003) and Michie (2000) also identify the following common themes in Indigenous Knowledge that are intrinsic to its integration in the science classroom and curriculum:

- Based on experience
- Often tested over centuries of use

- Developed collective database of observable knowledge
- Adapted to local culture and environment
- Dynamic and changing: a living knowledge base
- Application of problem solving
- Oral transmission sometimes encapsulated in metaphor
- Not possible to separate Indigenous Knowledge from spirituality, ethics, metaphysics, ceremony and social order
- Bridging the science of theory with the science of practice
- A holistic (IK) versus reductionist (western science) approach
- An ecologically based approach
- Inclusive versus the specialization of knowledge
- Contextualized versus decontextualized science

Studies on cultural beliefs and science in Africa conclude that the teaching and learning of science in school is not successful because the subject is not linked to everyday life experiences and the language of instruction alienates students (Clark & Ramahlape, 1999; Dlodlo, 1999; Dzama & Osborne, 1999; Shumba, 1999). There should be a relationship between school science and what happens in children"s homes for border-crossing of knowledge to be successful.

Learning school science requires students to cross boundaries between the cultural context of their home, family, and community and the cultural context of Western science (Snively & Corsiglia, 2001). This can only be achieved with effective cultural border crossing which involves flexibility, playfulness, and a feeling of ease, without mystifying Western science or mythicizing indigenous knowledge (Aikenhead & Jegede, 1999). People"s ways of thinking and knowing are rooted in their indigenous lives, a prerequisite in African schools which is a fusion of various forms of knowledge (Dei, 2000). Science teaching that acknowledges students" knowledge and cultural-based ways of thinking has potential to make science more meaningful to students therefore, teachers may need opportunities to consider the ways in which mainstream science marginalises indigenous knowledge as they consider the practical implementation of indigenous knowledge in the science classroom, (Chinn, 2007).

Science teaching that acknowledges and values students" indigenous knowledge has been seen to increase students" interest and participation (Brown, Muzirambi & Pabale, 2006) and could lead to more personalised and relevant learning (Keane, 2006; Webb, 2013). When students meaningfully engage with science learning, better educational outcomes are expected (Aikenhead & Elliott, 2010), which could have long-term benefits for both individuals and societies. Including Indigenous knowledge in the classroom is a step towards recognizing diversity in ways of knowing, as well as recognizing the value of Indigenous knowledge.

Regardless of the positive impact of indigenous knowledge in the classroom, the International Council for Science (ICU) has called for criteria to distinguish traditional knowledge from pseudoscience (Bala & Joseph 2007) based on the systematic character of science about how science explains, establishes knowledge claims, how it represents the world, expands knowledge and the ideal of completeness it pursues.

2.6 The Effect of Indigenous Knowledge Incorporation on Students' attitudes in science

Attitude is a notion that refers to a person's style of thinking, acting, and behaving, and it is produced as a result of the learning experiences that pupils have (Mensah, Okyere & Kuranchie, 2013). "Attitudes are sentiments, typically affected by our beliefs, that predispose our behaviors to objects, people, and situations," according to Myers (2013). (p. 574). According to research, there are three main components of attitude: cognitive, emotional, and behavioral (Hogg & Vaughan, 2011; Maio & Haddock, 2010). According to Mensah et al. (2013), the cognitive component is what the individual thinks or believes about the attitude object, whereas the affective component is the individual's thoughts or emotions regarding the attitude object. Then there's the behavioural component, which is the proclivity to respond in a specific way. Although the concept of "attitude" and its effects on learning have long been a source of concern and debate in educational circles, attitudes research is still relatively new on the educational research timeline (Osborne, Simpson, & Collins, 2003).

It all started in the 1920s, when Thurstone discovered that attitudes could be measured (Simpson, Koballa, Oliver, & Crawley, 1994). By the 1960s and 1970s, attitudinal research had greatly increased, with a focus in one of these three areas: measurement of student attitudes; measurement of change in student attitudes following various treatment methods; and identification of relationships in support of student attitude and science-related behaviours (Simpson et al., 1994). (Simpson et al., 1994).). Attitudes were viewed as "both facilitators and outcomes of scientific learning" by researchers in the late 1970s and early 1980s, and research efforts concentrated on recording student attitudes and their link with science accomplishment (Koballa & Glynn, 2007). By the 1990s, attitudinal research had slowed since it appeared that no significant direction or outcomes for modifying attitudes in classroom practice had been presented. The reduction was significant enough to create worry among educators while also necessitating further investigation by scholars. Since a result, student attitudes have been one of the focus areas of research, as studies have shown that attitudes have a significant impact on how students profit from their academic experiences (Redish, Saul, & Steinberg, 1998). According to studies (Simpson, Koballa, Oliver, & Crawley, 1994; Weinberg, 2000; and Thompson & Mintzes, 2002), attitudes are inferred from behavior rather than reflecting what humans are pre-thought or predisposed to do. Prior knowledge, according to Simpson, Koballa, Oliver, and Crawley (1994), is a predisposition derived from a person's initial opinion. Prior information and experience, according to Baldwin, Ebert-May, and Burns (1999), impact the knowledge acquisition process, which affects students' views. In the recent decade, scientific education has seen great development and expansion, as has study on "student attitudes that influence and are shaped by student classroom experiences" (Adams, Perkins, Dubson, Finkelstein, & Wieman, 2006). Part of the rise in attitude research might be attributed to the continual fall in the number of students pursuing science-related occupations (Osborne, Simpson & Collins, 2003). Previous studies have indicated that the classroom and home contexts have an influence on science attitudes. Simpson and Oliver (1990) discovered a strong link between the student, self, school, family, and attitude. There are distinctions between attitudes toward science and attitudes toward science (Gogolin & Swartz, 1992; Simpson, Simon & Collins, 1994). "The manner in which scientists believe in and perform their work" are scientific attitudes (Simpson, Simpson & Collins, 2003, pp 1051). "A person's favorable or negative response to the enterprise of science" is defined as "attitudes toward science." To put it another way, they refer to whether or not a person likes or dislikes science.

The focus of this research is not on scientific views, but rather on attitudes toward integrated science, which is an amalgamation of all the various aspects of science. Although attitude is one of the emotional factors that has been discovered and examined for nearly nine decades, there appears to be no clear explanation of what attitudes are in the literature.

Osborne, Simpson, and Collins (2003) divided attitude into four categories that may aid in defining what attitude is:

i. feelings elicited by a circumstance
ii. an emotional response to a stimuli
iii. anticipated outcomes
iv. the connection between a circumstance and personal ideals

When the term of attitude toward science is utilized in the literature, all of the characteristics are included in some way. McLeod (as mentioned in Taylor, 2004) took a different approach to attitudes.

To convey the wide concept of all emotions, ideas, and sentiments about science, he chose to use the term "affect." McLeod classified science's emotional realm into three categories: beliefs, feelings, and attitudes. According to McLeod's classification, students' attitudes are based on their likes and dislikes, their enjoyment during classes, and their preference during teaching. This region of choice is linked to classroom environment studies' preferred environment. When seen in the perspective of McLeod's classification of attitudes, this region is more prevalent in schools, resulting in a preference for his classification.

Good attitudes about a topic are an essential aim of most science curriculum, both as desirable outcomes in and of themselves, and because students with positive views are more likely to pursue science-related courses and careers. Students' views about science decline with age, according to a literature review by Ramsdem (1998) and

Osborne, Simpson, and Collins (2003), and boys have more favorable attitudes toward science than girls. Coleman (2004) reported that in a cross-national study of secondary school science students in high and low academic achieving schools in Korea, science students in high academic achieving schools had a positive attitude toward science, whereas science students in low academic achieving schools had a negative attitude toward science.

However, the findings contradicted those of similar research conducted in Singapore, which found no significant differences in attitudes toward science among children in both high and poor academic achievement schools. Students in both types of schools had a good attitude toward science. Coleman's research, on the other hand, employed science, which provides the idea that science is a homogeneous topic and hence misrepresents the attitudes of students from these types of institutions. The problem is that students' views toward various subjects may differ (physics, chemistry and biology). As a result, it is necessary to determine what students' attitudes about certain science topics are in schools whether with low or high academic achievement.

In the case where attitudes form a very vital part of classroom learning, indigenous knowledge can act as a powerful tool in the learning environment to teach students. The various forms of knowledge students gain from living and working in their communities or homes from local activities termed as their experiential learning prior to their exposure to science in the classroom could help them feel ownership of the knowledge they bring into the learning environments. This leads a respect of their culture, tradition and identity and a positive change in attitudes. Therefore, the integration of indigenous knowledge will lead to education that goes beyond the classroom leading to positive attitudes towards science and also becoming a knowledge source for communities‟ sustainable development.

2.7 Problems associated with the Integration Process of Indigenous Knowledge in Science Teaching

According to Hortshemke and Schafer (2007), IK should not be viewed as a panacea for scientific education since it may cause issues when it is used. Learning through IK may result in cognitive dissonance or cognitive conflict between scientific and non-scientific language as well as daily language (Le Grange, 2007). Learners must replace their previous knowledge integrating the new information they are gaining via education (Kibirige & Van Rooyen 2006; Le Grange, 2007; 2006). Learners may have difficulty applying scientific principles in the classroom when they are expected of them. For example, the student could answer questions in the test using ordinary language, which could result in the learner losing marks because he or she is needed to apply scientific ideas.

During the grading of national exams, teachers may not comprehend what the student write due to cultural differences, which may result in misunderstandings of what is being examined.

In reality, Kibirige and Van Rooyen (2006) stated that IK cannot be codified or transferred between communities since it is locally based. Similarly, according to Nyika (2017), most teachers do not utilize IK in the classroom since it is not effective. As a result, they prefer to concentrate on the work that will be examined in the tests and final examinations. Teachers must complete the curriculum on time and exams should be prepared for the students thus IK is viewed as a waste of time. Similarly, IK may be incompatible with a person's faith on the path of both teachers and students

(Cronje, Beer, & Ankiewicz, 2015; Hodson, 2009). According to Mhakure and Otulaja (2017), if teachers do not have a clear grasp of the link between IK and western science, IK may be misunderstood. They went on to say that the syllabus doesn't clarify how to teach IK in the classroom, which makes it difficult for teachers to include it into their lectures. Most schools have instructors who are not native English speakers. As a result, integrating IK into the classroom may not be feasible or appropriate.

When instructors are not from the same environment or neighbourhood, this might be an issue for the community as well as their students (Mhakure & Mushaikwa, 2014), or when the class is made up of a diverse group of students from various cultures with diverse backgrounds (multicultural class), the instructor may not be sure which IK to employ. In this scenario, employing IK might lead to unfairness in the classroom owing to the students' diverse social origins (Taylor, 1999). Cronje, Beer, and Ankiewicz (2015) and Ogunniyi (2007a) both point out that some professors may have difficulties integrating IK in their lives because they were schooled only in western methods of knowing. As a result, a shortage of locally educated teachers to teach IK might potentially be a problem (Mhakure & Otulaja, 2017). Mukwambo et al. (2014) emphasize the importance of science ideas. Therefore, instructors must be critical thinkers in order to discover scientific ideas buried in cultural practices, as well as activities that may be in contradiction with western science. Furthermore, not every IK is scientifically significant (Hortshemke et al. Schafer,2007).

Another one of the major challenges facing indigenous knowledge integration is the prejudice towards it by some teachers, learners, and researchers. There are debates on whether indigenous knowledge constitutes authentic knowledge, let alone authentic science (Horsthemke, 2004). This perception is fueled by the long-standing history of western sciences" higher advantage over indigenous knowledge over other ways of knowing which has left very little room for knowledge diversity. Another challenge to integration of indigenous knowledge in formal education arise from teachers" lack of belief about the actual relevance of indigenous knowledge and how it can contribute significantly in addressing the socio-economic needs of the country (Dei, 2002; Gachanga, 2007; Mwenda, 2003; Semali, 1999).

Questions have been raised as to whether indigenous knowledge is really desired for inclusion in the curriculum in given communities (Horsthemke & Schafer, 2007) because some science educators and teachers have doubts about the usefulness of indigenous knowledge and prefer to not use it because they fear they may be teaching Pseudoscience (De Beer & Whitlock, 2009), which is mostly as a result of lack of instructional methods and relevant pedagogical knowledge needed to effectively implement it in the science classroom (Ogunniyi, 2007).

There has also been a delay in the integration process because teacher trainers and colleges taught and trained solely on western science instruction and framework, hence, the present teachers in schools understand very little about indigenous knowledge and how vital it is in the science classroom (Moyo, 2011; Ogunniyi, 2004).). Also, because of the absence of guidelines for the integration of Indigenous Knowledge Systems in teaching and learning, schools, districts and provincial authorities are not prepared to implement Indigenous Knowledge (Mushayikwa & Ogunniyi, 2011). Understanding the nature of indigenous knowledge and the nature of science and learning is therefore an important step towards indigenous knowledge-science integration (Ogunniyi 2004). Effective integration of indigenous knowledge and science into western science can only be achieved with the removal of constraints that are inherent in the two subcultures of science. The constraints may be found in the perceptions held by people, among which are:

- The perception of many scientists and science educators that western science is universal, objective, authoritarian, value free, infallible and unchangeable.
- The perception that indigenous science is inferior and is full of superstitions and myths.
- Reluctance of authors and curriculum developers to include the contributions of indigenous science in science textbooks and syllabuses.
- The communication gap between practitioners of indigenous science and their counterparts among scientists and technologists.
- The secrecy associated with indigenous science practitioners.
- Indigenous science practices differing from one country to another. Each African country has a large number of these practices. However, these have not been studied.
- Lack of a science and technology policy framework that recognizes indigenous knowledge systems as science.

2.8 Overview of Empirical studies relevant to the present study

Some examples of science educational studies associated with the effect of indigenous knowledge on students" performance are presented below:

Kpan (2020) carried out a study to investigate indigenous knowledge systems and the curriculum of basic schools in the Nadowli District using 58 respondents made up of teachers, traditional healers, chiefs and elders.

The results of the study showed that, the teachers in the district played a major role in affecting the perceptions of students with confirmations from the questionnaire and interview schedules with increase in students" performance when indigenous science is efficiently used in the classroom.

Also, Ekwam (2014) in a survey also investigated on the influence of community indigenous knowledge of science students" performance in chemistry. The study aimed at determining the relationship between attitude towards community indigenous knowledge of students and students" performance in chemistry with 224 students using a chemistry performance test (CPT), Questionnaires and interviews. The results of the study showed a positive influence of community indigenous knowledge on students" performance and understanding in chemistry.

Manzini (2000) also in a study with 24 students on learners" attitudes towards the teaching of indigenous African science as part of the school science curriculum showed an unprecedented level of interest in the classroom characterised with great enthusiasm.

Additionally, Chaiklin & Davis (2015) on an attempt to use the radical-local approach in designing and teaching for Ghanaian pupils about the ideas of measurement and attributes of measurement with students from an average achieving school in Cape Coast Metropolis involving investigation examples, followed by presentation of results by groups and class discussion of these results coupled with flexible language policy resulted in strong interest and engagement in all lessons as evidenced by their engagement in group discussions, their attention to answers, etc..

This study was also in line with Wager (2012) who put out framework for integrating cultural out of school practices with his study with 17 elementary school teachers in the United States who participated in a semester long professional development seminar and survey on how 8–10-year-olds used maths outside of school. The results of the survey were used to design lessons. The survey helped him to analyse and design curricula that validated students out of school experiences and forming a connection with school mathematics to result in meaning making.

In conclusion, the findings from the empirical studies above provide evidence to support that indigenous knowledge incorporation in science lessons promote students" achievement in science.

2.9 Implications of the reviewed literature to the Present study

All the literature reviewed in this chapter presents understanding on the nature of indigenous knowledge, its basis, significance and effectiveness in promoting positive attitudes and enhancing the understanding of students in concepts in science evidenced by positive performance results.

The empirical studies reviewed above clearly show the inadequacy of focusing solely on western science in enhancing students" performance in science. Finally, the review of the literature in this study presented avenues for the researcher to support the effectiveness of integrating indigenous knowledge in promoting students" performance and achievement in science with enough empirical evidence.

2.10 Conceptual Framework of the Study

Based on the theories of Albert Bandura and Lev Vygotsky, a conceptual model was developed for the study. When students are exposed to science topics, they are thrown into a state of disequilibrium. Relating the concepts to indigenous knowledge (from their immediate environment) however, seem to enable students to develop and create linkages with their cognitive structures and reorganize their already existing schema to better understand the concepts presented to them which will in turn increase student performance. See the conceptual framework in figure 1 below.

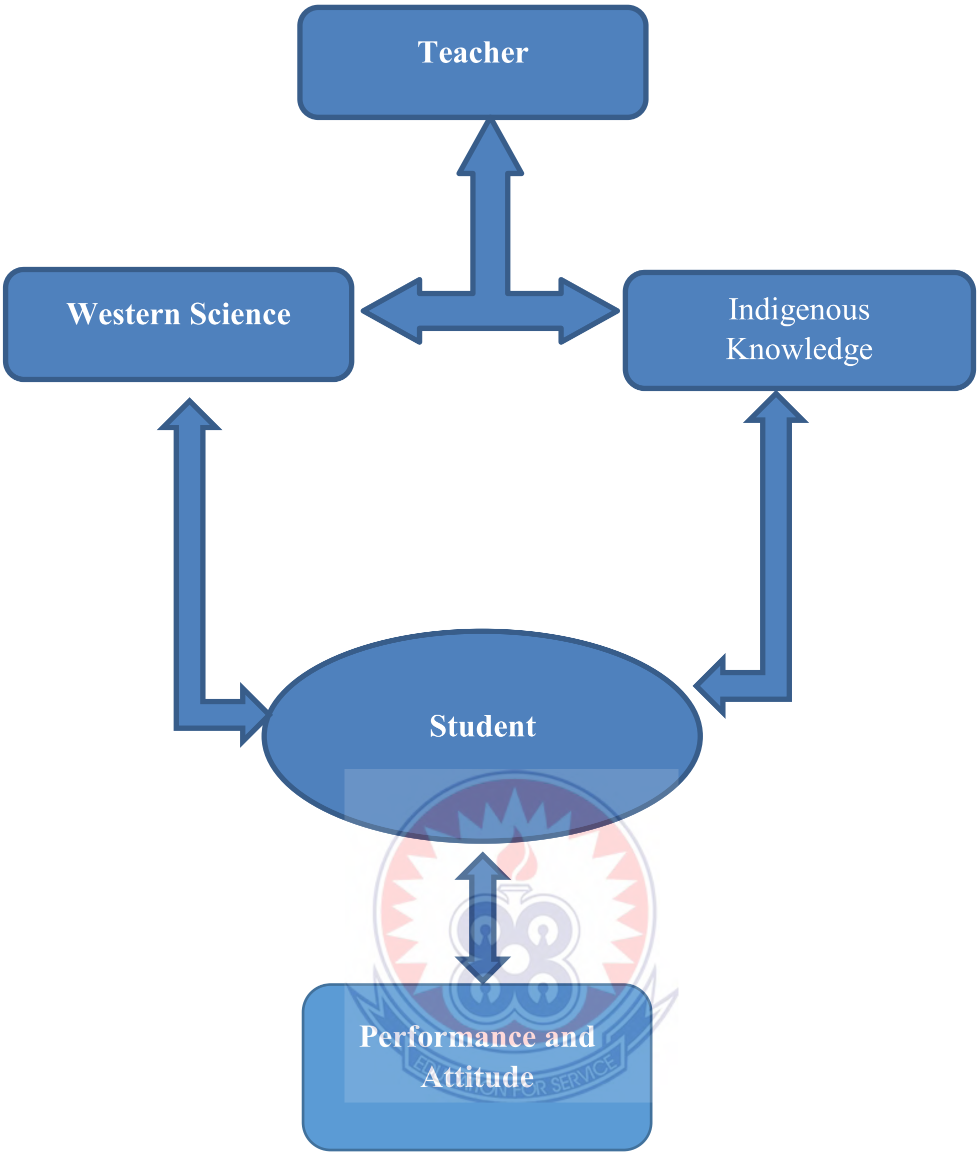

Fig 1: Conceptual framework of the study

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter represents the general plan for carrying out the study. The plan outlines the procedures undertaken and how they are implemented during the study.

3.1 Research Design

The research design of the study is action research. Action research is research that is mostly used to identify problems and perform planned out activities that will be used to reflect on one‟s practices to bring about improvement, innovation and understanding of the problem being investigated (Cohen, Manion & Morrison,2007; Amedahe, 2002, Bell,2004; Best & Kahn 1995). It is a stepwise probe to gather information about the operations of a particular school, how teaching occurs and how their students learn (Mills, 2003). The data gathered in action research provides insight and development in reflective practice and student outcomes (Cohen, Manion & Morrison, 1994). In this study, the data and results provided insight and served as a source of reflective practice to effective teaching of integrated science in the classroom.

3.2 Population

Namong Senior High Technical School (NASTECH) is a mixed school with a population of about 1400 students in Offinso in the Ashanti Region of Ghana. The school offers six programmes namely General Science, Business, General Arts, Agricultural Science, Home Economics and Building and Construction of which all are mandated to learn integrated science as a core. Integrated science is one of the core subjects apart from English, Mathematics and Social Studies that students need to pass before gaining admission into any tertiary institution in the country. The target population of the study is made up of all students in NASTECH.

3.3 Sample and Sampling Procedure

Purposive sampling technique was employed for the study. The form two classes were chosen for the study because, they had had one-year base tuition which meant that they were familiar with common concepts in integrated science. The sample of the study was chosen from the accessible population (all students in SHS 2) based on the performance of students in each of the programmes. The general arts students among all the other programmes had the lowest percentage pass as seen in the most recent WAEC results in integrated science in the school. The sample 2GAB, one of the three general art classes namely 2GAA, 2GAB and 2GAC was chosen from the accessible population of form 2 students which is an intact class of 52 students. Therefore, the sample size was 52 students.

3.4 Instrumentation

Achievement Tests (pre-intervention and post-intervention) and questionnaires were used to collect data for the study. The pre- intervention test (Appendix B) was a diagnostic test designed to measure the performance of the students before the implementation of the intervention. After the administration of the intervention, a similar test (post-intervention) made up of 20 test items (Appendix C) was given to evaluate the extent of the effect of indigenous knowledge integration in teaching the topics (intervention) that were chosen for the study. The data gathered from the pre and post intervention tests were used to answer the research questions. The 20 multiple choice questions covered Measurement, Water, Soil, Acids, Bases and Salts and Soap Making. Both pre and post-tests lasted for 30 minutes to answer.

A close ended questionnaire was also designed and used to collect data from the students regarding their attitudes after the implementation of the intervention. The responses from the questionnaire were used to answer the research question three.

The questionnaire was a 5-point Likert scale made up of 10 questions ranging from strongly agree (1) to strongly disagree (5) on each side of before and after the intervention.

3.5 Validity

The tests were labelled "Science Achievement Test" and administered at the early stage (pre-intervention stage) and at the end of the intervention (post-intervention stage). Taking into consideration face validity, content validity, proofreading and reduction of errors, the test was presented to a lecturer in the Science Department of the University of Education, Winneba (UEW) and two Senior High School Head of Departments of science with at least five years teaching experience at Namong SHS and Dwamena Akenten SHS for comments on the appropriateness of the test based on the SHS Integrated Science syllabus content. The comments about question restructuring and mistakes were corrected then pilot- tested at Dwamena Akenten Senior High School located in Adukro the same area with 25 students after being sure of the questions reflecting test items from the Ghana Education Service Syllabus. The test was administered twice (thus the second test was administered two weeks after administering the first test).

3.6 Reliability

The reliability coefficients for the test and questionnaire were determined using test-retest reliability and Cronbach alpha coefficient reliability determination test respectively after the pilot tests. The test-retest reliability was estimated to be 0.72

and that of the questionnaire was 0.75 respectively. According to Cicchetti (1994) test reliability values between 0.60 to 0.74 and above 0.75 are considered excellent. Therefore, the reliability value of 0.72 was considered to be good.

3.7 Data Collection Procedure

Copies of letters seeking for permission to conduct the research were taken from the Head of Department of Science Education, University of Education, Winneba and given to the Headmistress and Head of Science Department of the school.

At the beginning of the pre-intervention stage, the students were administered for a pre-intervention test before instruction took place. The students were taken through series of lessons during the instruction phase. After three weeks of instruction and three weeks of application and practice, the post-test was administered. Data (scores of students) from pre-test and post-tests were collected. The questionnaire was also administered a day after the post-intervention test to receive their responses on the integration of indigenous knowledge into teaching integrated science on their attitudes. Students who needed help to complete the questionnaire in terms of further explanation were given. The respondents were assured of the anonymity and confidentiality of their responses therefore, they were asked not to write their names on the sheet.

3.8 Data Analysis

The responses obtained from questionnaire items were coded and analysed through the use of Statistical Package for Social Science (SPSS) version 16.0. Descriptive statistics function of the SPSS was used to analyse the data from the test using percentages.

3.9 Pre-intervention

The Pre – intervention test was designed by the researcher taking into consideration questions on the topics chosen from the syllabus that would be vital in this study. The responses from students were then carefully analysed to inform the researcher on the strategies to employ at the intervention stage.

3.10 Intervention

The design of the intervention was done after the analysis of the diagnostic stage (Pre-intervention stage). The pre-intervention test revealed the level of understanding of the students on the various topics and the gap between their understanding of what is taught in the classroom and their community experiences. Upon the analysis of the students‟ performance, the following activities were designed for implementation:

- Pre–class Reading assignment on measurement, water and soil conservation, acids, bases and salts and soap making.
- Noting down relevant community science that are related to the topics.

Students are not „tabula rasa‟. In most science courses, students‟ contributions are mostly not considered but in reality, the students might have already experienced some science concepts in their community aside the classroom. This really affects the interest of students towards science courses. Pre- reading is a vital part of teaching and learning. At every juncture, it is more appropriate that learners are given the opportunity to prepare themselves before every class.

The Ghanaian SHS integrated science subject is designed to cover three years of teaching and learning. Measurement, Water and soil conservation and Acids, bases and salts are few of the topics that are taught at the early stages in the first and second year.

3.11 Intervention Phase

Pre – Reading Assignment

Students always start reading and studying topics only after they are taught in class in most introductory courses. Meanwhile, coming to the classroom prepared is a vital trait that encourages student involvement and teacher facilitation. Students" ideas and contributions always play an important role in the teaching process and learning. If the students prepare well before lessons, their responses to conceptual reasoning questions will give the instructor insight into what students find difficult, complementing the instructor"s ideas on what materials need most emphasis (Crouch & Mazur, 2001).

In view of this, the researcher designed a manual to serve as a guide for the students to come prepared before every lesson (Table 1.0). This was done to introduce the learner to the topics, increase classroom involvement and encourage organization of ideas with regard to community science about the topic for each lesson.

Table 1: A Manual for Students to come to Class Prepared

Week	Topic	Reading Assignment(s)	Reference Books
1	Measurement	Meaning of measurement, the importance of measurement, the units (SI and derived), measuring accurately using scientific instruments, errors in measurement	Integrated science Approachers Series Pages 10-32, Aki Ola Integrated Science for SHS Pages 10-33.
2	Water	Distinguish between hard water and soft water, demonstrate how to soften water and the treatment of water for public consumption	Integrated science, Approachers Series Pages 403-414, Aki Ola Integrated Science for SHS Pages 296-302.
3	Soil	The principles of soil and water conservation, methods of maintaining soil fertility and practices that lead to its depletion	Integrated science Approachers Series Pages 382-401, Aki Ola Integrated Science for SHS Pages 283-294.
3	Acids, Bases and Salts	Definitions for acid, bases and salts and common preparation methods for salts and their uses.	Integrated science, Approachers Series Pages 360-381, Aki Ola Integrated Science for SHS Pages 266-281.
4	Soap Making	Preparation, storage and use of the local black soap	Integrated science, Approachers Series Pages 902-904, Aki Ola Integrated Science for SHS 528-529

Week 1: Lesson 1

Topic: Measurement

Objectives

By the end of the lesson, the student will be able to**:**

(a) define measurement

(b) list at least 2 reasons why measurement is important

(c) outline at least 5 things in their environment that can be measured

Mode of Teaching: Classroom discussions, group work

Materials: Textbooks, mineral bottles, open milk and tomato tins

Introduction and Activity

Students in the class are grouped into groups of six. Each group is presented with a 1 litre bottle and empty tins of milk and tomato puree of varying sizes. Each group is then given 15 minutes to work on the task.

1. Why do we measure?

   For accuracy and precision, to promote fairness in trade

2. What do we measure?

   Mass of Gari, width and length of a table, humans (tailors and seamstresses measure the various sizes of the human waist, arm length, etc.)

3. Why do you think we should measure what has been indicated in question (2) above?

After 15 minutes, each group represented by a group leader presents and elaborates their answers to the whole class. The teacher then introduces the lesson to the class by facilitating the students as they finetune their answers on the importance and relevance of measurement. The teacher then brainstorms the students on what is being measured from the things indicated in question (2) above. Examples of some answers given are; we measure the height of a human, the mass of a bag of rice or frozen fish. The teacher then facilitates the students to be aware of the attributes of measurement and identify what is measured from things that were identified as measurable.

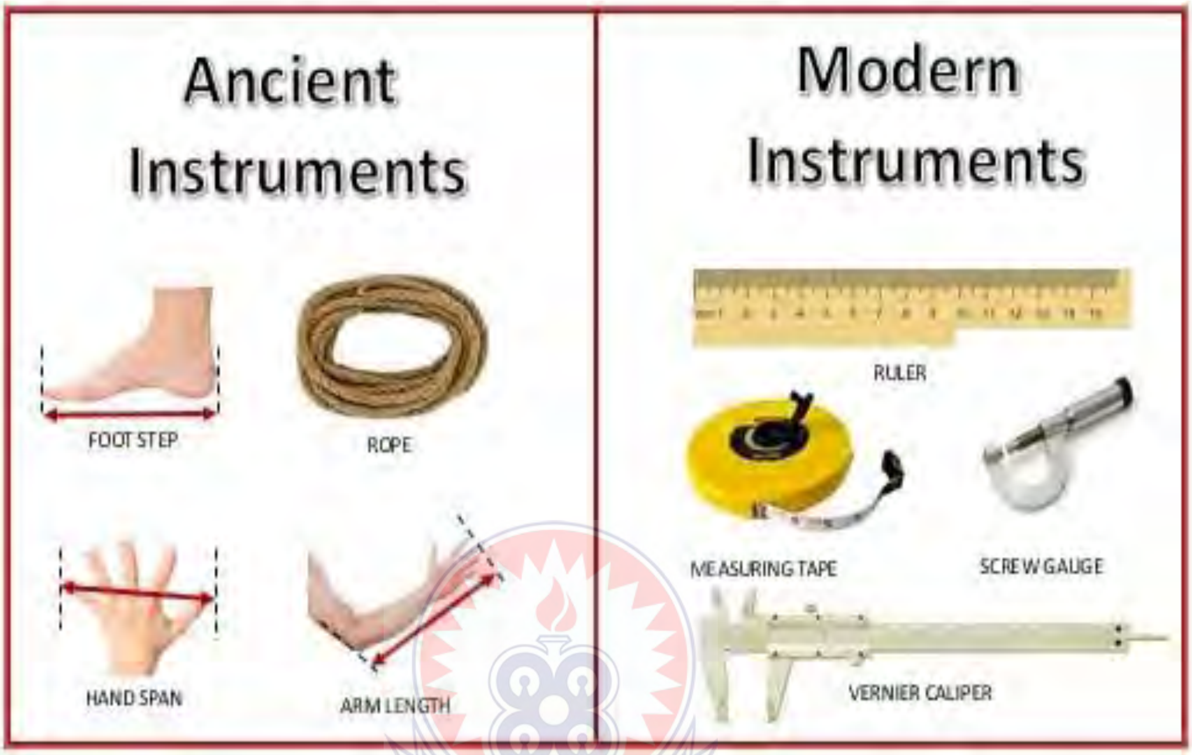

Figure 2: Ancient and modern instruments for measurement

Teacher discusses with students the indigenous ways of measurement in the local communities.

1. Length – usage of a rope, footstep or leg span for plots of land, hand span for the edges of objects, arm length for cloths, shoulder to neck for waist sizing, broomstick for foot size, e.t.c

   Ancient measurement of length was **based on the human body**, for example the length of a foot, the length of a stride, the span of a hand, and the breadth of a thumb. There were unbelievably many different measurement systems developed in early times, most of them only being used in a small locality

2. Weight – gold weights (mrammou), the hand, e.t.c..

3. Time – the sun, sticks, shadows, Church bells or Imam calls e.t.c..

   Often referred to as the sand clock or a sand glass, the hourglass was constructed from two separate glass bulbs that were rounded and held together by a neck of narrow glass. The hourglass contained particles of sand in it. When it was turned upside down, a measured amount of sand particles dropped down from the top part of the glass to the bottom part of the glass.

   Sunlight shifts over the course of a day, hitting the Earth directly around noon, from the east in the morning and from the west later in the afternoon and early evening. In Ghana, people have used their shadows or sticks to tell time based on sunlight"s changing directions and its effects on shadows. At different times of the day, your shadow gets longer and shorter, or may disappear. You can tell the time based on your shadow"s current length.

   Volume – empty tins and bottles

Finally, through classroom discussions, teacher and students explore various ways people have measured things and the different attributes of things in the present and past both locally and internationally. For example, foot for length, the sun or shadows for telling time, the rule of thumb, rope, inches, hand span, etc.…

Teacher ends the lesson by introducing to them the universally known quantities in recent time and their units from the answers given above.

Summary

The teacher summarizes the lesson from the reasons for measurement, what we measure, the attribute of the things we measure and some universally known quantities of measurement and their units.

Exercise

1. What is measurement?
2. Outline two reasons why measurement is important in your local community.
3. List 2 ways indigenous people used in measuring length.

Expected Answers

1. Measurement refers to the comparison of an unknown quantity with a known quantity.

2. (i)To prevent overdose and underdose

(ii) To promote fairness and avoid cheating

3. Length was measured based on the human body such as using the span of the hand, the breadth of a thumb, the length of a foot, the width of a finger, the distance of a step, etc.…

Week 1: Lesson 2

Topic: Measurement (11)

Objectives

By the end of the lesson, the student will be able to**:**

(a) list at least 2 quantities that can be measured from things in their environment

(b) define basic and derived quantities with the help of their units

Mode of teaching: Classroom discussion, demonstration, group work

Materials: Textbooks, metre rules, measuring cylinders, balance, a pineapple, a loaf of bread

Introduction and Activity

Teacher facilitates students through a recap of the previous lesson as they list the basic units of measurement. Putting students back in their groups, they are each presented with a metre rule and a pineapple or loaf of bread and a common balance to be used by all the groups represented by a group leader. The students are then given 15 minutes to measure all the attributes they can think of on their pineapple and bread. After 15 minutes, the group leaders to each group present their data (findings) to the whole class which elaborates on the heights, widths and masses of the same thing being measured. Teacher summarizes their responses and introduces derived units to the students as derivatives of the basic measurements they took from the pineapple and loaf of bread. Teacher then brainstorms students on the possible errors they may have encountered as they measured and how those errors can be avoided.

Summary

Teacher summarises the lesson brushing through basic quantities, derived quantities and the errors in scientific measurements.

Exercise

1. List 2 quantities that can be measured from a bar of soap
2. Outline 3 basic quantities and their units
3. How different are basic units from derived units?

Expected Answers

1. Mass, length,

Quantity	Unit
length	Metre
mass	Kilogram
Time	Second

2. Base units are fundamental units from which all derived units can be obtained. Each derived unit is a combination of two or more base units.

Week 2: Lesson 3

Topic: **Hard Water**

Objectives

By the end of the lesson, the student will be able to**:**

(a) define hard water and soft water

(b) demonstrate common ways of hardening and softening of water

Method: Group activity and classroom discussions

Materials: a cupful of water from different sources (bottled water, tap water, water from a pond, borehole, river, well, etc.), a teaspoon of salt, soap and source of heat.

Introduction and activity

Through classroom discussions, teacher introduces the lesson with explanations on the hardness and softness of water.

In their groups, students are presented with the same brand of soap and cups of water from different sources; well, borehole, rain water from a reservoir and tap water to demonstrate the level of hardness or softness of the water from different sources. They present their results on a graph sheet while being brainstormed on the local ways hardening and softening of water is done in the local community and why these practices are performed.

(a) Addition of alum

(b) Addition of salt

The groups are then presented with a teaspoon of salt each to demonstrate the hardness and softness of water again with cups of water from different sources. They present their results again on a graph sheet. They also demonstrate the softening of water in their various homes by boiling the salt water till the salt crystallizes out and the condensed water is collected.

Figure 3: An indigenous water filter

Teacher then facilitates students through the advantages and disadvantages of hardening and softening of water while brainstorming students on the local ways water was softened in their communities used like in Figure 3, an indigenous water filter which is used to filter water in the forests and farms for farmers and hunters in the absence of clear or purified water.

Summary

Teacher summarizes the lesson by elaborating through the hardening and softening of water

Exercise

1. What is hard water?
2. Demonstrate how you can soften temporary hard water to make it suitable for consumption in your local community.

Expected Results

1. Hard water is water containing high concentrations of dissolved minerals.eg. calcium
2. Temporary hard water can be softened by boiling. Boiling removes the water‟s calcium content, resulting in softer water.
    - Bring the water to a boil for a few minutes
    - Let it cool for a couple of hours, the calcium minerals should settle at the bottom of the pot
    - Siphon or scoop the top of the water, leaving calcium minerals behind.

Week 2: Lesson 4

Topic: Water filtration

Materials: a cupful of water from different sources (water from a pond, river, and shallow well) and source of heat.

Objectives

By the end of the lesson, the student will be able to;

(a) outline some common methods of filtering water in their local communities

Mode of teaching

Classroom discussions, demonstration and group activity

Introduction and Activity

Through classroom discussions, teacher brainstorms students on some methods used in filtering water in their local communities.

(a) Decantation

(b) Boiling

(c) Filtering with a clean cloth

Each method is discussed on how it is implemented and the common methods used in the local communities.

Boiling

Boiling is a traditional method of treating water. For people in rural communities, it takes one kilogram of firewood to boil one litre of water for one minute. It kills all germs that causes water borne diseases in water. Boiling is an old age satisfactory practice that was used and is still used in the rural communities.

Filtration

Filtration is also a traditional practice which when done correctly, improves the effectiveness of all the methods by pouring dirty or muddy water through a fine, clean cloth used to remove a certain amount of the suspended solids and filt. This method is very economical and mostly practiced in the villages.

Sedimentation

Sedimentation is when water is left to stand undisturbed for some time and then decanted of the clear water above leaving the waste substances underneath.

Solar Disinfection

This is when water is exposed to direct sunlight. Solar disinfection kills most germs that causes diseases with increased sun exposure time and mostly practiced in communities where wood is scarce. This method can be practiced with readily available materials but takes more time and requires sunny weather to be practiced.

The three Pot Method

The three-pot method reduces dirt and germs that cause diseases by storing water in containers, allowing the dirt to settle and moving cleaner water to different containers over time. This system greatly removes dirt and disease-causing germs in the water. This system is also low-cost ,easy to use and can be practiced with locally available resources.

In groups, students are presented with a clean cloth, cups of water from a shallow well, pond or river that had been left to stand for at least one hour to demonstrate decantation, boiling and filtration water filtering methods.

Students present their observations which leads to the discussion of the advantages and disadvantages of each of these methods.

Teacher ends the lesson by taking students through the steps for the treatment of water for public consumption.

Summary

Teacher summarizes the lesson by brainstorming the students on the various methods for water filtration and water treatment for public consumption

Exercise

1. List and explain 3 common methods used in filtering water in your local community

Expected results

1. Decantation: This is the process of separating immiscible materials by transferring the top layer into another container.
2. Filtration: This is the process in which solid particles are removed by the use of a filter medium that permits the fluid to pass through but retains the solid particles.
3. Boiling: it is the process by which a liquid turn to vapour when it is heated to its boiling point.

Week 3: Lesson 5

Topic: Soil Conservation

Objectives

By the end of the lesson, the student will be able to**:**

(a) list the principles of soil conservation

(b) outline with reasons at least two indigenous practices farmers undertake in our local communities to protect and conserve soil.

Method of Teaching

Classroom discussions, group work

Introduction and Activity

Teacher introduces the principles of soil conservation to students and brainstorms them on the local farmyard practices made up of soil fertility management practices, pest management practices, weed management practices and crop preservation practices that were commonly used in the local communities.

- These include mixed cropping, early planting (early planting to allows crops receive enough rainfall and reduce pests and diseases).
- Farmers prefer to plant green vegetables and millet on farms they burn grass or trash because the ash is assumed to be a source of nutrients and also burning is believed to kill crop pests.
- Farmers rely on crop rotation to rejuvenate the soil. Some root crops are highly perishable when harvested. When farmers harvest for example cassava and not all of it is consumed or sold, the fresh tubers are buried in moist soil measuring one foot deep, a practice which makes the tubers stay fresh for up to seven days. The common methods of processing cassava involve peeling, slicing, drying and storing in baskets. For bitter cassava varieties, it is peeled,

sliced and left to ferment indoors for three days. It is later dried, chopped and finally ground or pounded into flour.

- For grain crops like beans, farmers ensure that beans are planted as the second crop in the rotation system to rejuvenate the soil.
- Farmers also use concoctions of ash, goat droppings and water as insecticide to control pests and diseases. Ash is used as an important component for preserving specifically beans. Some farmers mix ash with water to form a light paste and add to the beans before storing in containers made from dry banana leaves, fibres and sticks. Currently however, this method is no longer common because such storage facilities needed to be kept outside and there have been rampant cases of theft. Others use anthill soil as manure because it helps to easily retain soil moisture.
- Farmers also put elephant grass flowers and neem tree leaves in beans because the scent produced by the plants species repels storage pests.
- Caterpillars were reported as the most important sweet potato pests. They are controlled by picking the infested leaves and burying them. Ash is sometimes mixed with animal liquid waste and sprinkled on vines. Farmers sometimes apply cow dung on potato vines and also rogue potato leaves. Lastly, farmers also carry out some form of rudimentary biological control of pests. They catch black ants and release them in sweet potatoes fields to eat the caterpillars.
- Farmers use various means at every stage of the plant growth to cope with the problems of soil fertility loss. This include making mounds by collecting and heaping trash in preparation for planting sweet potatoes, tobacco and vegetables which are preferably planted on raised seed beds. Farmers also add

crop residues like kitchen waste/refuse and manure from goats, chicken, and cattle to their fields and fallow plots to enhance nutrient status. Farmers mostly use elephant grass and maize stalks to conserve soil moisture and add manure after decomposition when mulching (Akullo, Kanzikwera, Birungi, Alum, Aliguma, Barwogeza, 2007).

Teacher then facilitates students through the classification and sources of soil nutrients.

Summary

The teacher summarizes the lesson by elaborating with the students through the importance of maintaining soil fertility and some practices that deplete the soil.

Exercise

1. Outline some of the principles of soil conservation
2. List 2 indigenous farming practices you know of in your community.

Expected results

1. Protection of soil from impact of rain drops

   To slow down the water from concentrating and moving down the slope in a narrow path

   To slow down the water movement when it flows along the slope

   To encourage more water to enter into the soil

   To increase the size of soil particles e.t.c…
2. Mixed cropping

   Shifting cultivation

Week 3: Lesson 6

Topic: Acids, Bases and Salts

Objectives

By the end of the lesson, the student would be able to**:**

1. list at least 2 common acids and bases and their sources
2. outline the preparation of local salt in their local community

Method of Teaching

Classroom discussions, group work

Teaching and learning materials: source of heat, salt water, tongs, beaker, test tube, litmus paper, an orange, vinegar, soap, wood ash arranged on the table.

Introduction

Teacher introduces to students about acids, bases, salts and their common sources. Teacher then presents an orange, vinegar, soap and wood ash to be sorted out as either acids or bases using litmus paper.

After 15 minutes, each group member presents their work to the whole class. Using the students‟ presentation as a foundation, teacher discusses with students the properties of acids and bases.

Teacher also presents to students bases that can be prepared in the local communities such as the ash of cocoa pods or unripe plantain peels, readily available acidic foodstuffs in their raw forms (raw plantain, cashew fruits and their nuts, raw cocoyam).

Teacher then brainstorms students on the local (solar) preparation of salt at Ada, Weija and Komenda in Ghana (sea water is pumped into shallow embarkments or pans as shown in Figure 4. A student living in Ada describes the local processes of salt mining in his local community.

- As the wind and sun begin to evaporate the water, the salt content is increased and the water is moved through a series of gates. When saturation is reached, deposition of the salt begins in the crystallisation pans or embarkments.

Three salt production methods used in Ghana

1. **Artisanal Salt Winning** – This mode of production is practised mainly in areas where the population has access to the large coastal lagoons of Keta and Songor. The practitioners of this method basically wait for the dry season when the lagoon dries up and salt is crystallized out. The lagoon bed area is then shared amongst the community members and on a given day, everyone goes onto the dry lagoon to harvest salt.
2. **Traditional Solar Salt Production on a small scale**

   This method is an improvement of the salt winning method where embarkments have been created to pump sea or lagoon water and allowed to stand to allow its salinity to increase. The water is then allowed to flow into crystallisers for it to crystallise into salt. The salt is then harvested and more water allowed into the crystallizers throughout the dry season.
3. **Modern salt production on a large scale**

   This method is the modern salt production method which involves fractional crystallisation of dissolved salts in lagoon or sea water in various ponds as the water is moved from evaporators through concentrators to crystallisers where sodium chloride is crystallised out. The range of salinity of the water in each of the ponds is regulated and is graded with the lower salinities in the evaporators and concentrators (which incidentally occupy about 90% of the land surface area).

Each group is then presented with a pair of tongs and test tubes of $2cm^3$ of brine to take turns at heating till all the water has evaporated. The students then observe and record their findings.

Figure 4: Salt mining activities in Ada

Summary

Teacher summarises the lesson through questions and answers on acids, bases, salts, their sources, properties and the preparation of salts.

Exercise

1. List 2 common acids and bases and their sources that you know of.

Expected Answers

1. Ash- from burnt wood

   Ascorbic acid- oranges

   NaCl- Sea food

Week 4: Lesson 7

Topic: Preparation of Black Soap

Objectives

By the end of the lesson, students will be able to:

1. apply the knowledge learnt from acids, bases and salts into the preparation of local black soap.

Method of teaching

Classroom discussions, field trip

Introduction and Activity

From the local soap preparation centre in Namong market, the students gather around the local women as they prepare "amonkyen", the local black soap through the following processes and in Figure 5:

1. Palm oil is heated to bleach it to make it ready for soap making
2. Burn empty cocoa pods/plantain skins to obtain ashes
3. The ashes are dissolved in water to obtain a solution of potash.
4. The potash solution is added to the hot palm oil, previously made
5. The mixture is boiled while stirring and soap is formed, foaming to the surface
6. Hot soap is scooped off and placed on a cooling table
7. Preferably, other additives maybe added such as fragrance, aloe vera, etc... may be added to the cooled soap before it is packaged for sale/use.

After the one-hour field trip, the teacher discusses with students their observations and experiences in the market about the preparation of black soap (alata samina).

Traditional black soap contains mainly water, cocoa pod ashes/plantain skins ashes and palm oil (ngu) or palm kernel oil (adwe ngu) boiled together to form soap. The procedure is as follows and in Figure 5 below:

Pure traditional black soap or alata samina is soft and high in natural glycerine content that makes it readily absorb moisture readily from the air. It must therefore be stored in dry locations or in plastic bags. Black soap exposed to air will have a thin coloured film which is caused by the absorption of moisture from the air. It is therefore advisable to keep it in dry locations away from moisture until ready for use.

Figure 5: Stages of African black soap preparation

Summary

Teacher summarises the lesson by summarising the soap preparation process and discussing with students the importance and uses of soap.

Exercise

1. List at least 2 basic substances that can be used in the preparation of soap.

Expected results

1. Ash from cocoa pod or lye

   Shea butter or glycerine

3.12 Post – Intervention Phase

At the end of the implementation of the intervention, a well-designed post-intervention test (twenty test items) on Measurement, Soil and Water Conservation and Acids, Bases was administered by the researcher. This test was similar to the one administered at the pre – intervention stage. This was done to measure the effect of indigenous knowledge incorporation on students" understanding and academic performance. A set of questionnaires was also administered by the researcher to evaluate students" attitudes before and after the implementation of the intervention. The results of the Pre-intervention test, post-intervention test and questionnaire were analysed and presented in the next chapter.

CHAPTER FOUR

RESULTS

4.0 Overview

In this chapter, the data collected from the questionnaires and tests are analysed. The data collected during the research has been analysed through of descriptive and inferential statistics and the results presented based on the research questions posed. Statistical analyses were carried out using SPSS version 16 for Windows and also Microsoft Excel. The results of the data analysis are presented in tables and figures.

A t – test statistic assuming equal variances was used for testing the hypothesis at 0.05% level of significance. The results of the data are presented in tables and figures.

The demographic characteristics of the students are presented first and the results of the analysis of the data from the research instruments are presented based on the research questions.

4.1 Demographic Characteristics of the respondents

The study sample was made up of 52 students out of which 30 were males and 22 were females. Below is a pie chart representation of the characteristics of the students in Figure 6.

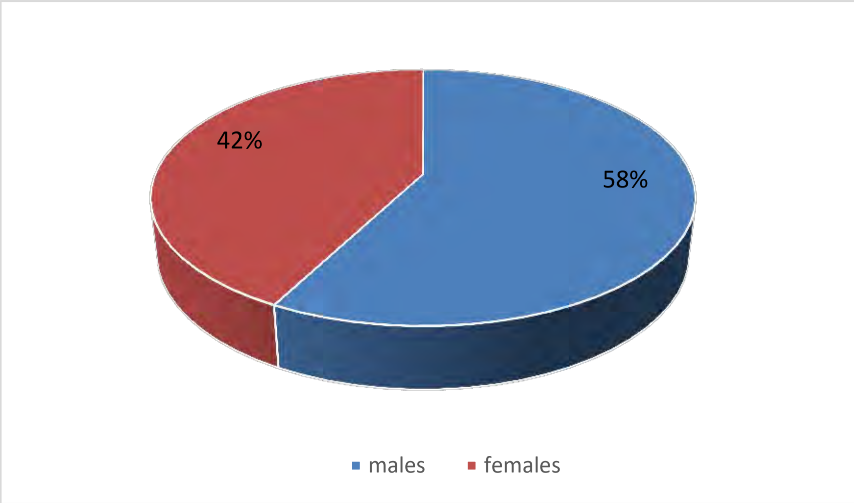

Figure 6: Pie chart representing the gender distribution of respondents

Figure 6.0 shows that for the study sample, 57.69% (n=30) were males and 42.31% (n=22) were females.

The age distribution of the respondents is shown in Table 2.

Table 2: Age distribution of respondents

Age	Frequency	Percentage
14-16	13	25%
17-19	27	51.92%
20-22	8	15.39%
23 and above	4	7.69%
Total	**52**	**100.0**

The dominant age group range was 17-19 years (51.92%, n=27), followed by 14- 16 years (25%, n=13), followed by ages 20-22 years (15.39%, n=8) and finally followed by ages 23 and above years (7.69%, n=4) respectively.

The results of the analysis of the data collected were presented along the research questions:

1. What is the knowledge level of SHS form two students in selected science topics before the integration of indigenous knowledge?
2. What is the effect of indigenous knowledge integration on students‟ performance in selected topics in integrated science?
3. What is the effect of integrating indigenous knowledge on students‟ attitudes in learning selected topics in integrated science?

4.2 Research Question One

1. What is the knowledge level of SHS form two students in selected science topics before the integration of indigenous knowledge?

The knowledge level of the students before the introduction of the intervention is shown in Table 3:

Table 3: The knowledge level of the students before the introduction of the intervention

Score	Frequency	Score	Frequency
0	1	10	3
1	2	11	0
2	3	12	2
3	7	13	1
4	8	14	1
5	10	15	1
6	6	16	1
7	4	17	0
8	1	18	0
9	1	19	0
		20	0
	∑f = 43		**∑f = 9**
Total			**52**

With the pre-intervention test made up of 20 multiple choice questions where 10 is the pass mark, Table 3 shows that 43 students (82.69%) failed by scoring between 0 and 9 in the pre-intervention test while 9 students (17%) passed by scoring from 10 to 20 as summarised in Table 4.

Table 4: Summary of the scores of the pre- intervention test.

Score (passed)	Score (failed)	Total
9	43	52
17%	82.69%	100%

Therefore, 82.69 % of the total number of students failed before the introduction of the intervention while 17.31% of the total number of students passed the pre-intervention test out of the total score which was 20 marks.

4.3 Research Question Two

2. What is the effect of indigenous knowledge integration on students‟ performance on selected topics in science?

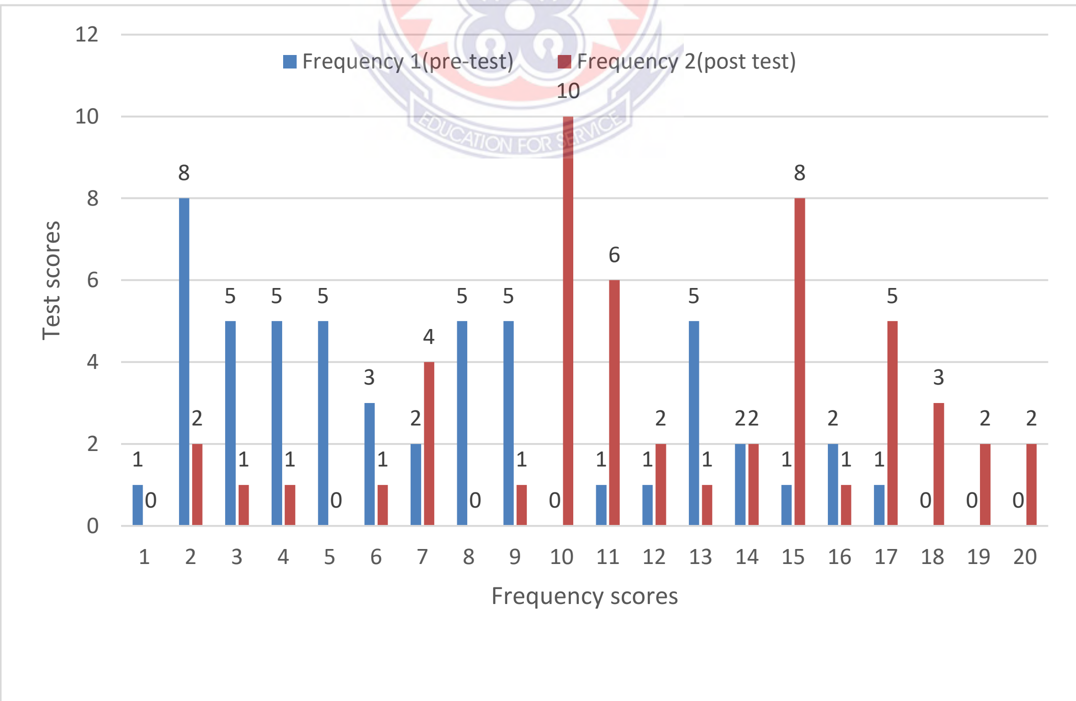

Figure 7: Bar graph of frequency scores of pre-intervention and post intervention scores

Figure 7 shows the frequency distribution on a bar chart showing a contrast between the pre- intervention and post-intervention scores.

With the tests made up of 20 multiple choice questions where 10 is the pass mark, 43 students (82.69%) failed by scoring between 0 and 9 in the pre-intervention test while 9 students (17%) passed by scoring from 10 to 20. Therefore, 82.69 % of the total number of students failed before the introduction of the intervention while 17.31% of the total number of students passed the pre-intervention test out of the total score which was 20 marks.

Meanwhile, after the intervention and from table 5, 10 students (19.23%) scored 9 and below while 42 students (80.77%) scored 10 and above confirming the increase in students" performance from the scores of the ot- intervention test.

Table 5: Summary of the scores of the post - intervention test

Score (passed)	Score (failed)	Total
42	10	52
80.77%	19.23%	100%

Hypothesis Testing

To determine whether there was statistically significant difference in the academic performance of students in selected science concepts after being exposed to indigenous knowledge, a null hypothesis was formulated.

Ho: There is no statistically significant difference in the academic performance of students before and after integrating indigenous knowledge to teach selected science concepts.

The one sample tail t-test analysis was employed and the mean score for the tests showed statistically significant difference (t (51) = 4.731; p<0.05). This is illustrated in Table 4.

Table 6: Results of t-test Analysis on the mean scores of the pre-intervention and post-intervention scores

Test	N	Mean Score	SD	df	t	p-value
Pre-intervention	52	5.846	3.455	51	4.731	7.924×10^{-13}
Post-intervention		10.577	2.906			

Both the pre-intervention and post-intervention test were scored over 20 marks with 10 marks as the pass mark. The mean score of the pre-intervention test was 5.846 (SD =3.455) whilst that of the post-intervention test was 10.577 (SD = 2.906), yielding a mean difference of 4.731. The result clearly show a difference in their academic performance after the intervention. The calculated t-test analysis was found to be statistically significant at 0.05 significant level (t (51) = 4.731; p= 7.924×10^{-13}), meaning that the difference between the pre-intervention test mean score and that of the post-intervention test was statistically significant. Therefore, the null hypothesis Ho which states that, „"There is no statistically significant difference in the academic performance of students before and after using indigenous knowledge to teach selected science concepts""" is rejected.

Hence indigenous knowledge in teaching and learning could significantly influence students" performance in science concepts.

4.4 Research question three

3. What is the effect of integrating indigenous knowledge on students" attitudes in learning selected topics in integrated science?

To find out the effect of indigenous knowledge on student"s attitudes in teaching and learning of selected topics in Measurement, Soil, Acids, Bases and Salts and Water, responses from the questionnaire administered at the end of the post intervention phase were computed and used to determine the effect of students" intervention on student"s attitude towards the learning of selected topics in integrated science. Table 6 shows frequency count and percentages of students" responses on questionnaires related to the attitude of students towards teaching and learning of selected topics in integrated science after the intervention stage.

From the Table 6, it could be seen that out of the 52 students, 28 (53.85%) students agreed, 15(28.87%) students were neutral while 9 (17.31) students disagreed that science was very difficult for them. Meanwhile, after the intervention, no student agreed to this same statement, 2(3.85%) students were neutral while 50(96.16%) students disagreed to it.

In answering questionnaire item two, 42(80.77%) agreed, 6(11.54%) were undecided while 4(7.7%) students disagreed that they will always be afraid of science. After the intervention, no student 0(0.00%) agreed to this statement, 1(1.92%) were undecided while 51(98.07%) disagreed to it.

Table 7: Students' attitude towards science after integration of indigenous knowledge in teaching

					Attitude towards science lessons	**After intervention**				
SA	**A**	**N**	**D**	**SD**		**SD**	**D**	**N**	**A**	**SA**
F (%)	**F (%)**	**F (%)**	**F (%)**	**F (%)**		**F (%)**	**F (%)**	**F(%)**	**F (%)**	**F (%)**
19 (36.54)	9 (17.31)	15 (28.87)	6 (11.54)	3 (5.77)	1. Science is very difficult	32 (61.54)	18 (34.62)	2 (3.85)	0 (0.00)	0 (0.00)
18 (34.62)	24 (46.15)	6 (11.54)	2 (3.85)	2 (3.85)	2. I will always be afraid of science	14 (26.92)	37 (71.15)	1 (1.92)	0 (0.00)	0 (0.00)
19 (36.54)	15 (28.85)	6 (11.54)	10 (19.23)	2 (3.85)	3. I hardly understand lessons in science class	16 (30.77)	35 (67.31)	1 (1.92)	0 (0.00)	0 (0.00)
2 (3.85)	7 (13.46)	15 (28.87)	20 (38.46)	8 (15.38)	4. I look forward to eagerly contribute in science lessons	0 (0.00)	0 (0.00)	2 (3.85)	39 (75.00)	11 (21.15)
3 (5.77)	7 (13.46)	11 (21.15)	17 (32.69)	14 (26.92)	5.Science class is one most interesting classes	0 (0.00)	0 (0.00)	3 (5.77)	7 (13.46)	42 (80.77)
16 (30.77)	14 (26.92)	13 (25)	8 (15.38)	1 (1.92)	6. Science concepts are different from my everyday experience in my environment.	4 (7.69)	48 (92.31)	0 (0.00)	0 (0.00)	0 (0.00)
14 (26.92)	26 (50)	9 (17.31)	3 (5.77)	0 (0.00)	7. Lessons in science class bored me	33 (63.46)	17 (32.69)	2 (3.85)	0 (0.00)	0 (0.00)

4 (7.69)	12 (23.08)	9 (17.31)	13 (25)	14 (26.92)	8. Lessons in science class are full of fun	0 (0.00)	0 (0.00)	3 (5.77)	45 (86.54)	4 (7.69)
5 (9.62)	6 (11.54)	1 (1.92)	21 (40.38)	19 (36.54)	9. I can apply my classroom science at home	0 (0.00)	0 (0.00)	0 (0.00)	5 (9.62)	47 (90.38)
1 (1.92)	2 (3.85)	5 (9.62)	28 (53.85)	16 (30.77)	10. Science is important to my future career	2 (3.85)	17 (32.69)	13 (25)	18 (34.62)	2 (3.85)

For questionnaire item three, 34(65.39%) students agreed, 6(11.54%) were undecided while 12(23.08%) disagreed that they hardly understand science lessons in class. After the intervention, no student (0.00%) agreed to this statement,1(1.92%) was neutral while 51(98.08%) students disagreed to it.

In item four, 9(17.31%) students agreed, 15(28.87%) were undecided while 28(53.84%) students looked forward to eagerly participate in class before the intervention. On the other hand, 50(96.15%) students agreed, 2(3.85%) were undecided while no student 0(0.00%) disagreed to eagerly participate in class.

In questionnaire item five,10(19.23%) students agreed, 11(21.15%) were undecided while 31(59.61%) students disagreed that the science class was one of the most interesting classes while after the intervention 49(94.23%) students agreed, 3(5.77%) were undecided and no student 0(0.00%) disagreed to the same item.

In questionnaire item six,30(57.69%) students agreed, 13(25%) students were undecided and 9(17.30%) disagreed that science concepts are different from their everyday experience while after the intervention, no student agreed or were undecided 0(0.00%) with all the students responses disagreeing to it.

In questionnaire item seven, 40(76.92%) students agreed, 9(17.31%) students were undecided and 3(5.77%) students disagreed that science lessons bored them while after the intervention, no student 0(0.00%) agreed, 2(3.85%) were neutral while 50(96.15%) students disagreed to the same item.

Furthermore, in questionnaire item eight, 16(30.77%) students agreed, 9(17.31%) were undecided and 27(51.92%) students disagreed that science lessons are full of fun while after the intervention, 49(94.23%) students agreed, 3(5.77%) students were neutral and no student (0.00%) disagreed to this statement.

11(21.16%) students agreed,1(1.92%) student was undecided and 40(76.92%) students disagreed that they can apply classroom science in their homes while all the students 52(100%) agreed to the same questionnaire item after the intervention with no student (0.00%) either being undecided or disagreeing to the same statement.

Finally, in questionnaire item 10, 3(5.77%) students agreed, 5(9.62%) students were undecided and 44(84.62%) students disagreed that science is important to their future career while after the intervention, 20(38.47%) agreed, 13(25%) students were undecided and 19(36.54%) disagreed to the same statement.

From the analysed data, the general trend in the responses from the pre-intervention show that students attitudes toward integrated science was unsatisfactory while the post- intervention responses show that students attitudes toward integrated science was very satisfactory.

Comparing the overall student responses before and after the intervention of integrating indigenous knowledge in selected topics in integrated science shows a slight attitude change and improvement in students" interest.

CHAPTER FIVE

DISCUSSION OF RESULTS

5.0 Overview

In this chapter, the results of the research questions from one to three are discussed.

5.1 Research Question One

- What is the knowledge level of SHS form two students in selected science topics before the integration of indigenous knowledge?

This research question sought to find out the content knowledge possessed by the students before the implementation of the intervention.

From Table 4 page 90, 43 students made up of 82.69% of the class scored below 10 marks while 9 students made up of 17.31% of the class scored above 10 i.e., between 10 and 16 out of the 20 marks.

Overall, the performance was poor. The findings of this study are congruent with those of Changeiywo (2000) and Aduda (2003) who in their study on the impact of indigenous Samburu community perception of science on student"s performance in chemistry reported that the performance of students who take science was below average.

The finding indicated that the students did not possess deep enough understanding on science concepts to be able to either aid their learning or serve as the basis for more scientific conception.

The reason for the low science content knowledge level could be attributed to inadequate linkage of science to students‟ relevant previous knowledge which serves as indigenous knowledge in our local communities that students are exposed to at the very beginning before classroom science. According to Jegede (1999), the mainstream paradigm of school success ignores the impact of socio-cultural elements on student learning, which is insufficient for understanding how African pupils learn science. He also goes on to state that, the indigenous worldview inhibits learners' initial adoption of Western science. Indigenous (non-Western) learners are involuntarily selective when making observations in science classroom. The indigenous learner may explain natural phenomena in ways that appear non-rational to Western science, but the learner experiences are no contradictions in his or her conceptual framework.

Stears et al. (2003) states that, relevant previous knowledge provides stronger connection to materials taught, deepening the level of interaction between learners and the teacher.

This finding agrees also with UNESCO (2006) on integrating African indigenous knowledge in Kenya‟s formal education system which expresses the need for a more participatory approach to education that involves communities. Part of what is stressed in these is the integration of cultural heritage and values as the grounding for education, perpetuated through transmission of indigenous knowledge. Diversity of knowledge should be valued and need not be reduced to the standards and epistemology of western perspective of knowledge base.

The study also confirms a study conducted by Banda (2008) „Education for all (EFA) and the African Indigenous Knowledge System (AIKS): the case of the Chewa people of Zambia‟ which found out that there was a gap between the school and the co which results from differences and sometimes contradictions between school and community cultures, different discourses and purposes of education, schooling; learning, and literacy between the Western education paradigms and local schools, lack of participation and collaboration among all stakeholders-traditional chiefs, local leaders, and elders in particular curriculum design and execution; a perceived lack of practical or relevant information on occupational skills in formal school curriculum; poor and sometimes non-existent vocational skills in formal school curricula and non-use of students' imagined indigenous knowledge in the educational curriculum

Graven and Schafer (2013) argue that knowing what the learners already know is critical since new information is acquired by connecting it to what they already know. Because when a familiar topic is offered, prior knowledge piques the learners' attention. It encourages learners to participate more actively in conversations during social encounters (Sedlacek & Sedova, 2017; Vygotsky, 1978). When instructors examine their students' past knowledge, they are honouring their socio-cultural backgrounds (Mavuru & Ramnarain, 2017; Stears, Malcolm, & Kowlas, 2003).

Results from numerous studies have shown that the use of indigenous knowledge not only enhances students understanding, but also increases their interest in learning in and out of the classroom.

5.2 Research Question Two

- What is the effect of indigenous knowledge integration in science teaching on students‟ performance in selected topics in integrated science?

  The frequency analysis of the pre- intervention and post-intervention scores showed an increase in students‟ performance where 42 students representing 80.77% of the sample scoring 10 and above which is the pass mark as compared to 9 students representing 17.31% of the 52 students who passed in the pre-intervention test.

The t-test analysis of the pre-intervention test and post-intervention test scores of the students before and after the intervention presented in Table 5 page 80 also showed that a statistically significant difference existed between the scores of the pre-intervention and post-intervention tests. The mean pre-test score before the administration of the intervention was 5.84. After the implementation of the intervention, the mean scores of students increased to 10.58, and this was recorded as the mean post-intervention test score. The improvement in the students mean post-intervention test scores after the intervention therefore indicated that the integration of indigenous knowledge in some science concepts had a positive effect on the achievement of the students.

The findings of the study thus supported the research hypothesis that there is a statistically significant difference in performance of students after the intervention.

These findings are in line with Millar"s (2004) study in which he found out that knowledge learned during practical activities is usually stored in the long-term memory of the learners. In addition, learners were also able to make connections between their everyday experiences and what they learned in the classroom. Kuhlane (2011) reiterates that relating learning to learners" everyday knowledge allows learners to learn scientific concepts in a comfortable and non-threatening environment.

Roschelle (1995) explains that learning mostly starts from prior knowledge and then learners learn from the presented materials. Teaching should start with the thoughts that are familiar to the learners. This is in the same vein that most of the materials that were used during these hands-on activities were those found in the learners" immediate environments. In this way, they were able to link learning of science to their real lives. From the studies above, it could be argued that learners were not aware that they could find acids and bases from their environment which could be used to teach these topics. Thus, bringing the materials in the classroom that these learners were familiar with enabled them to learn scientific concepts.

5.3 Research Question Three

- What is the attitude of students towards the integration and learning of selected concepts in science?

Findings with respect to research question three showed that there was a significant improvement and change in the attitudes of students towards the learning of integrated science.

In order to evaluate the effectiveness of indigenous knowledge in science education, the researcher analysed the responses of the questionnaire. From the students" responses, it was quite evident that the integration of indigenous knowledge positively affected students" learning by helping to promote a better understanding of concepts taught, challenging students to apply their knowledge to other new learning situations and providing opportunities for students to assess their learning progress. Analysis of students" responses also revealed that the intervention had a positive influence on the teaching of integrated science since it helped to adequately revise students" prior knowledge, stimulate their interests, engaged and focused their attention on topics and encouraged them to participate actively in class lessons.

The use of indigenous knowledge in science lessons fostered team work and cooperation among students. Learners love interactive learning because it is efficient, effective, and adaptable, according to Saleeb and Dafoulas (2011). It also promotes the comprehension of topics. In conclusion, the researcher believes that the use of indigenous knowledge in science teaching positively affects both the teaching and learning of science.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Overview

This chapter is made up of the summary of findings, recommendations for further studies and conclusions.

6.1 Summary

This study delved into the effect of indigenous knowledge on students‟ performance and attitudes in selected topics in integrated science. The following objectives guided the study to:

1. Investigate the knowledge level of students on integration of indigenous knowledge in selected integrated science topics.
2. Ascertain the effect of indigenous knowledge integration in science instruction on the performance of students in selected integrated science topics.
3. Assess the attitude of students toward the integration and learning of selected topics in integrated science.

To address these objectives, three research questions were formulated and a hypothesis which was tested at 0.05 level of significance. The research questions that guided the study were as follows;

1. What is the knowledge level of SHS form two students in selected integrated science topics before the integration of indigenous knowledge?
2. What is the effect of indigenous knowledge integration in science teaching on students‟ performance in selected topics in integrated science?
3. What is the attitude of students towards the integration of indigenous knowledge in the teaching and learning of science?

To determine whether there was statistically significant difference in the academic performance of students in selected science topics after being exposed to indigenous knowledge, a null hypothesis was formulated.

Ho: There is no statistically significant difference in the academic performance of students before and after using indigenous knowledge to teach selected science concepts.

The background of the study highlighted on the definition and basis of indigenous knowledge in Africa specifically Ghana, its relevance and how its integration in science curricula could benefit students understanding as opposed to solely western science.

The statement of the problem pointed to the fact that the declining achievement of students in integrated science as evidenced by the WAEC could be remedied by the integration of indigenous knowledge in the teaching and learning of science.

Literature relevant to the study in chapter two highlighted on the conceptual and theoretical frameworks of the study, the current mode of science education in Ghana, indigenous knowledge systems and their implications and problems affecting IK implementation in science in Ghana.

The research design used was the action research design. The sample used for the study comprised 52 year two students at Namong Senior High School, Offinso-Namong. The sample comprised one intact class of 30 boys (57.69%) and 22 girls (42.31%).

Instruments namely Science Achievement Test 1&2 and Questionnaire were used to collect data in this study. The Science Achievement Test comprised of 20 multiple choice items which covered selected topics in integrated science.

The Questionnaire comprised of ten items structured on a five-point Likert scale. The questionnaire was administered purposely to evaluate students‟ attitudes after IK integration in the classroom.

The intervention was administered over a period of 4 weeks and the data collected before and after the administration of the intervention were analysed using students t-test and descriptive statistics such as mean, standard deviation and percentages.

Knowledge level of SHS form two students in selected integrated science topics

The results from the study showed that the knowledge level of the students in the selected topics were very low considering their low performance in the pre-intervention test where only 9 (17.31%) students scored 10 and above while 43(17.31%) students scored below 10 which was the pass mark.

Effects of the integration of indigenous knowledge on students' performance in selected topics in Integrated science

The study revealed that integrating indigenous knowledge in an interactive learning setting had a positive effect on the students‟ performance in selected topics in integrated science. From the descriptive statistics, 42 (80.77%) students scored 10 and above in the post-intervention test as opposed to 9 (17.31%) students in the pre-intervention test signifying a huge increase in the performance of students. The results showed that the mean score before the intervention was 5.85, which rose to 10.58 as the mean score for the post-intervention after the administration of the intervention.

This indicates that, the intervention had a positive effect on the students" performance in the selected science topics which manifested in the improvement in scores and performance. Also, there was statistically significant difference that existed between the mean science achievement post-intervention test scores and the pre-intervention test scores. This therefore indicated that the indigenous knowledge integrated in selected topics in integrated science had a positive effect on the mean achievement scores of the students.

Attitude of students toward indigenous knowledge in the teaching and learning of selected topics in integrated science

Responses on questionnaire administered computed into frequency and percentages after the intervention clearly exposed the change in attitudes of students. The results showed that majority of the students had negative interest towards the teaching and learning of selected science topics before the implementation of the intervention. After the intervention stage, responses on questionnaire revealed that there was a slight improvement in the attitudes of students towards teaching and learning of selected topics in integrated science. Therefore, the integration of IK has a positive effect on the teaching and learning of science. This conclusion was derived based on the evaluation questionnaire that was administered at the end of the intervention.

6.2 Conclusion

From the results, it can be concluded that the teaching of western science is in isolation, teaching indigenous knowledge integrated in integrated science promoted a better understanding of concepts and consequently enhanced students" achievement in science. This conclusion is evidenced by the comparatively higher mean achievement post-intervention test score attained after the intervention. Indigenous knowledge integrated in integrated science promoted understanding of science topics by the students. It also makes students aware that science is what they see and interact with in their environment in the community.

The final conclusion made in this study was derived from students" responses to the items on the questionnaire. It can be concluded that the integration of the indigenous knowledge in science has a positive effect on the teaching and learning of science. Out of the total of 52 students, more than half of the students agreed to the fact that the use of the integration of indigenous knowledge helped to promote a better understanding of concepts in science. This was clearly reflected by their mean achievement post-intervention test scores which was significantly higher than their pre-intervention test scores.

6.3 Recommendations

Based on the results of the study, the following recommendations are made;

1. The Municipal Head of Education should initiate in-service courses for science teachers in Namong Senoir High Technical School to equip them with the skills of Indigenous Knowledge so as to enhance their effectiveness in teaching of science subjects.
2. Learning of integrated science and other science subjects in senior high school curriculum should not be taught in isolation but hand in hand with indigenous knowledge. This could help students interpret their cultural beliefs in scientific phenomena to modern science hence enhancing understanding in integrated science and other sciences.

3. Students in Namong Senior High School should be exposed to more practical activities using locally available materials so that they can perform simple scientific analysis and relate it to their applications in real life situations.

6.4 Suggestions for Further Research

1. The study concentrated on the influence of indigenous knowledge on students" performance in selected topics in integrated science in Namong Senior High School. Such a study should be done at the primary level and Junior High School to investigate the effect indigenous science on students" performance in integrated science.
2. Indigenous knowledge in integrated science should be studied at the senior high school level of education to determine its influence on students" performance in other science subjects such as biology, physics and agriculture.
3. In order to increase the scope of generalization, this study should be replicated in other senior high schools in Ghana.

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APPENDIX A

UNIVERSITY OF EDUCATION, WINNEBA

POST-INTERVENTION QUESTIONNAIRE

Introduction and instructions

The following questionnaire is part of a study been conducted for a Master of Philosophy degree. You are required to respond to the items as sincere as possible. The information that you will provide will only be used for the purpose of research and will be kept confidential. Therefore, **do not write your name on this questionnaire**. Please note that there are no rights or wrong responses to these items but what is only appropriate to you. The questionnaire is made up of two parts, part A is designed to collect personal information and part B is also designed to collect general information. Each item is followed by five options; choose the option that best describes your opinion by indicating a tick (√) in the appropriate box.

Section A

School: ……………………………………………………………………………………….

Date of Birth (Dd/Mm/Yy): ………………………………Age……………………

Gender: Male ☐

Female ☐

Section B

Note the Scale:

SA – Strongly Agree

A – Agree

N - Neutral

D - Disagree

SD - Strongly Disagree

Before intervention					Interest towards science lessons	After intervention				
SA	**A**	**N**	**D**	**SD**	1. Science is very difficult	**SD**	**D**	**N**	**A**	**SA**
					2. I will always be afraid of science					
					3. I hardly understand lessons in science class					
					4. I look forward to eagerly contribute in science lessons					
					5.Science class was one most interesting classes					
					6. Science concepts are different from my everyday experience in my environment.					
					7. Lessons in science class bored me					
					8. Lessons in science class were fun					
					9. I can apply my classroom science at home					
					10. Science is important to my future career					

APPENDIX B

UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE ACHIEVEMENT TEST 1 (PRE-INTERVENTION TEST)

Name of participant………………….. Date:……………… Class………..……

GENERAL INSRUCTIONS: This test contains ten (10) questions. Answer ALL.

1. Water boils at ……………….. C and feezes at ………….. C
   (a) 0°C, 100°C (c) 50°C, 100°C
   (b) 100°C, 50°C (d) I00°C, 0°C

2. Choose the odd one out from the following properties of acids.
   (a) They have sour taste
   (b) They turn blue litmus paper red
   (c) They turn red litmus paper blue
   (d) They react with bases to form salt and water

3. Which of the following is **not** an importance of measurement?
   (a) It prevents overdose and underdose
   (b) It prevents cheating
   (c) It promotes fairness
   (d) It promotes time wastage

4. Which of the following ways aids in the softening of water?
   (a) Addition of bicarbonates (c) addition of alum
   (b) Addition of salt (d) addition of excess lime

5. All the following are components of soil except
   (a) Rubbish (c) air
   (b) Water (d) inorganic matter

6. The following are attributes that can be measured from your body except
   (a) Weight (c) time
   (b) Height (e) temperature

7. Which of the following ways depict measurement in the olden days?
   (a) Using a vernier calliper (c) using a micrometre screw gauge
   (b) The rule of thumb (d) using a beam balance

8. The following are or may cause errors in scientific experiments except
   (a) Parallax error (c) defects in instruments
   (b) Zero error (d) reading from the bottom of the meniscus of liquids

9. Water is considered as a universal solvent because
   (a) It dissolves many solutes
   (b) It dissolves many solvents
   (c) It dissolves less solutes
   (d) It dissolves less solvents

10. All the following are essential elements required for plant growth except
   (a) Potassium (c) nitrogen
   (b) lithium (d) phosphorus

11. The reaction between an acid and a base to form salt and water is called….
   (a) Neutralisation reaction (c) oxidation reaction
   (b) Chlorination reaction (d) reduction reaction

12. Which of the following leads to soil depletion?
   (a) Mulching (c) Fallowing
   (b) Leeching (d) agroforestry

13. HCl is found in which part of the human body?
   (a) Brain (c) rectum
   (b) Small intestine (d) stomach

14. Pick the odd one out of these methods of softening hard water.
   (a) Boiling (c) decantation
   (b) Filtration (d) addition of baking soda

15. All but one of the following are properties of soft water
   (a) It has pleasant taste (c) It does not form scum
   (b) It easily lathers with soap (d) it is suitable for the dyeing of clothes

16. The following are attributes of fertile soil except...
   (a) Dark brown in colour (c) rich in organic matter
   (b) Brick red in colour (d) rich in humus

17. Fat or oil is added in the production of soap because
   (a) It aids in saponification of the soap (c) it allows the soap to harden
   (b) It makes the soap greasy (d) it increases the basic content of the soap

18. All the of the following are uses of water except
    (a) Drinking (c) washing
    (b) Ploughing (d) cleaning

19. The following are methods of maintaining soil fertility except……
    (a) Mixed cropping (c) application of fertilizer
    (b) Cover cropping (d) soil erosion

20. Which of the following instruments is used for measuring length?
    (a) Beam balance (c) micrometre screw gauge
    (b) Vernier callipers (d) metre rule

APPENDIX C

UNIVERSITY OF EDUCATION, WINNEBA

SCIENCE ACHIEVEMENT TEST II

(POST-INTERVENTION TEST)

Name of participant………………….. Date:……………… Class………..……

GENERAL INSRUCTIONS: This test contains ten (10) questions. Answer ALL.

1. All the following are possible errors that may occur during measurement except
   (a) Parallax error (c) using the right tool for the right job.
   (b) Wrong calibration of instrument (d) zero error

2. The unit for power is known as
   (a) Energy (c) watt
   (b) Joule (d) ampere

3. The following are derived quantities except
(a) Volume (c) force
(b) Density (d) length

4. Which of the following measuring instruments can be used to measure the volume of kerosene?
(a) Spring balance (c) Measuring cylinder
(b) Beam balance (d) lever-arm balance

5. All the following are sources of hard water except
(a) Shallow well (c) rivers
(b) Sea (d)rain

6. ……………… leads to the depletion of soil
   (a) Soil erosion (c) afforestation
   (b) Green manuring (d) tiling

7. Which of the following fertilizers known to be inorganic?
   (a) Compost (c) guano

(b) Liquid manure (d) basic slag

8. Measurement is important because ….
   (a) It leads to overdose and underdose
   (b) It encourages precision
   (c) It promotes subjective opinions
   (d) It encourages cheating
9. All the following are methods for filtering water except
   (a) Decantation (c) distillation
   (b) Stirring (d) evaporation

10. All the following are sources of organic acids except
(a) Apples (c) milk
(b) Palm oil (d) stomach
11. The system of farming in which a mixture of crops is grown on the same piece of land is known as ……………
(a) Mixed farming (c) cover cropping
(b) Mixed cropping (d) mulching

12. Pick the odd one out of these agents of soil erosion
(a) Water (c) human beings
(b) Wind (d) trees

13. Water losses in soil can be controlled by all but one of the following
(a) Mulching (c) surface mining
(b) Cover cropping (d) tiling

14. Which of the following is a characteristic of soft water?
(a) Soft water has a sweet taste (c) it lathers well with soap
(b) It has ions in it (d) it promotes the formation of shells of eggs and snails

15. Which of the following is the chemical formula table salt?
   (a) $NaCl$ (c) Mg_2Cl
   (b) $CaCl_2$ (d) Na_2SO_4
16. Pure water has a pH of
(a) 4 (c) 6
(b) 5 (d) 7

17. All but one of the following are factors influencing soil erosion
(a) Rainfall (c) vegetation cover
(b) Soil texture (d) famine

18. Soil fertility can be conserved by all the following except
(a) Farming activities (c) fallowing

(b) Application of fertilizer (d) mulching

19. One of the properties of acids is that, …..
    (a) Acids turn blue litmus paper red
    (b) Acids turn red litmus paper blue
    (c) Acids are slippery in nature
    (d) Acids have bitter taste

20. During the dilution of an acid, always …..
    (a) Add water to acids (c)base to acids
    (b) Add acids to water (d) acids to bases

APPENDIX D

MARKING SCHEME FOR APPENDIX A

SCIENCE ACHIEVEMENT TEST 1 (PRE-INTERVENTION TEST)

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

(Scoring: 1 mark each) **Total score = 20 marks**

APPENDIX E

MARKING SCHEME FOR APPENDIX B

SCIENCE ACHIEVEMENT TEST II (PRE-INTERVENTION TEST)

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

(Scoring: 1 mark each) **Total score = 20 marks**

APPENDIX F

Maranatha Assemblies of God

P.O. Box 138, A/R- Offinso

11th September, 2020.

The Headmistress,

Namong Senior High School

Offinso.

Dear Madam,

PETITION TO CONDUCT RESEARCH IN YOUR SCHOOL

My name is Priscilla Wepea Achare, a teacher in your school and a student of th University of Education Winneba pursuing Master of Philosophy in science education. I write to you to seek for your approval to conduct research in your school.

The rational for this research is to enhance students" performance in a wide range of science concepts by integrating indigenous knowledge.

I hope my request meets your kindest consideration.

Yours faithfully,

Priscilla W. Achare.

APPENDIX G

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF INTERGRATED SCIENCE EDUCATION
P. O. Box 25, Winneba, Ghana
ise@uew.edu.gh
+233 (020) 2041077

Our ref. No.: ISED/PG.1/Vol.1/9
Your ref. No.:

Date: 11th March, 2021

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION
MISS ACHARE, PRISCILLA WEPEA

We write to introduce, Mr Achare is a postgraduate student of the Department of Integrated Science Education, University of Education, Winneba, who is conducting a research titled:

Incorporating Indigenous Knowledge in Science Instruction and its Effect on Students' Performance in Selected Science Concepts

We would be very grateful if you could give him the assistance required.

Thank you.

Yours faithfully,

DEPT. OF INT SCIENCE EDU.
UNIVERSITY OF EDUCATION, WINNEBA
P. O. BOX 25
WINNEBA

ALEXANDRA N. DOWUONA
PRINCIPAL ADMIN. ASSISTANT
For : HEAD OF DEPARTMENT

www.uew.edu.gh