UNIVERSITY OF EDUCATION, WINNEBA

FACTORS THAT IMPEDE THE FORMATION OF BASIC SCIENTIFIC CONCEPTS IN STUDENTS: A CASE STUDY AT THE MANKRANSO SENIOR HIGH SCHOOL

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MASTER OF EDUCATION

2022

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A Dissertation in the Department of Science Education, Faculty of Science Education, Submitted to the School of Graduate Studies, in partial fulfilment of the requirement for the award of the degree of Master of Education (Science Education) in the University of Education, Winneba

NOVEMBER, 2022

DECLARATION

CANDIDATE'S DECLARATION

I, MICHAEL KWADWO BOAKYE, hereby declare that this dissertation, with the exception of quotations and references contained in published works which have all, to the best of my knowledge, been identified and acknowledged, is the result of my own original research work and that no part of it has been presented for another degree in this university or elsewhere.

SIGNATURE: …………………………………...

DATE: ……………………………………..……...

SUPERVISOR'S DECLARATION

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

SUPERVISOR'S NAME: DR. ROSEMARY NAANA KUMI-MANU

SIGNATURE: …………………………………………

DATE: ……………………………………..……...……

DEDICATION

This piece of work is dedicated to my parents Mr. and Mrs. Oduro Asare, my siblings, my Grandfather Mr. Boakye as well as my wife Mrs. Agnes Boateng for their immense contribution towards this round of my education.

ACKNOWLEDGEMENT

I wish to express my profound appreciation to the Almighty God who made it possible for this project to become a reality. My sincere appreciation also goes to my supervisor

Dr. Rosemary Naana Kumi-Manu for making this project work a success through her guidance and supervision. May the Good Lord richly bless and replenish to her anything lost in this regard.

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ABSTRACT

This study sought to investigate the factors that impede the formation of basic scientific concepts in students in the Mankranso Senior High School. The simple random selection was done to select one class from departments with multiple classes in Mankranso Senior High School for the study and made available a sample of one hundred and ninety-five (195) respondents for the study. The purposive sampling approach was used to select four (4) science teachers out of accessible population of 122 teachers in the school. Descriptive survey design and a five- point Likert -type scale questionnaire backed by focus group interviews and field observations were used to collect data from respondents. Statistical Package for Social Sciences (SPSS, Version 20) was used to analyse the data collected. The data were then represented in tables using descriptive statistics. The result showed students have developed poor attitudes towards science and 80.0% of them offer to read science only because it is a compulsory subject, also,75.0 % of science teachers could not employ laboratory experiments at all in their lessons as facilities were so limited and thus reserved for only students reading elective science courses. The attitude of students towards science has been generally poor and could lead to poor concept formation. There is still opportunity to raise students' interest through the use of laboratory activities to supplement teaching scientific concepts, the adoption of participatory teaching methods and creative pedagogical skills by science teachers; and provision of study materials to students. These could stimulate the interest of students to learn integrated science as a subject and cause them to gear attention towards it. It was therefore recommended that Government of Ghana through the Ministry of Education and Ghana Education Service (GES) should provide requisite teaching learning materials to the school to enable teachers to adopt the participatory approach that would foster concept formation in students. Also, it has been recommended that Government of Ghana and its Stakeholders should consider building more laboratories in schools to increase accessibility to non-science students and teachers to help intensify practical activities and improve concept formation in students.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter considers the background to the study and a written statement of the problem. It continues with the purpose and the objectives of the study. It also explores the research questions that this research is dedicated to solving as well as the significance of the study. To add to it is the limitations and delimitations of the of the study which are also discussed under this chapter.

1.1 Background of the Study

Science is a compulsory subject studied in the basic schools as well as the senior high schools in Ghana. For better understanding of basic scientific principles and their application to real life situations, science at the Senior Secondary School level, is clarified into chemistry, biology and physics. These aspects are handled by teachers with specialized and advanced knowledge in their respective fields. The introduction of integrated science as a compulsory subject in the senior high schools in Ghana is to raise the level of scientific literacy of all students and equip them with the relevant basic scientific knowledge needed for their own living and also for making valuable contributions to production in the country. It is also aimed to provide excellent opportunities for the development of positive attitudes and values in the youth such as experimentation, correct recording of data, reasonable deduction making, etc. (GES Teaching Syllabus for Integrated Science, 2010). These basic skills that science instills in its learners are deemed very important for the development of the nation.

The world as a global village needs scientifically literate people. According to Ministry of Education (2003) no nation can grow and develop without science and technology. This is because the development of a nation's economy is directly linked to the development of the study of science and technology. As such, developed countries like Britain, Japan, America and Russia have become economic giants due to the application of science and technology in their daily activities. This means that human resource in science and technology needs development and this starts from the school.

In view of this, the Ghanaian government has made science and technology the pivot of its development plan (Ghana National Association of Teachers, 1996). Therefore, it was envisaged in the Vision 2020 policy document of Ghana that, the nation would be at a better position in the development of science and technology where production of finished products would characterize the economy leading to reduction in unemployment rate. Important as science has become in the current stage of development, it is undeniably one of the most difficult subjects when students consent is sought. The Chief Examiner for West Africa Examinations Council, Ghana (WAEC) in his 2018 report for WASSCE in Integrated Science stated that, 'the standard of the paper compares favorably with that of the previous year (2017). However, the performance of candidates was poor compared to the previous year (2017). Also, he added that candidates have poor knowledge of scientific terms and conventions as applied in science'. The chief examiner's report made mention of the fact that students find it difficult responding to basic life science problems. This may be attributed to poor concepts formed or in some cases no concept at all formed by students of Integrated Science which may be due to some challenges. These challenges may include inadequate concept development, inappropriate methods of teaching, lack of teaching and learning materials, lack of teaching laboratories, nonavailability of reference materials, etc. Once the student does not form basic concepts and develops negative attitude towards the subject, they become helpless.

According to World Bank (2004) the most widely recognized challenge to school improvement comes from deeply entrenched instructional practices that make students memorize a great deal of information with the limited purpose of reproducing it in examinations. In many schools, science is taught with the conventional method of teaching and listening by teachers and students respectively. This method of teaching makes it difficult for most students to understand, grasp and apply scientific principles to their daily lives. As such, they end up memorizing facts without understanding the principles behind them (Sarfo, 2009).

Among other things, the perception of students on science as a subject, the availability of teaching and learning materials, and well-equipped scientific laboratories, as well as teachers' pedagogical skills in impacting the requisite knowledge using available materials and facilities are also important factors. It is thus imperative that this study explores these variables in an attempt to explore the impediments to concept formation in integrated science at the Senior High School level in Ghana.

1.2 Statement of the Problem

It has been observed by the researcher that students especially non-science students' performance in Integrated Science at Mankranso Senior High School is continuously falling. The analysis of 2018 WASSCE results of Mankranso Senior High School revealed that the percentage pass was 63.10% as against 72.05% of 2017 in which cases D7 and E8 are passes in WAEC grading system. This shows a significant decline in the performance in integrated science revealing that as much as 152 out of the 412 students presented in 2018 had F9 and as much as 80 and 158 students had D7 and E8 respectively in Integrated Science.

Information gathered from tests and terminal examination scripts of students of Mankranso Senior High School where the researcher teaches indicates that students' performance in Integrated Science relative to other subjects is very poor. In view of this, the question of the availability of teachers with the requisite pedagogical skills, presence and utility of scientific laboratory, and other teaching and learning materials, as well as, student's perception (psychological consideration) on integrated science as a subject need to be addressed. Therefore, this study seeks to answer such questions in an attempt to investigate the factors that impede the formation of basic scientific concepts in students at the Mankranso senior high school.

1.3 Purpose of the Study

The purpose of the study was to investigate some of the factors that impede the formation of basic scientific concepts by Mankranso Senior High School students. This study is also conducted to find out the possible factors that negatively affect science teacher's strategy of teaching and science concept development of students and to make recommendations for improved performance.

1.4 Objectives of the Study

The objectives of this study include the following

1. To find out students' attitudes and perceptions about integrated science and its effect on their science concept formation.
2. To find out whether science teachers teach using laboratory experiments to aid concept formation

3. To find out the appropriate teaching strategies that can be adopted by science teachers that acknowledge, accommodate and provide for the student prior to learning experiences.

1.5 Research questions

This research work seeks to answer the following questions:

1. What are the attitudes and perception of students on the teaching and learning of Integrated Science?
2. To what extent do science teachers use laboratory experiments to aid concept formation?
3. Which strategies do science teachers use in presenting their lessons to acknowledge, accommodate and provide for the student prior to learning experiences?

1.6 Significance of the study

This research is aimed at giving a clearer picture of the reasons why there is decline in the performance of students in Integrated Science. Possible solutions to the reasons will be sought for improved performance. The findings will be of enormous help to Mankranso Senior High students in the sense that they will be well equipped with the basic scientific concepts that will help them to increase their knowledge, prepare them for the task in the classroom, and also help them for further studies.

Findings from this research will be relevant in guiding science teachers in the Mankranso Senior High School to present science lessons using methods that enhance formation of relevant science concepts by students for better understanding and applicability of science.

1.7 Limitations of the Study

The research was limited to Mankranso Senior High School in the Ahafo Ano South West District in the Ashanti Region of Ghana. This is just one school out of the lot in Ghana, generalizations made from this study may therefore not be the same as those in different locations with different characteristics.

1.8 Delimitations of the Study

This research targets 195 students sampled from the Mankranso Senior High School in the Ahafo-Ano South West District comprising of General Science, Arts, Visual Arts, Home Economics, Business and General Agriculture students from the second-year batch of the Mankranso Senior High school. The researcher deemed it important to use the second-year students as they were available in school during the study period.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

In this chapter, the importance of science is discussed, as well as various definitions of concepts provided by various authors, the characteristics of concepts, various descriptions of concept formation, and the conditions under which concepts are formed are also considered. It also elucidates the various types of concepts and the strategies that teachers must employ when dealing with them. The chapter attempts to explain conceptual change, as well as the perspectives of some educational philosophers on the subject, as well as how learning should proceed in the face of conceptual change and the factors that can cause it. Finally, the chapter discusses problem solving under the steps involved in problem solving and various definitions of problem solving.

The chapter is discussed under the following headings;

- ✓ Science and its implications to society
- ✓ Meaning of concepts
- ✓ Types of concepts
- ✓ Concept formation
- ✓ Factors affecting concept formation
- ✓ Conceptual change and facilitation
- ✓ Problem solving

2.1 Science and its Implications to Society

Jegede (1980) defined science as a body of knowledge and process of acquiring knowledge. He emphasized that science is the major instrument for solving problems of society. The most basic goal of teaching integrated science, according to the Ghana

Education Service Integrated Science teaching syllabus (2010) is to provide the student with basic problem-solving abilities within his/her immediate environment through analysis and experimentation. This fundamental goal of integrated science learning necessitates that students learn science not just for examination purposes, but also to use scientific concepts in problem solving in their contexts. DeBoer (2000) is also of the view that, students of science have to grasp the science concept to be able to manipulate parameters in their environments and apply scientific methods in solving problems of society. All approaches on scientific learning argue that students must create relevant concepts in order to understand and apply the science they learn in their settings.

2.2 Meaning of Concept

Various definitions are given by many researchers to concepts and for that matter, science concepts. Some of these descriptions are stated below.

According to Roets as cited by Sarfo (2009) 'the opinions of people are articulated by way of words, images, signs, symbols, and concepts. Roets (1995) further explains that science concepts are the symbols, impressions and knowledge representing concrete objects and abstract ideas in the field of the natural sciences. Carey (2000) defines concepts as mental representations that, in their simplest form, can be expressed by a single word, such as plant or animal, alive or dead, table or chair, apple or orange. Carey further states that, two concepts could be combined to form a third representational structure. One example of the latter is "density," which is defined as "matter per unit volume." This is an example of a notion that can stand on its own yet is the result of the interaction of two other concepts. More sophisticated ideas, such as "the theory of natural selection," can describe an entire notion. Concepts, in other words, allow us make deductions and explain even more complex ideas within a specific representational system. Thus, concepts can serve as building blocks for more complicated or even abstract representations. According to the preceding description a concept is an idea of how something is or a principle involving how something should be done.

Bernard (1966) describes a concept as a person's impression of an object or situation he or she draws on his or her total knowledge in order to work out how the object or situation is constituted. Arends (1991) emphasizes that concepts are the basic building blocks for thinking particularly, higher-level thinking in any subject, and concepts allow individuals to classify objects and ideas and to derive rules and principles, in addition to providing foundations for the ideal networks that guide our thinking. In view of this, it will be interesting to conduct research to investigate the extent to which students acquire appropriate scientific concepts, because the acquisition of appropriate scientific concepts enables students to demonstrate the necessary library skills as well as those required for processing, organizing, and integrating data. Arends (1991) also emphasizes that generalizations are founded on conceptual commonalities. These parallels are referred to as key characteristics of the various concepts. Every concept, such as an atom, is defined and explained in science based on its critical qualities. Atoms are distinguished from other ideas such as molecules by the features and qualities that cause us to refer to something as an atom.

The development of a sound logical framework aids students in the formation of good scientific concepts. Students who understand science concepts perform better in science tests and in other courses. It is frequently observed that proficiency in science mirrors performance in other relevant topics. Child (1981) is also of the opinion that, concepts are best defined by their characteristics or attributes. He enumerated seven of these characteristics;

a. Concepts are generalizations, which are abstracting particular sensory events, and critical attributes. They are not the actual sensory events but merely representations of some aspects of these events in the mind.
b. Concepts are dependent upon previous experience such as home background, educational opportunity, and emotional perceptional connections.
c. Concepts are symbolic in human beings in form of words, numbers, chemical symbols and physical formulations.
d. Concepts can form 'horizontal' or 'vertical' organizations. For example, horizontal classification can be things such as reptiles (snakes, lizards and crocodiles) which belong to the same major group of animals simply because they possess attributes in common. Vertical classification can be due to the presence of hierarchies or categories, which increase in complexity as one, proceed through the classification. For example, cats, bears, panthers and seals, which are all flesh-eating mammals.
e. Concepts are terms or abstract words emanating sub-consciously by extension or intention. These are concepts, which have common agreement and acceptance or having special significance with no universal acceptance. For example, concepts which have extensional use are those words whose meanings have widely acknowledged meanings. Concepts with intentional use are those concepts, which vary from person to person due to personal or subjective experience of an individual.
f. Concepts may be irrational, because their origins are obscure and based on unusual methods of concept formation from reality.

g. Concepts formed without conscious awareness; these are values established by our culture, which in one way or the other influence our daily conduct of life formed as habits from childhood without our realizing it. For example, prejudices, dislike for certain foods, attitudes towards religion may be implanted in a person for life. (Sarfo 2009).

In view of this it will be prudent for a researcher to investigate how concepts that have intentional use impede the formation of basic scientific concepts by students.

Arends (1991) again indicated that science concepts are mental organizations about the world that are founded on similarities between objects or events. They are ideas that have been generalized from specific cases. When we develop concepts, we take note of the fact that, while things in a collection may differ, they also have certain characteristics. These comparable qualities serve as the foundation for categorizing the items into concepts. Based on the above considerations, a concept might be defined as an idea of how something is or a principle involving how something should be done.

2.3 Types of Concepts

According to Sternberge and Ben-Zeev (2001) there are at least five forms of expressing concepts. These forms are: Concrete concepts, Abstract concepts, Verbal concepts, Non-verbal concepts and Process concepts. They explained that concrete concepts may be seen, touched, or heard. In other words, they have some direct sensory input, such as a plant, computer hardware, or a dog. In contrast, abstract conceptions are thought that have no direct sensory input unless through metaphor or analogy, such as chemical reactions and friction. Verbal concepts are sometimes thought of as classes of ideas or objects that are best understood and exploited through language, such as chemical bonding and equilibrium. These examples may also be classified as abstract concepts since they have no direct sensory input. Therefore, types of concepts may overlap. Non-verbal concepts are often thought to be best understood; making mental pictures to represent their critical attributes and examples are, the atom and electrons. The process of painting mental pictures to aid learning and production is often referred to as visualization or modeling. Non-verbal concepts include perimeter, area, volume, and mass. Mechanisms such as photosynthesis or atomic reactions are represented by process concepts.

Abdullahi (1982) contends that concepts exist in two kinds, empirical and theoretical. Empirical concepts are observable or demonstrable and can be operationally defined. They can be measured relatively, for example diffusion, freezing, volume, pressure, density, speed, velocity, acceleration, potential energy, etc. Theoretical concepts are non-observable, and do not lend themselves well to perception, and are not directly measurable. For example, atoms, cell, genes, protons etc. As a result, it was therefore imperative that the researcher explore the barriers that impeded students from acquiring and implementing empirical or theoretical concepts, as well as design strategies that can be used to assist students in grasping theoretical and empirical concepts. Abdullahi (1982) continues to emphasize that every individual builds his or her world on concepts. They come in all types and some are much more significant than others. As one learns and experiences new things, he or she draws upon and increases his or her conceptual “store houses” and this increases knowledge (Sarfo, 2009).

2.4 Concept Formation

Human Beings will constantly put old concepts to use and in the process, frequently extend them and acquire new, related ones (Sarfo, 2009). It is good to know that concept acquisition, formation or development has no end. This is so because at any time in a person's life, a new concept can be acquired provided the person is psychologically tuned. According to Novak (2010) the chain of concept usage, enlargement and revision is continuous as long as we are able to think. Everyone learns concepts, whether they like to or not. Concepts enrich as well as extend and order our psychological worlds. Many concepts such as table are, acquired because they have functional value; useful for something we need or use or want to do. The process of acquiring and using new concept is described as concept formation. According to Sarfo (2009) Concept formation is the process of integrating a series of features that group together to form a class of ideas or objects. He explained that developmentally, a younger child might define a bird as any object that flies in the air. The first time this child sees an airplane in flight, he may point to the sky and say, "Bird!" The observant parent or caregiver might correct the child by saying, "No that's an airplane. Birds fly but they have feathers. Airplanes fly but they don't have feathers." (Sarfo, 2009). This in effect means that the old concept is modified to suit the experience of the child hence forming a new concept of airplane.

According to Roets (1995) the formation of concept in the cognitive structure is not purely a result of direct observation and past experience, but cognitive process such as organization; interpretation and combination of thoughts. Therefore, concept formation and development of thought go hand in hand and there is gradual progress from naïve egocentrism to adult logic and objectivity. The implication is that the way a person thinks invariably affects the way the person forms concepts. In view of this, the study focused on the factors that account for the student's adherence to naïve egocentric ideas and find it difficult to progress to logical and objective standpoints. Arends (1991) describes concept formation as the acquisition of conceptual skills in one's cognitive framework. This means that concept formation is an interpretation of understanding of what have been experienced. Individuals internalize their experience in a way which is partially their own. They construct their own meanings. These personal "ideas" influence the manner in which information is acquired. From another perspective, a concept is formed when certain qualities and relationships are seen repeated in a number of successive experiences. Through several trials you can identify what qualities and relationships make a given concept (Arends, 1991). The implication is that students make observations of events and give their interpretations for such observations and the strategies used to acquire new information. All these help the students to form concepts.

In view of this it became expedient to investigate the observational skills of the student with the view of finding out how these skills affect the way they form concepts in Science.

Zirbel (2001) contends that learning is a mental process that depends on perception and awareness, on how addition stimuli and new ideas get integrated into the old knowledge database (a process Piaget called 'assimilation'), and on how, through reasoning (a previously acquired mental mechanism), the entire database gets re-organized, which results in alternations of the mental structures and the creation of new ones (a process called 'accommodation'). Zirbel (2001) continues that adding new information is the first part of learning and so the whole learning process involves the integration, re-organization and creation of new mental structures. This implies that, whenever one refers to an object that is not present or an activity that is not going on; the impression of these must be created in the mind of the person. Dirkx (2001) made mention of the fact that learners construct their own meanings and these personal ''ideas'' influence the manner in which information is acquired. In view of this it is obvious that the students' already existing concepts, experiences, logic and objectivity will affect how they form scientific concepts. As such it is relevant for the subject masters to discover the already existing concepts and modify them in the acquisition of a new one. According to Arends (1991) a concept is formed when certain qualities and relationships are seen repeated in a number of successive experiences. Through several trials you can identify what qualities and relationships make a given concept. The implication is that students make observations of events and give their own interpretations to the observations. The teacher can however guide the students to make better and more scientific deduction from observations. This requires the students doing enough practical work in the form of laboratory experiments and hands on models. Possibly the most important role of concepts is cognitive economy (Rosch, 1978). Imagine if there were no concepts we would have to learn and recall the word that represents each individual entity in our world. For example, each type of table, automobile, or tree would need its own name in order for us to learn and communicate about it in any meaningful way. The size of our mental vocabulary would be so large that communication would be nearly, if not outright, impossible (Smith, 1988).

Sternberg and Ben-Zeev (2001) intimated that one way to promote concept formation is to preview the various concepts students would meet during the school year or school day or a lesson as cited in Sarfo (2009). They suggested the following strategies;

a. Teachers are to present learners with the definition of the different types of concepts, telling them which type they will see most and least often in class.
b. Teachers are to provide learners with examples of important concepts of each type taken directly from their textbooks, class syllabi, and/or outlines.
c. Teachers are to help students to develop a firm sense of the critical attributes that define individual concepts, making clear that each concept (i.e., separate) may share some critical attributes with other concepts. Writing the critical attributes on one side of a flash card and the concept on the other side may help them to collaborate with others or go off by themselves to learn the attributes. The concept flashcards may also help students to retrieve the concept from memory.

Zirbel (2001) contends that learning is a mental process that depends on perception and awareness, on how addition stimuli and new ideas get integrated into the old knowledge database (a process Piaget called 'assimilation'), and on how, through reasoning (a previously acquired mental mechanism), the entire database gets re-organized which results in alternations of the mental structures and the creation of new ones (a process called 'accommodation'). Zirbel (2001) continues that adding new information is the first part of learning and so the whole leaning process involves the integration, re-organization and creation of new mental structures. This implies that, whenever one refers to an object that is not present or an activity that is not going on; the impression of these must be created in the mind of the person. Arends (1991) describes concept learning as the process of constructing knowledge and information into comprehensive cognitive structures. Grotzer (1999) stated that in the cognitive sciences the term "deep understanding" generally refers to how concepts are "represented" in the student's mind and most importantly how they are "connected" with each other. Representations are generally made in the form of images in simple cases, and in the forms of models in more abstract situations. Deep understanding then means that the concepts are well represented and well connected. As such deep understanding of a subject involves the ability to recall many connected concepts at once, where every single concept has a deep meaning in itself. Zirbel (2001) stated that deep thinking involves the construction of new concepts and is almost always based on what the student already knows. When a learner "makes sense" of new material he is able to make the connections between different concepts. Ausubel (1963) asserts that language adds additional meaning to an already acquired concept. His focus is on both images and language. Ausubel (1963) also recognizes that the two stages, imaging and verbalizing, may occur simultaneously, especially in older children. As children learn to increase their verbal conceptual bases, their ability to comprehend written material also increases.

From the above it can be deduced that the ability to form science concepts depends upon the learner's own background and the conditions under which the learners learn. In a well-organized course of study, concepts formed early in the year are used to develop new concepts that occur later. Concepts are most easily acquired when familiar and concrete perceptual materials are used.

2.5 Factors that Affecting Concept Formation

Concepts as defined are formed by everybody of any age. There are many factors that affect the concepts formed by a person. Some of the factors that affect concept formation and for that matter science concept formation are elaborated below.

2.5.1 Vocabulary

Henderson and Wellington (1998) succinctly put it that, "The quality of the classroom language is bound up with the quality of learning". Wellington and Osborne (2001) further explain that "language development and conceptual development are inextricably linked. Thought requires language and language requires thought". These extremes are enumerating the importance of vocabulary to learning and concept formation. Fraser, Meir and Le Roux (2000) reported that poor vocabulary and command of the English Language made the majority of learners to find it difficult and even impossible to express themselves in terms of their own experiences and capacities. The issue of language also impacts on the formation of concepts. To cite word for nature in Japanese and the word with which nature is translated, "Schizen", has a very different culturally based connotation (Cobern, 1996). Mensah (2002) argued that the formation of all concepts is determined by the cultural, religious and language background of the learner. It could therefore be hypothesized that the cultural, religious and language background of the learners, in part, determine the formation of all concepts, regardless of the learning area to which they apply. Oxford (2003) also reports that language proficiency adds additional meaning to already acquired concepts. His focus is on both imagery and language. He also recognizes that the two stages, imaging and verbalizing, may occur simultaneously, especially in older children. As children learn to increase their verbal conceptual bases, their ability to comprehend written material also increases.

With reference to science education, Wellington and Osborne (2001) underlines that research findings indicate that language, in all its forms, matters to science education. In particular, it is not just the language in itself but rather what educators do with language. This is because what educators do with the language inadvertently affects how the learner uses the language and that is fundamental to the learning of science. With countries like Ghana where English is learnt as a second language, the difficulty many students may face is differentiating between the everyday meaning and scientific meanings of words. Henderson and wellington (1998) exposed this by saying "For many pupils the greatest barrier to learning science is the language barrier". One of the major reasons why language becomes a barrier to Limited English Proficiency (LEP) learners is because scientific terms, whether technical or non-technical, are unique in nature and they are seldom encountered in other contexts or in English as a Second Language instruction. According to them the meanings the words hold in everyday English is not exactly the same as the scientific meaning. An example of his explanation can be seen in the scientific term "force". Coercion intending to influence action is referred to as force. So, a student might say "don't force me" with a meaning. Scientifically, force will be defined as pull or push on a body and mathematically expressed as product of mass and acceleration. Another example is "work". Work is used in everyday life to represent any task that is done. Scientifically however, work is done when force is moved through a distance. As such a man holding a 5kg rice bag is seen doing no work scientifically.

According to Kim (2007) one of the key factors in helping LEP students achieve greater progress in learning science is the role played by the science teacher in lowering the language barrier. This is because according to her, language is a great barrier to students' learning. Some school of thought asserts that thoughts and ideas are associated with words. Different languages promote different ways of thinking and language does not completely determine thought but does influence it (Gozzi, 1989). This implies that limited vocabulary means limited cognitive activity. Language is important in many cognitive activities, such as memory and thinking. O'malley and Chamot (1990) also reported poor vocabulary and command of English Language as major problem to concept formation. By this, it is obvious that the proficiency of students in English language can be a barrier to their science concept development. Kim (2007) advocated for teaching of life sciences in local languages. She emphasized that thought begins in the local language and so when students are thought in their local languages, they will be able to connect to the concept being taught and make representations mentally of it. Teaching science in local languages have advantages over teaching it in second language but most of the local languages lack appropriate vocabularies for scientific terminologies.

2.5.2 Practical work

In another development Sirestarajah as cited in Sarfo (2009) reported that 'practical work forms an integral part of physical science. In his work in the Republic of South Africa, he reported that most schools in Venda had no laboratories for practical work. Teachers use the telling method which makes students learn by rote without understanding the concepts. As such, they cannot apply their knowledge to real-life situations. He further on suggested that when science is taught through experiments with improvised apparatus, students' learning occur in various domains of science education. Meaningful learning leads to the understanding of scientific concepts, and students construct their own knowledge, apply it to any situation and enjoy learning the subject' as cited in Sarfo (2009).

Kirschner (1992) enumerated the importance of practical work in concept formation but also stressed on the negative effect of practical work on students. He made mention of the fact that students engaged in practical work often get so embroiled in the details of what they are doing that they often miss the underlying principle. He and other concept researchers argued that science concept formation should not be dependent on practical work.

2.5.3 Culture and Environment

Some learners have difficulty understanding scientific concepts because they do not have the necessary conceptual, logical and linguistic background (Gagliardi, 1997). Other environmental factors that determine who the student has become are his social and emotional learning and upbringing. The language and culture certainly affect his characteristics, personal habits, and preset ways of thinking. The parents, specific mentors, relatives, peer opinions and interactions also affect his character and might influence personal beliefs. For example, various cultures provide culturally specific explanations for particular phenomenon. Some researchers found that some children's conceptions of the universe are intertwined with elements of theology and mythology that were passed on to them by adults, this even affects the beliefs of even highly educated adults, a way of presenting cultural traditions.

Taylor, Tobin and Cobern (1996) argue that the complexity of the composition of the learner corps in multi-ethic schools needs to be recognized and that a socio-cultural matrix needs to be adopted in terms of teacher and student beliefs about teaching and learning and modes of forming concepts in science. Social class, gender and ethnicity are additional factors associated with concept formation and learning. Kuhn (1993) reported that there is considerable diversity in student's current knowledge and that the diversity contradicts accepted views, and that much of this diversity seems to be unresponsive to instruction. The intellectual activity of the student is greatly affected by the student's current knowledge. From these findings, one can deduce that the early environment of children appears to be in sowing and nurturing the seeds of science and that the early environment of the teacher trainees was taken into consideration by the researcher. In doing so, however, they must recognize that there might be different views of the same and that those views must be respected. When different views are expressed, students must listen to and understand these views, and negotiate common meanings. Cobern (1996) acknowledged the fact that various modes of social and cultural interactions are present during concept formation. The implication of the above is that socio-cultural interactions may affect the formation of scientific concepts by students.

2.5.4 Curriculum

Eugene (1995) explains that much of the concept learning in schools is based on the curriculum of the school programme. Each day, students face a wide range of problems to be solved and not all problems are found in the science textbook. Younger children face word decoding and science calculating problems, early adolescents stare down growing time and materials management problems, and adolescents confront complex social situations and important decisions about what to do after high school. Solving problems such as these will require using the products of other areas of higher order cognition such as concepts, creativity, and critical thinking. Duit and Treaquest (1995) in their contribution explain that learners' naive concepts show a marked resistance to change. Thus, the naive concept that the students have may pose as obstacle to their understanding and formation of concepts of science. An effort was made in this research to identify some of the naïve conceptions that the students possess. Sangstad and Raaheim (in Gorman, 1947) maintain that cognitive errors may be eliminated by identifying, evaluating, and carefully classifying appropriate and relevant information. An adequate amount of recent information is needed to provide a complete background to the problem. Moreover, Qualter (1996) asserts that social class, gender and ethnicity are some of the factors that affect concept formation and learning. It was therefore, imperative that the researcher investigated the students background in Integrated Science and how it affected the formation of concepts in science.

Based on the literature the factors that influence children's concepts formation include age of the child or stage of cognitive development, genetics, peer groups, learning environment, language of teaching, the learning material, the child's experiences, previous knowledge, reinforcement and motivation and teaching methods. It was imperative for the researcher to find out how the language of teaching science impeded the formation of science concepts.

2.6 Conceptual Change and Facilitation

Hewson (1982) describes conceptual change as the process in which the person changes his or her conceptions by capturing new conceptions, restructuring existing conceptions or exchanging existing conceptions for new conceptions, (that is a process of conceptual change). When children reach school age and are given formal instructions, the previous concept retained in their minds may be naïve, incomplete, tentative or incorrect, and may interfere strongly with what the teacher is trying to convey (Victor & Lerner, 1971). They explained that most of the time teachers present information in science classes in an expository manner. Additional information will come from textbooks, films, videotapes and other sources. A small fraction of class time will be devoted to laboratory work. This state of affairs is not conducive to overcome the misconceptions. Conceptual change is the process of overcoming ones' misconceptions and adopting the correct concepts (Victor & Lerner, 1971).

In the constructivists view knowledge is a dynamic conceptual means of making sense of experience rather than a passive representation of an extant world. They stress that each person must individually construct meanings of words and ideas if they are to be truly useful (Treagust *et al,* 1996). The key features in the constructivists' view of learning as cited by Sarfo (2009) are:

a. The student's head is not empty
b. There are interactions between pre-existing ideas and new experiences and phenomena
c. Learners attempt to make sense of new experiences and phenomena by constructing meanings
d. Learners do not therefore, have to only assimilate new concepts but also develop,
e. modify and change existing ones.
f. The constructivists' view of learning can therefore be summarized as follows:
g. Learning outcomes depend not only on the learning environment but also on the knowledge that the learners possess.
h. Learning involves the construction of meanings. Meanings constructed by learners from what they see or hear may not be those intended. Construction of meaning is influenced to a large extent by the existing knowledge.
i. Construction of meaning is a continuous and active process.
j. Meaning, once constructed, is evaluated and can be accepted or rejected.
k. learners have the final responsibility for their learning
l. There are patterns in the types of meanings learners construct due to shared experiences with the physical world and through natural language.
m. The essence of one person's knowledge is the result of a personal interpretation of experience that is influenced by such factors as the learners' age, gender, race, ethnic background and knowledge (Treagust *et al*, 1996).

Lumps and Staver (1995) argue that the degree to which a learner will be prepared to consider and modify an existing concept will depend solely on how plausible the new concept is and how the learner is dissatisfied with the existing concept. This state of affairs is commensurate with the notion held by constructivist that all learning is a process of personal construction so that learners can construct scientific concepts if they are given the opportunity and also if they find out that the scientific concept is superior to the previously held concepts. Learning is generally understood to entail changes in a learner's knowledge where such changes are attributed to experience (Lump & Staver, 1995). Brown and Palinesar (1986) describe conceptual change as learning characterized by dramatic restructuring of the existing knowledge base. It is therefore worthy to note that, for a learner to be able to undergo conceptual change or a restructuring of the existing knowledge base, it is presupposed that prior concepts must be held. These prior concepts held by the learners may be alternative understanding about phenomena or they may be scientifically incorrect interpretation that the learners believe or an error in the explanations of phenomena constructed by the learners in response to the learner's prior knowledge and experience. This constitute misconception, and it can be due to the fact that the learners received insufficient or incomplete explanations and experiences about the phenomena or learners being exposed to misconceived meanings of phenomena or from the information handed on to the learners from the society. All these point to the fact that the learners have their own ideas that convey personal constructions and these ideas may be incomplete or contradictory and these ideas are often very stable and highly resistant to change. For such learners, who hold misconceptions, conceptual change is most likely to occur when and only when the new concept is intelligible and appear to be coherent and intellectually consistent, plausible and appear to be reconcilable with other aspects of the learners' view of the world (Treagust *et al,* 1996).

Johnstone and Qualter (1996) stated that children develop intuitive or informal conceptions about the world through experience and interaction with the natural and social environment. Often these conceptions, (also referred to as misconceptions, alternative concepts and alternative frameworks) are in contrast to prevailing scientific views. Abimbola (1988) has documented that naïve conceptions held by learners show a marked resistance to change. This issue constitutes one of the main learning obstacles in relation to learning areas in which the learning and understanding of concepts form an essential component. Cobern (1996) contends that a concept has an influence if it is central in an individual's prevailing worldview and scope if it has relevance for the individual over a wide range context. This view consequently makes provision for a variety of cultural connotations in relation to concept formation and adherence to concepts.

In view of this research to investigate the student's prevailing worldview with regard to the relevance of the concepts in science they learn will be of immense interest to the development of science education. This is in line with the constructivist notion that learners will construct scientifically orthodox concepts of natural and physical phenomena if given the opportunity and if they see that the scientific concept is superior to their pre-instructional conception. When learners are given formal instruction, the previous concepts retained in their minds may be naïve, incomplete, tentative or incorrect, and may interfere strongly with what the teacher is trying to convey. Such misconceptions are amazing, tenacious and difficult to change. As children construct their world from observation, trial and error, experiences, instruction from classroom teachers, words of wisdom from their parents, and numerous other sources, they form concepts to how the world works and behaves. Being pragmatics, children use the knowledge they have gained to explain the unfamiliar things they encounter. If the information seems to offer satisfactory explanation and it appears to work for them, it becomes ingrained in their behavior. As cited by Sarfo (2009). It can therefore be concluded that through formal and informal experiences learners develop ideas about events, objects and organisms. This implies that:

- ✓ Learners have explanations about their world
- ✓ Learners' current concept of their natural world influence what and how they learn science
- ✓ The concepts that the learners hold may be inadequate when compared to scientific explanations.

It is important to emphasize from the above implications that the most important single factor influencing science learning is what the learners already know. As a result, it was important for the researcher to investigate the students' knowledge of scientific facts, information, and concepts. In addition, the investigation was carried out to determine the level of involvement of the students during science lessons.

The researcher had to conduct this investigation because the students had already studied science in junior high school and had absorbed certain facts from their surroundings. They may have obtained knowledge that is inaccurate, naive, and resistant to change. This state of affairs might be a factor that could impede the formation of basic scientific concepts. Zirbel (2001) however argued that whether or not a student is going to undergo a conceptual change depends not only on the complexity of the concept itself, but also on the character and upbringing of the student, that is, it involves his entire personality, his general cultural and personal belief systems, his acquires and inherited intellect, his ability to follow and think through arguments and his personal attitude towards undergoing conceptual change. To form new concepts or change old inadequate ones the student has to be led through several processes. First, he has to consciously notice and understand what the problem is; second, he has to assimilate more information and try it into already existing neutral networks; third, he has to critically think through all the argumentation in his own words and reorganize this thought, he has to accommodate the knowledge and evaluate against his prior beliefs; and finally, he has to work towards obtaining fluency in the newly acquired and understood concept so that this concept itself has then becomes a mere building block for future, more advanced concepts. The premise here is that during the process of conceptual change, the student's mind undergoes reorganization, the formation of new neural networks, and the rewiring of old ones. This process is difficult to initiate and necessitates a significant amount of effort on the part of the learner. If we want the learner to go beyond conceptual change, we must ask him not just to willingly modify his opinion, but also to integrate the newly acquired knowledge into his neural thinking network to the point where it may be used to generate other concepts based on that full knowledge. The development of conceptual change has been outlined (Zirbel, 2001)

Step 1: Acknowledging the new information

Let us assume new material is presented. What will register with the student? If the student has an already existing network, he might pick up on a certain thought pattern, similarly, to how, for example, we might pick up on a certain sound we might like to hear. If the "sound" is somewhat unusual, chances are that we will notice it. If the sound is familiar, we will only notice it if we pay particular attention to it, otherwise it might be heard with the unconscious and might not get officially registered. This same is true with particular ideas that the student might encounter, if the idea does not stand out on its own, it might go undetected and become unintelligible.

Step 2: Filing and assimilating the new information

This is the point where the student will have to do some real thinking. Clearly, this depends also on how the student has previously learned to think through problems. What he has to do in his brain is to make some minor adjustments to the already existing networks and try to fit in the new information. At this stage the student is still assimilating the knowledge.

Step 3: Evaluating and accommodating the new information

At this state the student will be challenged profoundly. How, will he defend his beliefs? How strongly rooted are those beliefs? How many networks are activated while the student thinks through the problem? What methods does the student use to argue his way through the problems, this too requires the usage of already existing networks of "how" the student thinks, so it is both, his knowledge and his methods of thinking that are being challenged. Ultimately, what will have to happen is that the old and the new information have to be combined and critically evaluated. The new information has to be logically integrated into student's prior knowledge database.

During this process new neural circuits are being created and old circuits have to be rewired, after all, the prior beliefs do no longer fit together into the newly created networks. This might be a little different to forming new concepts, they involve the creating of new network, and perhaps tweaking the existing ones, conceptual change, however, involves all, creating new networks, tweaking existing ones, and disconnecting and disposing of no longer correct information and methods of thinking. In other words, to some degree, it involves almost complete rewiring and reorganizing thoughts and the neural networks.

Step 4: Enhancing the fluency

At this stage the newly established circuits will be ready to be used by the student at ease and without much effort, in other works the new knowledge and newly acquired way of thinking has become part of the students' foundation of robustly wired circuits. In fact, this circuit now has become a building block for further concepts. (Sarfo, 2009).

2.6.1 How to facilitate the process of conceptual change

Zirbel (2001) further mentions how a good teacher can help facilitate the process of conceptual change in the following steps.

Step 1: Hooking the student (acknowledging information)

From an educational perspective, it is the task of the educator to ensure that the particular idea does get noticed efficiently. In terms of teaching this might mean that if a new idea is presented the student might need to be told explicitly to pay attention, or is somehow forced into consciously noticing the particular idea that is being presented. In other words, the new idea has to be dressed up enough so that it gets noticed and preferably also so that the student is initially intrigued by it enough to want to know more.

Step 2: Suggesting bridges (assimilating information)

Again, this might be the place where a good educator can help the student. Although the student himself has to do the job of assimilating the new knowledge, a good educator might help with meaningful analogies that the student is already familiar with. This might help the student organize his ideas and help activate those networks that will be used later to help solve the problem.

Step 3: Querying and confronting the student (accommodating information)

The step of thinking through the problem, understanding it, and more importantly evaluating it, is the hardest part for the student. It requires the reorganization of knowledge, the creating of new neural circuits, and the rewiring of old ones. This is something a teacher cannot do for the student, and his help can only be relatively limited. The student has to be on his own. A good teacher comes in with two things, first he can guide them through the new explanations so that they really do make sense, and second, he can help them reject prior beliefs by having the student explain to him why they no longer work. Finding out exactly where the prior theory is defective might help the student, but unfortunately only if the student really is also willing to let go of his prior beliefs. Furthermore, what a good instructor can do at this stage is to continually challenge the student, provided the student is willing to be challenged.

Step 4: Practicing and constructing (familiarizing information)

The work of the teacher certainly does not finish with helping the student understand why his prior theory is not appropriate and why the new theory is so much better. Maybe the student even ends up agreeing and accepts the conceptual change, but this still does not mean that the student can readily apply his newly acquired skills. The student needs to practice, and this is a point where the teacher definitely can help again. He needs to provide the student with meaningful examples and other problems that involve the newly acquired concept. The idea is to make the student feel at ease with the new concept. In fact, further challenges might be appropriate here, examples that go beyond just regurgitating the problem, that involve applying the new knowledge and testing it (Sarfo, 2009). According to Akpan (1992) the interaction between the child's different ideas and the manner in which these ideas are used depends on effective teaching. Akpan asserted that cognitive scientists have proposed a model which is based on the hypothesis that information is stored in memory in various forms called "schemes".

A scheme denoted the diverse things or ideas that are stored and interrelated in memory. These 'schemes' also influence the way a person may behave and interact with the environment, and in turn may be influenced by feedback from the environment. This model of organization of schemes integrated with mental structures can be used to describe the acquisition of a new piece of knowledge or concept. The manner in which a new piece of information is assimilated is determined by the nature of the material as well as the structure of the learner's schemes. As a result, the identical experience presented to students in science lessons may be processed differently by each individual. According to Akpan (1992) these representations of scheme organization and scheme acquisition may account for the existence of personal conflicting and stable beliefs. The consequence of the above is that when a student expresses numerous contradicting concepts, various schemes are employed. As a result, when learning science, a student may notice an event that contradicts his or her assumptions and does not fit into his or her scheme.

However, the student may not be able to restructure his ideas immediately. To help the student to accomplish such reorganization in their thinking about natural phenomena, the following strategies have been suggested;

- ✓ The science teacher should give a wide range of experiences relating to the key ideas to be restructured.
- ✓ Teachers need to be aware that each student in his class may form a different concept from the same teaching. Some may form meaningful concepts and others may form inadequate or erroneous concepts. The teacher should use evaluation techniques to help find out which students need to repeat the same experience.
- ✓ The teacher must take time to help students to understand the meaning of a concept or word as it is used in a particular situation or context.
- ✓ Every teacher should have a repertoire of illustrations that indicate the importance of developing a meaningful vocabulary as part of the learning process.
- ✓ An important part of the child's science education is learning how to express his ideas in words that are meaningful not only to children but also to other people in the community (Sarfo, 2009).

2.7 Problem Solving

Ausubel (1968) defines problem solving as an operation in which both cognitive representation of past experience and the components of the current problem situation have to be reorganized in order to attain a particular objective. Problem solving, therefore, is an attempt to find an appropriate way of attaining a goal when the goal is not readily available, in this case, forming the right concept. The steps in solving problems are:

- ✓ Find and frame problems,
- ✓ Develop good problem-solving strategies,
- ✓ Evaluate solution and rethink

- ✓ Redefine problems and solutions overtime.

The ability to solve problems depends on the extent to which a person undergoes a conceptual change and this led to concept formation, which is a prerequisite for problem solving. The ability to form concepts correctly, therefore, reflects the extent to which a person is able to employ effective strategies to solve problems (Darko, 2004). It is therefore important for science teachers to guide students to find solutions to problems by following the principles that are outlined below:

- ✓ students should make use of all available alternatives.
- ✓ Students should discover a system of relations underlying solutions and promote their own principles.

According to the preceding, students are discouraged from thinking independently if teachers provide too many hints to the correct solutions. This is due to the students' inability to employ their own thinking abilities. In view of this, students should be allowed to participate in a series of activities aimed at discovering a meaningful means-results link, which is fundamental to problem solving. Levine (1999) stated that obstacles to solving problems include being fixated and not being adequately initiated. Being fixated means focusing on prior strategies and failing to look at a problem from fresh, new perspective. Functional tiredness is a type of fixation in which an individual tries to solve a problem in a particular way that has worked in the past. Levine continues to emphasize that problem solving is the systematic use of a stepwise approach to answering complex questions or addressing difficult issues. He listed the following as the critical steps in problem solving as cited in Sarfo (2009):

- ✓ Recognizing a problem when you see a problem

- ✓ Stating exactly what the problem is
- ✓ Searching memory to see if a similar problem has been dealt with in the past
- ✓ Searching and using prior knowledge and experience to solve the problem
- ✓ Preview the desired outcome
- ✓ Decide if the problem can be solved
- ✓ Break the process of attaining the desired outcome into a series of steps
- ✓ Conduct research
- ✓ Consider alternative strategies for solving the problem
- ✓ Select the best strategy
- ✓ Talk oneself through the task
- ✓ Pace yourself
- ✓ Monitor progress
- ✓ Manage difficulties
- ✓ Stop when the problem is solved and
- ✓ Reflect on the effectiveness of the problem-solving process and store it away in long term memory for later use (Levine, 1999).

To conclude students must create their own personal cognitive toolbox full with challenges that will work for them. As a result, the researcher studied the extent to which the students had formed their own problem-solving procedures, which is an essential component of scientific concept formation.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the research methods used in the study. This chapter focuses on the research design, the population, the research method, the research procedure and the ethical issues as well as the instrumentation of the study. This chapter continues to talk about the validity and reliability of the instrument. It finally focuses on the data collection procedure and data analysis

3.1 Research Design

A research design according to Yin (2013) is the strategy that explains how the samples will be gathered and what will be done with the samples in order to derive conclusions about the research. A research design is a study plan that provides the broad structure for gathering data to answer research questions.

Appropriate research design is necessary to answer the research issues under consideration. Various research designs were discovered in the quest for a suitable design, however for this research, the researcher chose to use descriptive survey research design to investigate the factors that impede the formation of scientific concept in students. Descriptive survey research design is an approach of descriptive research that blends quantitative and qualitative data to provide you with relevant and accurate information. A descriptive survey design engages the people at the center of the research objective (Ary, 2010). The descriptive survey research method was used because it helped the researcher to obtain the opinion of the representative sample of the target population which was used to infer the perception of entire population.

3.2 Population

According to Avwokeni (2006) population of the study is a set of all participants that qualify for a study. The target population usually has varying characteristics and it is known as the theoretical population. The accessible population is the population in research to which the researchers can apply their conclusions. This population is the subset of the target population and is also known as the study population.

The research focused on obtaining detailed information about some of the factors that impede the formation of basic scientific concepts. The participants were drawn from Mankranso Senior High School which happens to be the only senior high school at Ahafo Ano South West district in Ashanti region. The school has population of about two thousand, eight hundred and forty-five (2,845), one thousand, six hundred and sixty-three males (1,663) and one thousand, one hundred and eighty-two females (1,182) made up of six clusters (programs) in every year batch and they are divided into gold and green track. The total number of students in both tracks in the second year is about eight hundred and three (803).

3.3 Sample and Sampling Technique

According to Fraennkel and Wallen (2003) a sample in a research study is any group on which information is obtained. Research sampling technique is used in selecting individual members or a subset of the population to make statistical inferences from them and estimate characteristics of the whole population. Both probability sampling and non-probability sampling methods were employed in this study. The non-probability sampling method used is the purposive sampling approach; the probability sampling method used is the simple random sampling approach. The simple random sample is a randomly selected subset of a large population. The simple random sampling method was used to sample the year two track for the study because they were the only students available in school during the period of the study and the students were not subjected to any external examination pressure. The simple random technique was used to select one class from departments with multiple classes for example, general arts have 2A1, 2A2, 2A3a,2A3b, 2A4a, 2A4b and 2A5. The simple random sampling approach made available one hundred and ninety-five (195) students for this survey. The simple random technique was used to remove all hints of bias and ensure equal probability of the population. The purposive sampling approach was used to select four (4) science teachers out of the accessible population of 122 teachers in the school. Purposive sampling approach was used because the teachers sampled for the survey teaches one or two of the classes selected for the study and may get information required, and also save time and money. All the students in the selected classes at the time of the survey were involved in the investigation. The numbers in each class varied slightly since the population are not the same.

3.4 Ethical Issues

Permission was sought from the Headmaster of the school and objective of the research was explained clearly. The objectives of study were also explained to the teachers involved in the study and the classes that was involved.

Secondly the head of Science Department of the school was informed about the objectives of the research and his cooperation was solicited. Each respondent was assured of anonymity and hence teachers spoke freely about the conduct of science lessons in the school and students also freely responded to the questionnaire. This revealed valuable information about the teaching and learning of integrated science in the school.

3.5 Instruments

3.5.1 Questionnaire

In this study a researcher made questionnaire were used to gathering information from the respondents. According to Creswell (2002) a questionnaire is a tool used in survey design to elicit responses from participants in a study. Items on the questionnaire were designed to elicit students' interests and opinions about integrated science and its teaching. The researcher made questionnaire had seventeen (17) items in all. Part of the items on the questionnaire were organized on a five-point Likert type scale that ranged from "Strongly agree (SA) =5, "Agree" (A) =4, "Not Sure" (NS) =3, "Disagree" (D) =2 to "Strongly Disagree" (SD) =1. The five-category scale was used because it is more reliable (Owusu, 2014). The questionnaire was divided into two main sections. The section 'A' looked at the demographic characteristics of students. This demographic instrument had two (2) items. Item one (1) and two (2) were used to gather background information on gender and course studied. The section 'B' looked at the attitudes of students towards integrated science. The section had fifteen (15) items. Item one (1) to fifteen (15) were designed to determine if students value integrated science and how science classes are conducted at the school. The questionnaire on attitudes of students towards integrated science was solely closed-ended questions and were organized on a five-point Likert type scale. To respond to an item, the respondent was required to indicate their attitudes towards integrated science on a five-point Likert scale. Thus, from "Strongly agree, "Agree", "Not Sure", "Disagree" to "Strongly Disagree".

3.5.2 Observation

Observation is a useful instrument in determining what people actually do or how they actually behave in their contexts. Observation is highly flexible for data collection that allows the Researcher to have access to interaction in the social context and yield systematic records in many forms and context (Cohen & Morrison, 2007). Observation as a data collection method can be structured or unstructured. In structured or systematic observation, data collection is conducted using specific variables and according to a pre-defined schedule. Unstructured observation, on the other hand, is conducted in an open and free manner in a sense that there would be no pre-determined variables or objectives.

In this study structured observation was used since it was planned. The researcher adopted a structured observation for the following reasons (Martha, 1983);

1. It employs a less complicated and less time-consuming procedures of subject selection.
2. It can offer data when respondents are unable and/or unwilling to cooperate to offer information.
3. It is relatively inexpensive.
4. It offers first-hand information without relying on the reports of others.

Moreover, observation data collection method can be divided into overt, covert, participant, non-participant, controlled and natural observations. The observation schedule used for this research was a non-participant observation. Non-participant Observation involves observing participants without actively participating. This method is used to understand a phenomenon by entering the community or social system involved, while staying separate from the activities being observed (Liu & Maitlis, 2010). The researcher collect data by observing behavior without actively interacting with the participants. Non-participant observation was used to level out research biases in other methods and to reveal differences between what people say and what they actually do.

As a non-participant observant the researcher sat in the integrated science sessions and made notes on how much the teachers presented their lessons and how students participated in science lessons in an observing schedule. The class room observation schedule was a closed-ended questions. The observation items had twenty-five (25) items. Item one (1) to three (3) observed planning and preparation of the teacher. Item four (4) to thirteen (13) observed the teacher instructional skills in class. Item fourteen (14) to seventeen (17) looked at the teacher classroom management skills. Item eighteen (18) to twenty-one (21) observed the teacher communication skills. Item twenty-two (22) to twenty-five (25) observed the evaluation of the teacher during lesson. The observation guide helped the researcher to observe the manner in which integrated science teachers sampled presented their lessons. The schedule was scored on a five-point Likert type scale. The aspects of lesson were mainly, the teachers' planning and preparation, instructional skills, classroom management, communication skills and evaluation.

3.5.3 Interview

An interview is a conversation for gathering information. A research interview involves an interviewer, who coordinates the process of the conversation and asks questions, and an interviewee, who responds to those questions. Interviews can be conducted face-to-face or over the telephone. Interview can be grouped into two main types, namely unstructured and structured interview. Unstructured interviews do not have a set pattern and questions are not arranged in advance. Structured interviews have predetermined questions in a set order. They are often closed-ended, featuring dichotomous (yes/no) or multiple-choice questions. While open-ended structured interviews exist, they are much less common. The types of questions asked make structured interviews a predominantly quantitative tool.

In this study structured interview was used since it was planned. Structured interview was employed for the following reasons; it is easy to compare data, it is highly reliable, reduce stress and anxiety, and also time-effective for the interviewer (George & Merkus, 2022). The interview items were opened-ended questions and consisted of eight (8) items designed to be used as an interview guide to elicit response from science teachers on the best strategies that could be adopted in teaching to promote concept formation in students. Interviews were conducted on the four teachers at different times to find out what comments they have on various interview items to confirmed the responses on the student attitude toward integrated science.

Observations and interviews were conducted in a naturally occurring environment that is, during and after science lessons in the school premises.

3.6 Validation of the Instrument

The instrument used in the investigation was sent to the supervisor who has scholarly opinion about the formation of concepts in science and the factors that impede the formation of concepts. The supervisor carefully scrutinized the test items, discarded the invalid ones and suggested more appropriate ones. Enough information was gathered by the researcher about various instruments that have been used successfully for similar researches before use. By this, the researcher believes that the instruments used in data collection for this project work are appropriate.

3.7 Reliability of the Test

Reliability refers to the accuracy of measurement by test. If an instrument consistently yields the same results when it is used to measure the same thing, the instrument is said to be reliable. According to Amedahe and Gyimah (2002) reliability is generally expressed in a reliability coefficient which falls between 0.00 and 1.00. A perfectly reliable test will have a reliability coefficient of 1.00. There are three techniques for estimating the reliability of a test; these are parallel forms, test-retest and split- half reliability test (Julie, 2001).

To ensure reliability the items in the instruments were designed to cover the key areas raised in the research questions. Additionally, the reliability of the test was established by pilot- testing, thus the researcher administered the test items on some selected form two students from different classes who were actually not part of the study. This was done purposely to check if the time frame for the test and the difficulty level of the test items were in their range. The challenges encountered were noted and corrected to ascertain the reliability of the test. The Cronbach's coefficient alpha was also determined using SPSS data analysis software; and a reliability coefficient of 0.74 was achieved. This was aimed at determining the internal consistency of the data collection instrument.

3.8 Data collection Procedure

The questionnaires were distributed to all the students of the selected classes and it was by the researcher. The procedure for the filling of the questionnaire was explained thoroughly to the respondents by the researcher. Their responses were collected soon afterwards. The consent of the four science teachers was sought for observation of two lessons of each of them. The researcher sat at the back of the class whiles science lessons were on going. Strengths and weaknesses observed on the part of students and teachers during the science lesson were recorded. Interview was conducted on the four teachers at different times to find out what comments they have on various interview items.

3.9 Data Analysis

Data collected from the study were organized for analysis. Data were examined for errors and omissions and edited accordingly. The qualitative data were checked for mistakes to ensure uniformity across the methods employed. The opened-ended questions were analyzed by raising themes, and analyzed qualitatively. The data were then grouped into similar themes based on the objectives of the study.

For the quantitative data, various responses from respondents on the closed-ended questions were coded and resultant tables were generated to facilitate the analysis. The Statistical Package for Social Sciences (SPSS, Version 20) was used to code and analyse the data collected. The data were then represented in tables using descriptive statistics as these have the advantage of making the findings known to a variety of people who need to be informed. Also, results from the analysis were arranged in thematic forms to suit the responses obtained from the study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

This chapter contains the results from the responses given by respondents to the questions in the questionnaire. Tables showing the frequency of responses, percentage (%) distribution of responses and interpretations to the responses are discussed in this chapter. The discussion of results, implications and conclusions from these results are also discussed in this chapter. Finally, observation made from science lessons during the observational schedule and their implications are also discussed as well as response to the interviews conducted.

4.1 Gender of Respondents

The gender of the respondents is essential variable that need to be considered in this study. The data on these variables are presented in Table 1.

Table 1: Gender Distribution of Respondents

Gender	Frequency	Percentage (%)
Male	107	54.9
Female	88	45.1
Total	**195**	**100**

From table 1, 54.9 % of the respondents were males and 45.1 % females. It can be seen that there were more male respondents than female respondents. Even though the margin is not that wide, it is a notable fact. It can also be concluded that each gender was well represented in the sample.

4.1.1 Course of Study of Respondents

The researcher sought to identify the courses offered by the students sampled for the study and thus asked them to indicate it to that effect. The result generated is summarized in table 2.

Table 2: Courses of Study of Respondents

Department	Frequency	Percentage (%)
General Arts	44	22.6
Science	38	19.5
Business	34	17.4
Visual arts	31	15.9
Home economics	26	13.3
Agricultural science	22	11.3
TOTAL	**195**	**100**

According to table 2, the majority of the respondents representing 44.1 % sampled for the study were enrolled in science-related courses such as General Science, Home Economics and Agricultural Science. 38.5 % were studying arts related courses, Visual arts and General arts, while 17.4 % were offered Business as a course of study.

4.2 Research Question One: What are the attitudes and perception of students on the teaching and learning of integrated science?

The researcher wanted to ascertain the attitudes of students towards the teaching and learning of integrated science. Students were therefore made to respond to selected constructs on a scale of Strongly Disagree, Disagree, Not Sure, Agree, and Strongly Agree. The responses obtained are depicted in table 3.

Table 3: Attitudes of Students towards Science

Constructs	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
I find it difficult re-producing concepts in English language during assessment.	24(12.3%)	57(29.2%)	-	54(27.7%)	60(30.8%)
Lessons presented without practical sessions are difficult for me to understand	56(28.7%)	92(47.2%)	9(4.6%)	28(14.4%)	19(9.7%)
Teachers always use laboratory sessions to facilitate lesson delivery	3(1.5%)	15(7.7%)	-	122(62.6 %)	55(28.2%)
I enjoy lessons when practical sessions are used in presenting them	78(40.0%)	105(53.8%)	7(3.6%)	3(1.5%)	2(1.0%)
Teachers choice of words is always difficult to my understanding	33(16.9%)	41(21.0%)	-	57(29.2%)	64(32.8%)
I find it difficult understanding lessons presented in English very well.	39(20.0%)	29(14.9%)	18(9.2%)	51(26.2%)	58(29.7%)
I find integrated science difficult	66(33.8%)	53(27.2%)	27(13.9%)	37(19.0%)	12(6.1%)
I don't get good scores/grades in integrated science	72(36.9%)	66(33.8%)	-	44(22.6%)	19(9.7%)
The methodology employed by my science teacher does not suit me.	23(11.3%)	32(16.3%)	51(26.2%)	57(29.2%)	32(16.4%)
I do Integrated science because it is compulsory for all students	79(41.0%)	76(39.0%)	-	29(14.9%)	10(5.1%)
I do not have enough books and materials for science	77(39.5%)	93(47.7%)	3(1.5%)	16(8.2%)	6(3.1%)
I do not see the relevance of science in everyday life	23(11.8%)	31(15.9%)	21(10.8%)	80(41.0%)	40(20.5%)
Integrated science education provides me with useful knowledge and skills	62(31.8%)	73(37.4%)	34(17.4%)	17(8.7%)	9(4.6%)
If given the option, I will avoid integrated science	29(14.9%)	44(22.6%)	14(7.2%)	64(32.8%)	44(22.6%)
I am scared answering science questions in class.	19(9.7%)	20(10.3%)	27(13.8%)	86(44.1%)	43(22.6)
I hate the mathematics aspect of science	23(11.8%)	25(12.8%)	17(8.7%)	83(42.6%)	47(24.1%)
I have integrated science on my private time table	30(15.4%)	19(9.7%)	-	42(21.5%)	104(53.3%)

Data from table 3 indicates that 148 out of 195 students representing 76.4% cited that science lessons presented without practical sessions were difficult for them to understand. This could negatively affect concept formation in students. Similarly, 183 students representing 93.8% stated that they enjoy lessons accompanied by practical lessons. This implies that lack of laboratory activities to back lessons could make scientific concepts too abstract to students and reduce students' interest in learning science. Additionally, 86 out of 195 students representing 44.1% find it difficult understanding lessons presented in English very well, 81 students representing 41.5% find it difficult in re-producing scientific concepts in English language during assessment and 74 students representing 37.9% also find their teachers choice of words difficult to their understanding. Furthermore, 146 students representing 74.8% added that they do not have integrated science on their private time table. However, 120 out of 195 students representing 61.5% acknowledge that they do not see the relevance of science in everyday life. Nevertheless, as much as 170 out of 195 students representing 87.2% stated they did not have enough books and materials on integrated science.

Generally, interest influences attitude. Respondents who are interested in integrated science are more likely to be enthusiastic about the subject. Erdogan, Bayram, & Deniz (2008) found a close relationship between students' attitudes towards academic subject and their overall achievement. It can therefore be established from the table that lack of practical sessions in science lessons and lack of accessibility to learning materials are the factors affecting students' performance in science and could be the reason why most students find science as a difficult subject. Additionally, 150 out of 195 students representing 70.7 % do not obtain good scores/grades in integrated science. Poor attitudes and perceptions towards science could lead students into losing confidence and interest in learning science. As a result, one might deduce that the effect of poor concept formation is attributable to students' negative attitude toward integrated science.

4.3 Research Question 2: To what extent do science teachers use laboratory experiments to aid concept formation?

To answer this question teacher sampled were asked to indicate whether they used laboratory experiments in the teaching in the interview schedule. Their response is shown in table 4.

Table 4: Teacher's use of laboratory experiments to aid concept formation

Response	**Frequency**	**Percentage**
Always	-	-
Sometimes	1	25.0
Not at all	3	75.0
Total	**4**	**100**

Laboratory activities are essential in teaching science as it stimulates students' interest as well as develops their scientific skills (Dillon, 2008). However, responses from table 4 indicates that only 25.0 % of the teachers sometimes used laboratory experiments to aid concept formation, 75.0 % did not employ laboratory experiments at all. The teachers explained that the scanty laboratory resource available to the school was reserved for students reading elective science subjects making it hardly available for teaching integrated science. This is consistent with the findings of Cossa and Uamusse (2015) that laboratory equipment and learning materials are in short supply due to the lack of funds. Science is an experimental discipline; laboratory becomes an essential part in enhancing students' scientific skills (Suleiman, 2013). Young children are naturally curious and begin life as natural scientists (Louv, 2005) using students' natural curiosities improves their understanding and attitude toward science (Cronin-James, 2000).

Iqbal, Nageen and Pel (2008) also emphasized the importance of laboratory practical in concept development. In their research, they investigated experimental approach to science learning and found out that experiment attracts students regardless of gender, geographical location or level of interest. In their research where they investigated effects of exploratory and discovery-based approach of learning, they discovered that practical work boosted the interest of all students no matter their geographical location or gender or level of cognitive development and affected output in the affirmative. He therefore concluded that practical work supports science concept development and helps improve performance in science. According to Llewellyn (2002) inquiry is science, art and imagination combined, where students use critical, logical, and creative thinking to explore areas of personal interest, and that inquiry inspires students to be lifelong learners and to become independent thinkers. Thus, inspiring and encouraging students to do well in school can be achieved through inquiry - based science activities and laboratories. The lack of laboratory activities could therefore negatively affect concept formation in students. Subject masters also expressed disinterest in using the laboratory for integrated science lessons because there are no laboratory technicians to assist them and teachers must spend extra time setting up.

4.4 Research Question 3: Which strategies do science teachers use in presenting their lessons to acknowledge, accommodate and provide for the student prior learning experiences?

In order to ascertain the methods and practices adopted by integrated science teachers at Mankranso senior high school. The researcher observed 4 lessons by 4 different teachers. The observation was done on a scale of: 5 (excellent), 4 (very good), 3 (good), 2 (fairly good) and 1 (poor) on various aspects of the teaching process. Observations were categorized as I, II, III, and IV, with each indicating an observation made during a lesson by a specific teacher. For each component, the average score of the four teachers was computed and converted to percentages. The results of such are discussed thematically under instructional skills, classroom ma nagement and communication skills. Teacher's perspective on methods/ strategies bes t for concept formation is also discussed.

4.4.1 Instructional Skills

To assess the instructional skills of teachers sampled for the study, lessons were observed using a well-designed construct as a guide. The results obtained is depicted in table 5.

Table 5: Instructional skills

Category	Constructs	Observation				
		I	II	III	IV	Average
Instructional Skills	States purpose, objectives and procedures for the lessons.	40.0	20.0	60.0	40.0	40.0
	Give explicit procedural and instructional instructions of the lesson	60.0	60.0	80.0	60.0	65.0
	Uses a variety of teaching/learning strategies for the whole class, small groups, and individual students.	80.0	60.0	80.0	60.0	70.0
	Encourages students during lesson	100.0	80.0	60.0	80.0	80.0
	Makes connections between the instruction and prior knowledge and life experiences.	60.0	80.0	60.0	60.0	65.0
	Presents the lesson in a logical order.	80.0	60.0	80.0	60.0	70.0
	Use a questioning method that is appropriate for the student's level.	40.0	80.0	80.0	60.0	65.0
	Encourages students to think critically and solve problems.	60.0	60.0	80.0	60.0	65.0
	Uses techniques for modifying and extending student learning	80.0	60.0	60.0	40.0	60.0
	Engages students in lesson closure	60.0	40.0	40.0	60.0	50.0

From table 5 it is observed that every lesson starts with a statement of the purpose and the objectives to be achieved by the end of the lesson. Teachers sampled for the study had an average score of 40.0% in this regard, with a minimum and maximum score of 20.0% and 40.0% respectively. Starting a lesson without stating the objectives appropriately leave the students in dilemma without knowing what to pay attention to or is expected of them by the end of the lesson. This may affect their ability to grasp concepts appropriately.

Results from table 5 also shows that teachers attained an average score of 70% with regards to adopting variety of teaching/learning strategies to accommodate for whole class, small groups, and individual learning needs. It is also clear from table 5 that teachers gave explicit procedural and instructional instructions of the lessons with average score of 65.0%. Again, data from table 5 show that teachers scored 80.0% on the average on encouraging students during lessons; which was much encouraging. Also, teachers sampled for the study scored 65.0% on the average on linking students' relevant previous knowledge (R.P.K) to instructions and employing questioning method that is appropriate to student's level. Likewise, teachers scored 60.0% on the average regarding encouraging students to think critically and solve problems; and 50.0% on engage students in lesson closure.

It can be established from table 5 that teachers need to refine their instructional skills as the scores at this level were generally low.

4.4.2 Classroom Management and Communication Skills

In order to determine how teacher's, manage the classroom effectively, the level and appropriateness of their communication skills, teachers sampled for the study were observed during lessons. The scores obtained for this category is shown in table 6.

Table 6: Classroom Management and Communication Skills

Category	Constructs	Observation I	II	III	IV	Average
Classroom Management	Effectively manages classroom routines	80.0	80.0	80.0	80.0	80.0
	Respects the differences between students	100.0	80.0	80.0	80.0	85.0
	Maintains a positive working relationship with students.	60.0	60.0	80.0	80.0	70.0
	knows each student as an individual	60.0	80.0	40.0	60.0	60.0
Communication Skills	Expresses confidence and zeal in communication	80.0	60.0	80.0	60.0	70.0
	Communicates at the level of understanding of the students	100.0	60.0	60.0	60.0	70.0
	Uses appropriate and accurate non-verbal, oral/sign and written communication	80.0	80.0	80.0	80.0	80.0
	Projects the right voice, hand form, and orientation	100.0	60.0	60.0	80.0	80.0

From table 6 teachers sampled for the study generally performed well on classroom management with average scores of 60.0% to 85.0%. Similarly, they displayed superior performance in communication skills with average scores ranging from 70.0% to 80.0%.

With reference to science education, Wellington and Osborne (2001), research findings indicated that communication, in all its forms, matters to science education. In particular, it is not just the language in itself but rather what educators do with the language. This is because what educators do with the language inadvertently affects how the learner uses the language and that is fundamental to the learning of science. In nations where English is taught as a second language, such as Ghana, many students may struggle to distinguish between ordinary and scientific meanings of phrases. Conclusively, teacher's communication during lesson delivery is a factor that affects concept formation, and the teachers sampled for the study had good classroom management and communication abilities.

4.4.3 Methods/Strategies Best for Concept Formation in Students.

Teachers sampled were further asked to indicate the teaching strategies they deemed suitable to acknowledge, accommodate and provide for the student prior learning experiences; and enhance concept formation in students. The result is summarized in table 7.

Table 7: Methods/Strategies commonly used by Science Teachers

Strategy	Frequency	Percentage
Lecture	1	25.0
Demonstration	1	25.0
Demonstration & Lecture	2	50.0
Activity	-	-
Total	**4**	**100.0**

From table 7, 25.0% of the respondents stated that they solely used the lecture method in teaching, while 25.0% also indicated that they employed demonstration method as a teaching strategy. However, 50.0% of the respondents combined the lecture and the demonstration method. None of the respondents indicated using the activity method. In a focus group interview the respondents explained that, general science students have been prioritized with respect to access to the laboratory to the detriment of others. According to them, lack of access to the laboratory compromise efforts to incorporate activity and demonstration methods in lesson delivery.

4.4.4 The Impediments to Concept Formation in Students

The researchers asked teachers sampled for the study to state their perception on the impediments to concept formation in students. This is summarized in table 8.

Table 8: The Impediments to Concept Formation in Students

Response	Frequency	Percentage
Insufficient Logistics for integrated science lesson	2	50.0
Poor Parental Support	1	25.0
Lack of Students' Commitment	1	25.0
Total	**4**	**100.0**

From table 8, 50.0 % of the respondents cited insufficient logistics such as laboratory equipment, stock chemicals, etc., for integrated science lessons at the school as a hindrance to concept formation in students. 25.0 % indicated poor parental support as impediment. Moreover, field observations indicated that some students could skip school for a whole semester without attending class. Interviews with form masters indicate that, the Mankranso Senior School has inadequate housing facilities and most parents rent accommodation outside the campus for their wards. Students in such living arrangements have little or no supervision and tend to absent themselves from school. Such students could find it difficult understanding concepts taught in their absence thus making concept formation difficult. 25.0 % of respondents stated low student involvement; in a focus group discussion, respondents revealed that students remained passive and only participated in note taking. They rarely asked questions during science lessons and frequently gave completely incorrect responses to basic questions. Students showed complete ignorance as far as some topic areas are concerned. This observation is particularly prevalent in the integrated science fields of chemistry and physics. With regard to recommendation(s) for concept formation to teaching strategy, all teachers sampled recommended a student-centered participatory approach. They did, however, state that this strategy can only be fully implemented when the necessary logistics to support lesson delivery are made available.

4.5 Discussion of Results

The section discusses findings on the factors that impede the formation of basic scientific concepts by students in Mankranso Senior High School. The paper investigated factors that impede the formation of basic scientific concepts among 195 students sampled from the General Science, Home Economics, Agricultural Science, Visual arts, General arts and Business departments of the school for the study. The research specifically sought to establish: students' attitudes and perceptions about integrated science and its effect on their science concept formation; whether science teachers teach using laboratory experiments to aid concept formation and the appropriate teaching strategies that can be adopted by science teachers that acknowledge, accommodate and provide for the student prior to learning experiences. The discussions are made thematically under the research questions posed to guide the study.

Research question one: **What are the attitudes and perception of students on the teaching and learning of integrated science?**

Generally, the negative attitude developed in students towards science and the declining number of students choosing to pursue the study of science recently has become a matter of concern across the world (Cheng & Wan, 2016) and one of the purposes of contemporary science education is to develop a positive attitude toward science and to enhance the interest of young people in pursuing scientific careers (Azizoglu & Çetin, 2009). therefore, factors such as the way learning is organised could be an incentive or a disincentive to developing positive attitudes and perceptions in students. This study identifies that 93.8 % (n=195) of students would enjoy science lessons if practical activities were used to accompany them. This is in line with earlier studies conducted by Louv (2005) which identifies that students are intrinsically curious, thus inspiring and encouraging them through inquiry based science activities and labs could help develop a positive attitude in students towards science. Unfortunately, 90.8 % of the respondents, representing 177 of students have identified that, their teachers do not use laboratory activities during science lesson therefore making it very difficult for them to fully understand and apply scientific concepts. Furthermore, the research investigation also reveals that 41.5% representing 81 students find it difficult in re-producing scientific concepts in English language during assessment and 37.9% representing 74 students also find their teachers choice of words used during classroom instructions above their level of understanding. This could mean that about 37.9% to 41.5% of the students could not make the best of science lessons by virtue of language barrier.

According to Kim (2007) one of the key factors in helping Limited English Proficiency (LEP) students achieve greater progress in learning science is the role played by the science teacher in lowering the language barrier. This is because according to her, language is a great barrier to students' learning. Some school of thought asserts that thoughts and ideas are associated with words. Different languages promote different ways of thinking and language does not completely determine thought but does influence it (Gozzi, 1989). This implies that having a limited vocabulary equals having a limited cognitive activity. Many cognitive tasks such as memory and thinking, rely on language. Thus, English language as a medium of instruction in Ghanaian schools could be a hindrance to concept formation in students. (Henderson & Wellington, 1998). This study also found out that, 27.8% representing

55 of the students found the methodology adopted by their teachers for teaching unsuitable to their situation. According to Raymond (2012) teaching method has direct effect on student attitudes towards learning. Teaching methods therefore need to be varied to suit learner's cognitive demands without which students would not understand science lessons leading them into forming negative attitudes and perceptions about it. It is therefore of no surprise that this study further identifies that 60.0% representing 119 of the students find integrated science difficult while 70.8% representing 138 of students, had develop the notion that they do not get good scores in integrated science. This study further identified that 81.0% representing 158 students studied integrated science only because it is a compulsory subject and 37.4% representing 73 students would avoid integrated science as a study subject should the option be provided. It is therefore important that teachers adopt pedagogical skills appropriate to the level of 170 students that will help ensure concept formation in students. This study also discovered that 61.5% which represent 120 of students still acknowledge the relevance of science in everyday life. Regarding that, 69.2% representing 135 of students believe that integrated science provides them with useful knowledge and skills. However, it was unfortunate to discover that as much as 87.2% which represent 170 students did not have enough books and materials on integrated science.

Evidently 14.9% see integrated science as a scary subject and 24.6% feel uncomfortable with the mathematical aspect of science representing 29 and 48 students respectively. It can therefore be asserted that if students are provided with enough materials on science they may develop positive attitudes towards it and that will go a long way to improve concept formation in them. According to Bayaga and Wadesango (2014) the positive perceptions of students in learning a subject could help develop a positive attitude towards it, which will, in turn, lead to better performance. Thus, negative perceptions of students towards a subject will also contribute to their low performance in the subject (Mensah, Okyere & Kuranchie, 2013) and removing factors militating against the formation of positive attitudes and perceptions is a prerequisite to concept formation in students.

***Research question two:* To what extent do science teachers use laboratory experiments to aid concept formation?**

Lack of access to the laboratory compromise efforts to incorporate activity and demonstration methods in lesson delivery (Mabula & Mkonongwa, 2012). Lack of laboratory activities to back lessons makes scientific concepts too abstract and difficult for students to understand. This could lead students into forming negative attitudes and perceptions towards science. Science laboratory is an essential part in enhancing students' scientific skills and concept formation (Suleiman, 2013). However, it was identified in this study that 75.0 % of science teachers did not employ laboratory experiments at all in their lessons to enhance concept formation. According to Mabula and Mkonongwa (2012) there are several reasons for the ineffectiveness of laboratory activities such as the shortage of science teachers; limited laboratory equipment, and teachers' low competence in laboratory experiments since they themselves learnt science without practical sessions during their schooling. This study found that the only laboratory resource available for the school was reserved for the students reading elective science subjects making it hardly available for teaching integrated science. Science is an experimental discipline, laboratory becomes an essential part in enhancing students' scientific skills (Suleiman, 2013). Positive attitudes and increased student engagement have been observed when laboratory practical sessions are utilized (Elliott & Page, 2010; Lakin, 2006).

Laboratory activities make students active in science learning and help students to establish the accuracy of their beliefs.

In addition, laboratory activities involve students directly in experiment related to a given concept (Angus & Keith, 1992). Cronin-James (2000) stated that for young students, hands-on science has a stronger effect on knowledge acquisition. This is because students can conduct their own investigations and satisfy their curiosity which increases their engagement and supports their interest in science (Metz, 2008). The lack of laboratory activities can therefore reduce students' interest in learning science with negative impact on concept formation.

***Research question three:* Which strategies do science teachers use in presenting their lessons to acknowledge, accommodate and provide for the student prior to learning experiences?**

In order to ensure a better understanding of concepts, it is important that science teachers embrace the participatory/learner-centred approach in their lessons as it allows students to construct their own understanding of content and develop a personal feeling that knowledge is their own (Jacobson & Kolchak, 2009).

This study discovers that 25.0% of science teachers solely used the lecture method, which is highly teacher centered, in teaching. According to Jones (2007) the lecture method is the most convenient teaching method even though it may not have the greatest impact on student learning because it seems to be the easiest to prepare compared to other methods. He further adds that the impact of lecture method however, should not be underestimated. Covill (2011) on college students' perceptions of the traditional lecture method suggests that lecture is of great value and receives positive responses from students. He further suggested that the lecture method may carry learning characteristics such as problem solving, critical thinking, etc., usually found only in active learning. However, it is well established that this sort of enhanced lecture does contribute to student learning (Berry, 2008; Burke, James & Ahmadi, 2009; Campbell & Mayer, 2009). This could be because the lecture method is an extremely teacher-centered mode of teaching in which the teacher actively carries out all tasks while the students passively listen and take notes. It does not lend itself to hands-on activities that are essential for developing students' inquiry skills. When this occurs, students mainly commit facts and concepts to memory without grasping the principles underlying them, resulting in poor concept formation.

Additionally, 25.0% employed demonstration approach as a method of teaching. According to Mundi (2006) demonstration method refers to the type of teaching method in which the teacher is the principal actor while the learners watch with the intention to act later. Here the teacher does whatever the learners are expected to do at the end of the lesson by showing them how to do it and explaining the step-by-step process to them. (Ameh, Daniel & Akus, 2007). Mundi (2006) described it as a display or an exhibition usually done by the teacher while the students watch with keen interest. He further added that, it involves showing how something works or the steps involved in the process. A study conducted by Daluba and Noah (2013) in Kogi State, Nigeria on the effect of demonstration method of teaching on students' achievement in Agricultural Science, showed that male and female students taught by the Demonstration method performed better than those taught by the conventional lecture method. The demonstration method involves carrying out an activity related to a concept with students with the intent of making it more understandable to students. It enables students to visualize concepts, create mental pictures on them and get full grip on concepts. As a result, using the demonstration method in teaching the sciences could help promote understanding and formation of scientific concepts in students. The study also identifies that 50.0% of the respondents combined the lecture and the demonstration method. This is in line with the assertion made by Tormey and Henchy (2008) that if the lecture method is revised and combined with other teaching methods or used with educational technology it would produce greater effect.

It could be established from the discussion that the methods commonly used by teachers in the study area are the lecture and the demonstration method and combining these methods could generate a synergistic effect that could help promote scientific concept formation in students.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.0 Overview

This chapter is designed to give an insight into the major findings of the research under the topic “the factors that inhibit the formation of science concept by Mankranso Senior High School students”. The main factors that were identified during the research as contributors to the students’ poor understanding of basic scientific concepts are enumerated in this chapter and some other findings. The conclusions and recommendations drawn from the research are summarized in this chapter.

5.1 Summary of Findings

The study assessed the factors that impede the formation of basic scientific concepts by students in Ghana using the Mankranso Senior High School in the Ashanti Region as a case. In doing so, one hundred and ninety-five (195) students were sampled for the study.

The objectives of the study were to find out students’ attitudes and perceptions about integrated science and its effect on their science concept formation, find out whether science teachers teach using laboratory experiments to aid concept formation and find out the appropriate teaching strategies that can be adopted by science teachers that acknowledge, accommodate and provide for the student learning experiences.

Structured questionnaires backed with focused group discussion, observational schedule and extensive field observations were the main instruments used for data collection in this study. The following findings were made from the study.

1. This study discovered that, the majority of students believe that science is relevant in everyday life and provides them with useful knowledge and skills; meaning they were aware of the role science plays in the society. This notion among students may motivate them to embrace science as a study subject. When students develop interest in a subject they make conscious effort to learn and this could promote concept formation in them.
2. It was also identified that majority of the students offered to read integrated science only because it is a compulsory subject and would drop it if given the opportunity. This could have resulted from the fact that the majority of students did not have enough science books and materials, as evidenced by field observations in which the majority of students were found attempting to solve science problems without using calculators. Consequently, majority of students found integrated science difficult and were unable to achieve good scores/grades in integrated science. Few students blamed their difficulties with integrated science on the methodology used by their teachers. This is a disincentive to concept formation as it repels students from science, lowers their interest and concentration causing them to place less premium on science.
3. The study also discovered that, while teachers performed well in classroom management, communication, and evaluation skills, they needed to improve their instructional skills since their performance in this area was comparatively low. It was also discovered that integrated science teachers had less time to use the laboratory because this limited resource was reserved for students studying general science. Inadequate laboratory sessions make

scientific concepts too abstract for students understanding leading to poor concept formation.

4. Generally, on the issue of appropriate teaching strategies that science teachers can use to acknowledge, accommodate, and provide for their students' learning experiences. All of the teachers surveyed recommended the participatory approach, which is a student-centered method. It was also discovered that this approach can only be fully implemented when the necessary teaching learning materials to support lesson delivery are made available. According to the study, the lack of these logistics has led teachers to use approaches like the lecture method in teaching, this factor could impede concept formation in students.

5.2 Conclusion

The current study has highlighted the significant association between students' attitudes and perception towards science and concept formation. Although, overall data suggest that attitude of students towards science has been generally poor and could lead to poor concept formation; there is still opportunity to raise students' interest through the use of laboratory activities to supplement teaching scientific concepts, the adoption of participatory teaching methods and creative pedagogical skills by science teachers; and provision of study materials to students. These could stimulate the interest of students in taking up science as a study subject and cause them to gear attention towards it. This may be rewarded by students achieving good grades in science and being motivated accordingly to learn and appreciate scientific concepts which will serve as a forerunner to concept formation in students.

5.3 Recommendations

5.3.1 Recommendations for Government, school authorities and the students

Based on the findings made in this research the following recommendations are suggested to improve concept formation in students:

- Government of Ghana through the Ministry of Education and Ghana Education Service (GES) should provide requisite teaching learning materials to the school to enable science teachers to adopt the participatory approach that would foster concept formation in students.
- Students should be encouraged and sensitized to develop positive attitudes toward science because this has been shown to improve concept formation in students.
- Government of Ghana and its Stakeholders should consider building more laboratories in schools to increase accessibility to non-science students and teachers to help intensify practical activities and improve concept formation in students.

5.3.2 Recommendation for Teachers

- Teachers should refine their methodology and instructional skills to accommodate for the needs of their students and make the best of their lessons.
- Teachers should use language at the level of understanding of their students to improve their understanding on basic scientific concepts.
- Teachers should update themselves with knowledge and skills on laboratory procedures to help boost their confidence in using laboratory activities in their teaching.

5.4 Suggestion for Further Research

- Research should be carried out by future researchers on the availability of learning resources to students and its effects on concept formation.

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APPENDICES

APPENDIX I

Research and Study questionnaires

QUESTIONNAIRE FOR FINDING SOME FACTORS THAT IMPEDE FORMATION OF BASIC SCIENTIFIC CONCEPTSABOUT SCIENCE TEACHING AND LEARNING

SECTION A-DEMOGRAPHICS

Please tick one appropriate option as applied

1. Gender of respondents Male [ ] Female [ ]

2. Course Science [ ] business [ ] Home Econs. [ ] Visual Arts [ ]

General arts [ ] Agric [ ]

SECTION B-ATTITUDES OF STUDENTS TOWARDS SCIENCE

Indicate your level of agreement to the following statements – one option only

Question	**Strongly agree**	**Agree**	**Not sure**	**Disagree**	**Strongly Disagree**
1. I find it difficult re-producing concepts in English language during assessment.					
2. Lessons presented without practical sessions are difficult for me to understand					
3. Teachers always use laboratory sessions to facilitate lesson delivery					
4. I enjoy lessons when practical sessions are used in presenting them					
3. I find it difficult understanding lessons presented in English very well.					
4. Teachers choice of words is always difficult to my understanding					

5. I find integrated science difficult					
6. I don't get good scores/grades in integrated science					
7. The methodology employed by my science teacher does not suit me.					
8. I do Integrated science because it is compulsory for all students					
9. I do not have enough books and materials for science					
10. I do not see the relevance of science in everyday life					
11. Integrated science education provides me with useful knowledge and skills					
12. If given the option, I will avoid integrated science					
13. I am scared answering science questions in class.					
14. I hate the mathematics aspect of science					
15. I have integrated science on my private time table					

APPENDIX II

OBSERVATION SCHEDULE

CLASS ROOM OBSERVATION SCHEDULE ON SCIENCE TEACHERS

Question	5	4	3	2	1
PLANNING AND PREPARATION					
The teacher…					
1. demonstrates a thorough understanding of the subject.					
2. objectives are SMART, and the strategies are aligned with the instructional objectives.					
3. content connect with and challenges students present knowledge, skills and values					
INSTRUCTIONAL SKILLS					
The teacher…					
4. states purpose, objectives and procedures for the lessons					
5. give explicit procedural and instructional instructions of the lesson					
6. uses a variety of teaching/learning strategies for the whole class, small groups, and individual students.					
7. encourages students during lesson					
8. makes connections between the instruction and prior knowledge and life experiences.					
9. presents the lesson in a logical order.					
10. use a questioning method that is appropriate for the student's level.					
11. encourages students to think critically and solve problems.					
12. uses techniques for modifying and extending student learning					
13. engages students in lesson closure					
CLASSROOM MANAGEMENT					
The teacher…					
14. effectively manages classroom routines					

15. respects the differences between students					
16. maintains a positive working relationship with students.					
17. knows each student as an individual					
COMMUNICATION SKILLS					
The teacher…					
18. expresses confidence and zeal in communication					
19. communicates at the level of understanding of the students					
20. uses appropriate and accurate non-verbal, oral/sign and written communication					
21. projects the right voice, hand form, and orientation.					
EVALUATION					
The teacher…					
22. keeps track of students' progress and participation.					
23. immediately and constructively provides feedback					
24. evaluation is based on educational goals and objectives.					
25. uses formal/informal evaluation tools to assess students' learning before, during, and after instructions.					

KEY (5 excellent, 4 very good, 3 good, 2 fairly good, 1 poor)

APPENDIX III

INTERVIEW SCHEDULE FOR SCIENCE TEACHERS

APPROPRIATE TEACHING METHODOLOGY THAT CAN BE ADOPTED BY SCIENCE TEACHERS THAT ACKNOWLEDGE, ACCOMMODATE AND PROVIDE FOR STUDENTS PRIOR TO LEARNING EXPERIENCES.

1. What instructional skills/teaching methodologies do science teachers usually employ?

....
....
....

2. Which of these instructional skills do you deem best for concept formation in students?

....
....

3. Which of these instructional skills do you normally use in your lessons?

....
....

4. Why do you use the instructional skills outlined above?

....
....

5. What do you think are the impediments to concept formation in students?

....
....

7. What is/are your recommendation(s) for concept formation with regard to instructional skills?

....
....

8. Any other comments

....
....

APPENDIX IV

Introductory Letter

MANKRANSO SENIOR HIGH SCHOOL
P. O. BOX 33
MANKRANSO - ASHANTI
MARCH 31, 2021

THE HEADMASTER
MANKRANSO SENIOR HIGH SCHOOL
Dear sir,

APPLICATION TO CONDUCT SURVEY WITH SECOND YEAR STUDENTS

I would be much grateful if you would grant me permission to conduct survey with the second-year students by administering my questionnaires and also humbly request data on, 2018, 2019 WASSCE results on integrated science for my project work.

I am currently a Post-graduate Sandwich student in the Department of Science Education at the University of Education, Winneba and I am offering Master of Education in Science and working with Dr. Rosemary Naana Kumi-Manu as my supervisor.

The purpose of my study is to find out the factors that impede the formation of science concepts by students in Mankranso senior high school. The objective of the study is to find out students' attitudes and perceptions about integrated science and its effect on science concept formation, to find out whether science teachers teach using laboratory experiments to aid concept formation, and also to find out the appropriate teaching strategies that can be adopted by science teachers.

A copy of the complete research work will be provided to the school.

Hoping my application will be granted.

Thank you

Yours faithfully,

…………………………
MICHAEL KWADWO BOAKYE
0245523835