**UNIVERSITY OF EDUCATION, WINNEBA**

# DIFFICULTY IN INTEGRATED SCIENCE TOPICS PERCEIVED BY NALERIGU SENIOR HIGH SCHOOL STUDENTS

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# DECLARATION

## STUDENT'S DECLARATION

I, ABDUL-GANIU ALHASSAN, declare that this thesis, except for quotations and references contained in published works that have all been identified and duly acknowledged, is entirely my original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ……….…………………………

DATE: ……….…………………………………

## SUPERVISOR'S DECLARATION

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

SUPERVISOR'S NAME: DR. ISHMAEL KWESI ANDERSON

SIGNATURE: ……….…………………………

DATE: ……….…………………………………

# DEDICATION

This work is dedicated to my mum, Hajia Fati Adam and my children Faiq, Farida, and Fauqia. You are my God-given treasure in this life.

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I am immensely grateful to Allah Almighty for giving me life and guiding me through the research process. He is my shield, strength and sustainer.

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## ABSTRACT

The primary focus of the study was to determine SHS integrated science topic difficulty perceived by students. Secondly, the study was also meant to determine measures that could be taken to ensure the effective teaching of topics in Integrated Science. The study employed the descriptive survey research design. The population comprised students in Nalerigu Senior High Schools in the East Mamprusi Municipality. The sample of the study was made up of 200 integrated science students. Purposive and stratified sampling techniques were used to select participants for the study. Questionnaire and interview guide were used to collect data from respondents. It was found in this study that senior high school science students in East Mamprusi Municipality perceived some topics in the integrated science syllabus as difficult. These topics were: cells and cell division, acid base and salt, water, air movement, nitrogen cycle, hydrological cycle, respiratory system and food and nutrition, forms of energy and energy transformation, solar energy, photosynthesis, sound energy and nuclear energy, atmosphere and climate change, forces, motion and pressure, work and machines, endogenous technology, magnetism and biotechnology. Some of the measures to improve the situation were: provision of prescribed textbooks for science, frequent use of practical examples and discussion in class and embarking on educational trips. Based on the findings, it was recommended that workshops and in-service training programs are done for teachers to improve their content knowledge on the topics perceived to be difficult and strategies to teach such topics.

# CHAPTER ONE

## INTRODUCTION

### 1.0 Overview

This chapter is made up of the background to the study, statement of the problem, the purpose of the study, objectives, research questions, and the significance of the study. The delimitation and the limitation of the study are also presented. Also, in the chapter are the definition of terms and the organisation of the report.

### 1.1 Background to the Study

It is a general knowledge that integrated science is among the important subjects within the list of core subjects for basic and secondary education in Ghana and many other countries in the world. The general aims of the integrated science syllabus are designed to help the students to solve basic problems within their immediate environment through analysis and experimentation, as well as to keep a proper balance of the diversity of the living and non-living things based on their interconnectedness and repeated patterns of change (Curriculum Research and Development Division [CRDD], 2012). In the same CRDD document, another aim is to use appliances and gadgets effectively with a clear understanding of their basic principles and underlying operations and also to search for solutions to the problems of life recognizing the interaction of science, technology, and other disciplines.

Integrated science is studied by every student during the educational process for personal development and achievement in today's technologically advanced world. Mcshea (1995) called science a critical filter and noted that scientific knowledge was vital and played a fundamental role in the scientific and technological progress of any nation. Lack of scientific knowledge will affect one's chances of eligibility and reward on the job market, and severely hinders career advancement (Mcshea, 1995). Therefore, integrated science is seen as a requirement of educational systems worldwide.

Due to the current increase in the number of students seeking to enter universities, especially public universities it has become imperative for each student to pass exceptionally well to gain admission hence integrated science has been a prerequisite for access to higher education programs. Again, a good performance in integrated science is one of the basic requirements for further studies in many areas of educational importance. For instance, a Junior High School (JHS) pupil must obtain at least a credit or better in integrated science to enter Senior High School (SHS), and grade C6 to enter post-SHS institutions. This means that a candidate must pass the West African Senior High School Certificate Examination in integrated science conducted by the West African Examinations Council (WAEC) to earn a high school certificate.

The importance of integrated science in everyday life cannot be exaggerated or overstated. It borders on a variety of areas but concerns itself largely with calculations and physical quantities, and their relationships. Nearly every aspect of human life involves integrated science. For example, it a general knowledge that integrated science is an essential part of every scientific study such as engineering, industry, physical and social sciences, business, and health. Therefore, integrated science can be considered as a key to opportunities.

The quality of teaching and learning in any system of education of any nation will always be determined by the combined knowledge of the teachers who are stakeholders and the students’ efforts in learning within the educational system.

Teachers ought to strive to enrich their minds with new knowledge and ideas in their subject areas so that their teaching can become more exciting and attractive. The training of integrated science teachers will help to strengthen them with the requisite scientific knowledge, skills, and ideas to enable them to facilitate the learning of their students.

Arhin (2009) at a conference of Ghana Association of Science Teachers (GAST) reiterated that integrated science is viewed as a difficult discipline and students often fail to grasp the concepts if they are not taught by trained and experienced teachers who will facilitate teaching and learning using appropriate teaching methods and manipulative materials.

There have however been several interventions by Ghana Education Service to enhance effective teaching and learning of topics in integrated science. For example, there has been formal teacher training, teacher in-service workshops, and seminars to expose teachers to practical knowledge of the teaching and learning of integrated science. With these interventions in place, it is assumed that the teaching and learning of integrated science would be effective.

Training of integrated science teachers is expected to promote their effectiveness in the content area, teaching methods, knowledge about their students, lesson planning, and making connections between and within-subjects that is enhancing their pedagogic content knowledge (PCK). For example, an experienced, trained, and knowledgeable teacher will make appropriate connections between integrated science and geography in map reading, integrated science in the use of ratio and proportion, and so forth. Training empowers the teacher to integrate science and other subject areas. Hence training prepares teachers for good teaching and for good students' to achieve results.

Despite the training of teachers for integrated science education in Ghana, over the past few decades, there have been persistent reports of massive failure from WAEC chief examiner's report (2019), and this is concerning certain topics in integrated science. Topics such as Acids, Bases and Salt, Electronics, Forces, Motion, and Pressure keep appearing in the examinations and students fail in answering the question on them. They were not performing better because students found them to be difficult. Some students even before they enter the class, according to their experience they perceived that integrated science is difficult, Salau (1995, 1996). This seems to suggest a decline in students' performance year after year. There have been repeated reports of students' poor performance even though schools have teachers to deliver the content and practical aspects of the subject. This means there are still problems that need to be tackled. There is the need to identify the root cause of this problem and offer solution.

In a typical circumstance of making the learning of science topics easy for students, teachers are advised to use manipulative learning materials to facilitate students' understanding and forster their achievement in the subject Post (1992), and further posited that effective learning of integrated science often involves the use of manipulative materials and the opportunity to work with such materials. In the same study, it was stated that manipulative learning aids help learners move from concrete situations and problems to abstract ideas. Manipulative instructional items or teaching learning materials can help students' to understand abstract ideas. Hence, students may not resort to rote memorization of some concepts in science. Having students use manipulative aid (in this case using a science laboratory) would help the student to understand and apply the concept.

## 1.2 Statement of the Problem

Majority of students from Nalerigu senior high school fail in integrated science. The copious reports on SHS students' poor performance in integrated science by the WAEC attest to this disturbing situation (Chief Examiners' Report, 2019). The current situation of science teaching and learning in Ghana is a worry to all including government and the society at large. Research point out that many students found science to be difficult, dull and not interesting to them (Salau, 1995, 1996). At present, senior high school students' interest and academic achievement in integrated science education is diminishing. Lemchi (2001) noted that some students are losing interest in the integrated science. However, a good performance in integrated science is a prerequisite for pursuance of higher education. Therefore every effort must be done to help students to overcome their continuous failure of integrated science is paramount. As part of the remedy students perceived difficulty of integrated science topics must be identified so that teachers may focus more on those aspects in their lesson presentation.

## 1.3 Purpose of the Study

The purpose of the study was to investigate topics in integrated science that students of Nalerigu SHS perceive to be difficult.

### 1.4 Objectives of the Study

The objectives of the study were to;

1. identify topics perceived by students to be difficult in integrated science.
2. determine the difference in the perceived difficulty of topics in integrated science by males and females.
3. identify some measures that will be implemented by teachers to improve on students understanding of their perceived difficult topics in integrated science.

### 1.5 Research Questions

The study was guided by the following research questions:

1. Which integrated science topics are perceived by students to be difficult?
2. What is the difference in the perceived difficulty of integrated science topics by males and females?
3. What measures could be implemented by teachers to improve on students understanding of their perceive difficult topics in integrated science?

### 1.6 Null Hypotheses

The following null hypothesis was formulated and tested.

$Ho_1$: There is no significant statistical difference in students' perceived difficulty of topics in integrated science by males and females.

### 1.7 Significance of the Study

The significance of this study are many. It is expected that the findings of this research would enable science teachers particularly integrated science teachers to have better knowledge of students perceive difficult topics and therefore devise appropriate teaching strategies in teaching topics perceived to be difficult. It will also help students to get better understanding in learning those topics perceived to be difficult when teachers apply their revised teaching strategies in their teaching. The study will add to the existing literature on the topic difficulty in integrated science and it may also serve as a source of information for other researchers.

## 1.8 Delimitations of the Study

The study will focus on the perception of topic difficulty in integrated science by students. The research will focus only on Nalerigu senior high school students. It will also focus on first and second year students.

## 1.9 Limitations of the Study

Due to the strict observation of COVID-19 protocols, some students were not willing to observe and did not take part in the study. In administering the questionnaires, some students gave cursory responses to leave early.

## 1.10 Operational Definitions of Terms

1. Students' perception of difficult topics: Students' views of how easy or difficult it is to understand particular topics in the integrated science syllabus during and after studying them.
2. Teachers' perception of difficult topics: Teachers' views of how easy or difficult it is to teaching of particular topics in the integrated science syllabus.
3. Student interest in science: Students desire and preparedness or inclination to study integrated science now and in the future in preparation for a possible impending career in a science or a science related field.
4. Study habits: Study behaviors used by students to understand the integrated science subject content or subject matter covered in class.

## 1.11 Organisation of the Study

The study is organized into five main chapters. The first chapter highlights the background to the study, statement of the problem, the purpose of the study, research questions, and significance of the study. The chapter also deals with the delimitations of the study, limitations, and definition of terms. Chapter Two reviews related literature on the topic. Under this, the opinions of other researchers and educationists who have studied and written on the topic of difficulty in science would be discussed. The third chapter describes the method that was adopted for the study. It covers the research design, population, sample and sampling techniques, research instrument, data collection procedure, and data analysis plan. Chapter Four delves into the data analysis and interpretation of data collected. The fifth and final chapter gives a summary of the findings, conclusions drawn and the recommendations offered based on the findings from the study.

# CHAPTER TWO

## REVIEW OF LITERATURE

### 2.0 Overview

A review of related literature delivers an important link between existing knowledge and the problem under investigation. It includes all relevant written documents containing information related to the research problem. The documents include relevant periodicals, published articles in journals, abstracts, reviews, books, and research reports. The review of related literature points out research strategies, specific processes and instruments that have been used, and their outcomes.

- The literature was reviewed under the following headings:
- The Nature of the SHS Integrated Science Syllabus
- Concept of Perception
- Empirical Review of the Study
- Perceived Difficulty in Science
- Students' Interest in Science
- Factors that are posed as difficulty in learning topics in integrated science
- School factors affecting the learning of science
- Influence of Gender on the Learning of Integrated science
- Measures to improve teaching and learning of Integrated Science

### 2.1 The Nature of the SHS Integrated Science Syllabus

A syllabus, according to Elewokor (2007), is a statement of the contents of a subject which students are expected to study. It is also a statement of the order in which students are expected to study those contents. The definition of Burston leaves out a lot of elements found in the syllabus by way of recognizing only the content. The definition, therefore, represents a parochial view of the syllabus. A more comprehensive definition of syllabus is given by Farrant (2005) which recognizes the syllabus as an outline specifying the rationale, aims and objectives, contents, learning activities and evaluation tools of a particular subject, packaged in the school curriculum.

The goals of the integrated science syllabus are designed to help students to adopt sustainable habits for managing the natural environment for humankind and society (CRDD, 2014). Also, is to explore, conserve and optimize the use of energy as an important resource for the living world. Another aim is to adopt a scientific way of life-based on pragmatic observation and investigation of phenomena.

The syllabus covers a thre- year period of Senior High School Education. Each year's work embraces the five themes which are: *Diversity of Matter, Cycles, Systems, Energy and Interaction of Matter* (CRDD, 2010,2012). The five themes form the five sections of the syllabus for each of the three years' work. Details of the coverage of the themes are as follows:

### *2.1.1 Section 1 - Diversity of Matter*

The syllabus specifies that the world has great biological, physical and geological diversity and hence the study of diversity should enable students to appreciate that there is a great variety of living and non-living things around us and in the world in which we live. Students will also recognize that there are common threads that connect all living things and there are unifying factors in the diversity of non-living things that help to classify them. The study of diversity will allow students to appreciate the importance of diversity and the necessity of maintaining it. They will also come to realize that interconnectedness among the living and non-living things is necessary to create harmony in nature.

### *2.1.2 Section 2 Cycles*

The study of cycles should enable students to recognize that there are repeated patterns of change in nature and understand how these patterns arise. Examples of these cycles include the day and night cycle, life cycles of living things and the recycling of resources. Studying these cycles helps humans to predict events and processes and to understand the Earth as a self-sustaining system.

### *2.1.3 Section 3 - Systems*

The study of systems should enable students to recognize that a system is a whole consisting of parts that work together to perform a function. There are systems in nature as well as in artificial systems. Examples of systems in nature are the digestive and respiratory systems. Examples of artificial systems are electrical systems. A study of these systems allows humans to understand how they operate and how different parts influence and interact with one another to perform a function vital for life.

### *2.1.4 Section 4: Energy*

The study of energy should enable students to appreciate that energy affects both living and non-living things. It makes change and movement possible in everyday life. There are many forms of energy and one form can be converted to another. Humans use energy in many ways and for many different purposes. Humans are not the only living things that use energy. All living things obtain energy and use it to carry out life processes.

The study of this theme will allow students to appreciate the importance and uses of energy and the need to explore and conserve it.

### *2.1.5 Section 5 Interactions of Matter*

The study of interactions should enable students to appreciate that the interactions between and within systems help humans to better understand the environment and their role in it. There are many types of interactions. There are interactions between the living world and the environment at various levels; i.e. interactions that occur within an organism, between organisms as well as between organisms and the environment. There are also interactions between forces and objects. At the societal level, the interaction of humans with the environment drives the development of Science and Technology. At the same time, Science and Technology influence the way humans interact with their environment. By studying the interactions between humans and the environment, students can better appreciate the consequences of their actions.

Teaching syllabus for Integrated science (2007) stipulates that plans must be made for visiting well-established experimental and commercial farms, research institutes, and other institutions/organizations related to Science, Health and Agriculture. It added that visits must also be planned to scientific and manufacturing industries where students will observe scientific work and the application of science and technology in manufacturing. Video clips, digitized content, or CD ROM on processes and systems could also be shown where these are available.

Schools must adopt a team-teaching approach for this course since many science teachers of the moment are trained as physicists, biologists, chemists, agriculturists, etc. This deficiency will be remedied in the future if the universities start programmes in integrated science from where a new crop of integrated science teachers will be drawn. In the meantime, teachers are encouraged to tap the abilities of their colleagues in agriculture and other science fields for the effective teaching of this course.

The syllabus also recommends some assessment procedures in assessing students' learning outcomes in integrated science. In developing assessment procedures, it stated that teachers select specific objectives in such a way that they will be able to assess a representative sample of the syllabus objectives. Each specific objective in the syllabus is considered a criterion to be achieved by the student. The assessment mode recommended are class tests, homework, projects, etc. and these must be developed in such a way that they will consist of a representative sample of the important objectives taught over a period.

## 2.2 Concept of Perception

According to Gregory (1973), human beings always share different perceptions about issues. Gregory argued that perception was more than simply the decoding of information received by the visual system. Instead, it is a process of making inferences about the data and developing reasonable guesses based on what is most probable or likely. Adding to Gregory's assertion, Jennifer and Gareth (1996) detailed that perception is a process by which individuals select, organize and interpret the input from their senses (vision, hearing, touch, smell and taste) to give meaning and order to the world around them. Neisser cited in Hayes (1998) observed perception as a skilled activity that takes place over time, not a static, "snapshot"-like process. Geiger and Ogilby (2000) also said perception is the primary process by which we obtain knowledge about the world. According to Hayes (1998), perception is an idea, a belief, or an image one has as a result of how one sees or understands something. Through perception, people try to make sense of their environment and objects, events and other people in it. Some scholars viewed perception to mean how we interpret the information that we receive through the sense organs of the body (Jennifer & Gareth, 1996; Hayes, 1998).

The various definitions of perceptions show that perceptions are formed in a process and that it is susceptible to change. It is a process in that it is ongoing. It occurs over some time. Elewokor (2007) termed a study that showed how prejudice could affect perception. The experiments used a stereoscope which is a device for presenting a separate picture to each eye at the same time. They showed research participants mixed-race pairs of individuals, with one member of each pair shown to each eye. In general, people were most definite when they were picking out members of their race, and more unsure when they were categorizing people from other ethnic groups. But Afrikaaners, who were noted for their racial prejudices differentiated far more sharply between the races. They perceived subcategories or uncertainties in classifying people. Allport interpreted this as showing how the strongly racist views held by these people had affected their perception.

Perception formation according to Ferreira and Santoso (2006) is the strong influence exerted by information gained at earlier stages in building an individual's perception of something. The first information received not only impacts the knowledge organization of the human mind but also influences the processing of new information. Further to this, Ferreira and Santoso (2006) noted that where subsequent information is regarded as biased, preceding information benefits from greater validity, as the primacy effects foster precise perception because the expectations based on the first information are comparatively valid, whereas subsequent contradictory evidence lacks validity. As a result of past beliefs, information received at later stages by a person is only interpreted in the context of an existing mindset.

In other words, the assimilation of the later information will occur in the light of pre-established beliefs and expectations. Because the information received at an early stage shapes the impressions directly, this information plays a key role in influencing the information received at a later stage (Bierhoff, 1989) and how it is treated. Belief perseverance theory also maintains that individuals derive their expectations based on the first information received and that this affects the way they build impressions at later stages (Lord, Ross & Lepper, 1979; Bierhoff, 1989).

People are inclined to maintain the validity of their initial beliefs even where disconfirming information to those beliefs might be found. The consequence of this biased assimilation process is that individuals tend to regard the disconfirming information as irrelevant and unreliable (Lord *et al*., 1979; Bierhoff, 1989). The belief perseverance theory is supported by studies that examine the tendency of people to assign greater attention towards information that supports their preconceptions (Snyder & Gangestad, 1981). Although opposing views argue that individuals place more attention on disconfirming information than the theory suggests (Ferreira & Santoso, 2006).

Perception is also influenced by culture, learning, motivational support, predisposition to new situations and frequency of past confirmation of a congruent type (Ferreira &

Santoso, 2006; Alexander, Mundrake & Brown, 2009). Of all the factors that influence the perception of an individual, learning is the most paramount (Ferreira & Santoso, 2006). In every new situation, learning takes place and for that reason, it becomes crucial in determining the correlation that exists between our past experiences. Learning difficulties can be said to exist in any situation in which a student fails to grasp a concept or idea as the result of one or more of three factors (Ferreira & Santoso, 2006). According to these studies, the first factor concerns the nature of the ideas/knowledge concerning the concept to be learned. Indeed, according to Ballantine and Larres (2004), one of the most important single factors influencing learning is what the learner already knows. Similarly, Ferreira and Santoso (2006), claim that an individual's prior conception is derived from experience with the environment and their existing ideas which are used to model new situations.

The second factor concerns the demand and complexity of a learning task in terms of the information processing requirements compared with the student's information handling capacity. The third factor concerns communication problems arising from language use, especially about technical terms, general terms with context-specific specialized meanings, and the complexity of the sentence structure and syntax used by the teacher, compared with the student's language.

## 2.3 Empirical Review of the Study

From the literature, a lot of attitudinal studies have been carried out which include among others; perceptions and their influence on students' achievement in science and investigation of gender differences (Maison, 2004). McLeod (1992) indicated that affective background factors play a central role in learning science and in maintaining a continued interest in the subject. With regards to the effect of perceptions on students' learning, Maison (2004) indicated that "negative perceptions can powerfully inhibit intellect and curiosity and keep us from learning what is well within our power to understand" (p.223) which lends weight to the need to examine SHS 3 students' perceptions towards integrated science. Ruffell, Mason and Allen (1998) indicated that students who hold positive perceptions towards science tended to express a generally favourable perception towards science although Fraser and Butts 1991 (as cited in Ruffell, et al, 1998) found no significant correlation among students' perceptions and science. Also, Hammouri (2004) in a study of the effects of student-related variables on achievement in science of 3,736 Jordanian 8th-graders reported that perceptions were among the affective variables that led to variation in science achievement of the students.

The Fourth National Assessment of Educational Progress (NAEP) Science Assessment report indicated that males were more likely to report being good in science, even though both genders were equally likely to report enjoying science (Taylor, 2004). They also reported significant gender differences in perceptions towards science, self-confidence, and perceived usefulness, in favour of males.

Taylor (2004) in a study of 745 students in four high schools in Southern California perceptions towards science reported that students' perceptions towards science were positive. This followed an investigation Taylor (2004) further carried out concerning students' perceptions towards science using a test of perceptions. Students' perceptions towards science were found to be influenced by two factors namely enjoyment of science and normality of scientists.

Mallam (2002) in a study involving 240 female students drawn from five co-educational and six all-girls secondary schools in Plateau State, Nigeria, reported that females attending girls schools had more positive perceptions towards science than females attending co-educational schools. This finding indicated that even among the same gender, differences in perceptions towards science may exist based upon school type. Eshun (2000) in school type perceptions of secondary school students involving 1419 students from 12 secondary schools in the Central and Western Regions of Ghana reported that students' perceptions towards science were positive on all the eight variables measured namely:

- Usefulness of science
- Confidence in learning science
- Success in science
- Effective motivation
- Science anxiety
- Science as a male domain
- Understanding science and
- Like doing science.

The three highest responses were on the variables; success in science, confidence in learning science and usefulness of science in that order. The least positive response was for science anxiety followed by motivation. Eshun further reported differences in perceptions towards core science based upon school type. Girls in single-sex schools expressed more confidence in doing science compared to boys in single-sex schools while girls in mixed schools expressed far less confidence than boys from single and mixed schools. What this study seeks to explore is to ascertain whether differences exist in the perception of males and females in integrated science topics. Most of the studies on perception focused primarily on the subject as a whole and not on topics as this study sought to explore.

## 2.4 Perceived Difficulty of Topics in Integrated Science

Research literature from countries around the globe provides evidence of many commonalities in the types of problems and issues confronting the learning of integrated science topics, especially at the primary and secondary levels. Issues such as poor performance in science, low enrollment in science courses at the upper secondary and tertiary levels, as well as poor interest and attitudes to science have plagued the education systems of many countries for decades. Yet, despite numerous investigations into these areas, which served to inform various proposals and recommendations from reputable researchers and organizations on approaches and strategies to address them, these problems persist. Students are either still finding science too difficult, or, for various reasons, their interests are being drawn away from science. According to the Chief Examiner's Report (2010), students' performance in integrated science over the years is not the best and it is concerning certain specific questions under some topics which students face difficult.

There are varieties of reasons why students, especially at the secondary level, may perceive topics in science as difficult in comparison to other subject areas. It may be due to how the students perceive the subject based on their experiences with it, or even from information about the subject from other persons. Lopez (2009), commenting on the perceived difficulty of the subject area, indicated that this difficulty may be due to problems in the perception and thinking of students. Lopez analysis of the nature of perceived difficult topics led him to propose that this difficulty may be caused by the complexity of ideas and concepts existing at three different levels: macro and tangible, micro, and representational or symbolic. Using the concept 'water' to explain these levels; this concept can be taught at the macro level where students can observe the properties of water. It can also be taught at the micro-level where, for example, students are taught that water consists of molecules of hydrogen and oxygen. At the representational level, these molecules can be represented as a symbol $H_2O$.

These multiple ways of representing the same concept are common in secondary-level science courses, especially chemistry and physics. Johnston (2012), proposed that the interaction of these three levels may cause overworking of the working memory hence causing difficulty in conceptualizing various areas in science. Although the spiral nature of the curriculum should allow the gradual progress of learning concepts from concrete (macro-level) to abstract (micro and representational), very often in science teachers have to use all three levels in a single lesson.

Behar and Polat (2007) also pointed to misconceptions about science phenomena possessed by students as contributing to the difficulty of certain science topics. Chiappetta and Koballa (2006) defined misconceptions or alternative conceptions as ideas about phenomena that students bring to the classroom that does not correspond well with the scientific knowledge to be taught. They added that these alternative conceptions are tenacious and resistant to change by conventional teaching strategies. So these misconceptions may, according to Behar and Polat (2007), cause misunderstandings in certain science topics. This may especially be the case if the teaching strategies used by teachers are not adequate to allow for conceptual change.

A related argument put forward by Behar and Polat (2007) concerns the many terms and symbols used in the teaching of various science concepts. Many such terms are new to the students and so cannot be linked to their cognitive structures which, according to Behar and Polat, may also cause information overload in the working memory. In addition, some terms are known by students, but in a different context and with a different meaning to that used in science. An example is a concept of 'work'. Confusion may result which adds to the perception of the difficulty of the area of content.

Key factors in facilitating an effective learning environment in the science class are the teaching strategies used by teachers. As early as 1910, John Dewey criticized science teaching of the day as giving too much emphasis to the accumulation of information rather than to an effective method of inquiry (Lopez, 2009). Unfortunately, this argument appears to be as relevant today as it was then. Many times, teachers use the excuse of overloaded science curricula to explain their reliance on strictly didactic methods of teaching. Though these claims may have some merit, these teaching strategies may in effect, portray the subject as difficult to many students. Behar and Polat (2007) alluded to this when they identified the passive roles of students in the classroom and their perception of the teacher as the only source of knowledge, as contributing to the perceived difficulty of science topics.

## 2.5 Teachers' Attitudes toward Integrated Science Teaching

Among several variables that have been identified as important for the formation of students' attitudes to science is the teacher's attitude to the subject and his/her behaviour in the classroom. The existence of a correlation between attitudes and behaviour is widely accepted and has been identified as an essential attitudinal feature by different researchers in social psychology (Ajzen, 1988; Fishbein & Ajzen, 1975) and in science education (Koballa, 1988; Shrigley, 1990; Zint, 2002). Zint (2002) posited that, one, if not the most popular and successful theories in attitude-behaviour research is Fishbein and Ajzen's 'Theory of Reasoned Action' published in 1975 and 1980. The model describes an individual's attitude toward any object as a function of the individual's beliefs about the object as well as the implicit evaluative responses associated with those beliefs. That is, a person who believes that performing a given behaviour will lead to mostly positive outcomes will hold a favourable attitude toward performing the behaviour, while a person who believes that performing the behavior will lead to mostly negative outcomes will hold an unfavourable attitude (Ajzen & Fishbein, 1980).

According to Osborne, Simon, and Collins (2003), in their review cited several studies indicating that the most positive attitudes to science held by students in all grades were associated with a high level of personal support by the teacher and the comments teachers made in class.

Similarly, Fisher, Waldrip, and den Brok (2005) found in their study with 2178 Australian grade 5, 6 and 7 children a positive association between students' attitudes to science learning and the teacher's interpersonal behaviour in the science classroom. That is, students enjoyed learning science more, the more their teacher interacted with them before, during and after lessons, the more they kept eye-contact, smiled, and provided humour in the classroom (Fisher et al, 2005). However, teachers also benefit emotionally from positive teacher-student interactions. According to Hargreaves (2000), elementary and secondary school teachers attain emotional rewards and 'psychic rewards' from positive feedback from individual students as well as whole class groups. In his qualitative study with 53 teachers, Hargreaves (2000) found substantial differences in elementary and secondary school teachers concerning the type of affective reward and the degree of importance of both emotional and psychic rewards. Emotional rewards due to positive incidences with the whole class were cited as the main cause for adopting positive attitudes toward teaching by all elementary school teachers that responded satisfactorily to the appropriate interview question (Hargreaves, 2000). These teachers felt emotionally rewarded by, for example, being students' most favourite teacher, enjoying humour and informality with students, and experiencing "lots of 'warm fuzzies' with their classes" (p. 818). Individual breakthroughs of students have also a positive but less salient impact on elementary school teachers' attitudes. About half of the interviewed elementary school teachers that responded useably to questions concerning positive incidences with students regarded individual success cases of difficult or demanding students as most emotionally rewarding (Hargreaves, 2000).

These individual cases are what Lortie (1975) called the 'psychic rewards' of teaching: "Teachers feel rewarded when students show affection toward and regard for them and when students demonstrate that they are enjoying (or have enjoyed) their learning" (cited in Hargreaves, 2000, p. 817). Psychic rewards, therefore, seem to be as dependent on individual student's learning (cognitive domain) as on the emotional well-being (affective domain) of all students in a class. This stands in contrast to 'purely' emotional rewards that are mainly based on close emotional bonds or affective understanding between the teacher and her/his students, and secondarily on students' cognitive learning. Hargreaves (2000) also found that relatively more secondary than elementary school teachers feel 'psychologically rewarded' or satisfied with their teaching when perceiving students as emotionally and cognitively engaged in learning. That is, teachers' enjoyment, which is one of the major components of the attitude concept, seemingly becomes more positive with the degree of students' learning – a positive relationship that is further associated with teachers' expectations for students' learning that in turn rise with increasing grades.

A positive association between teachers' attitudes toward teaching and students' attitudes toward learning has also been described by Stenlund (1995). In his comparative study that was part of a cross-cultural study involving seven nations from North America, Europe, and Asia, Stenlund (1995) investigated the relationship of teachers' perceptions for students and student learning with teachers' enthusiasm or discouragement concerning professional work. Semi-structured, open-ended interviews were conducted with groups of two to 16 secondary school teachers that explored sources of enthusiasm in teaching, sources of discouragement in teaching, and possible solutions to enthusiasm and discouragement in teaching. The analyses, based on frequency distributions and chi-square tests to determine the significance of differences between the participating countries, revealed a consistency of responses regarding students and learning across all countries. One of the main findings is that teachers of most studied countries need students who are responsive, attentive, and eager to learn in order to enhance their own enjoyment in teaching (Stenlund, 1995).

Moreover, "teachers appear to attach fairly significant importance to individual student growth and development and the bonds that develop between the teacher and student as precursory conditions through which the teacher gains enthusiasm for his or her work life" (p. 156). These findings are similar to the outcomes described by Hargreaves (2000) regarding the positive association between teachers' attitude to teaching and students' attitude to learning. That is, teachers gain emotional rewards from positive incidences with the whole class as well as psychic rewards from individual student's positive development and the emotional bond that develop between teacher and student (Hargreaves, 2000).

Interestingly, the positive relationship between teachers' attitudes toward teaching and students' attitudes toward learning suggested by Hargreaves (2000) and Stenlund (1995) was proven true not only in regards to teachers' positive stance on the job but also with regard to the discouragement encountered by teachers; that is, negative disposition to their job as found by Stenlund (1995). To be more precise, the main source for teachers' discouragement is the perceived lack of motivation in students (Stenlund, 1995).

Devi (2005) found that success in teaching field depends upon two prime factors attitude towards profession and job satisfaction. Suja (2007) also confirmed similar findings. According to him, attitude towards profession, interest in profession and teaching experience influence job commitment of the teacher. Mathai (1992) in his study stressed that attitude towards profession and success in teaching are correlated to each other. In another study, Cornelius (2000) revealed that intelligence, attitude towards teaching and academic achievement of teacher trainee cast impression on their competence. Gynanduru and Kumar (2007) established that over achievers and average achievers possess more favourable attitude towards teaching in comparison to under achievers. Pushpam (2003) confirmed positive relationship between women teachers' attitude towards teaching and job environment.

Other factors that influence integrated science instructions are attitudes and beliefs towards teaching. Many research studies have reported that teachers' attitude towards science teaching is a strong indicator of both quality and quantity of science taught to the pupils (Schoeneberger & Russell, 1986: Wallace & Louden, 1992) as positive attitude towards integrated science teaching results in effectiveness and quality time spent on teaching. In a study by Koballa and Crawley (1985), found that teachers who had low beliefs in their ability to teach integrated science also developed negative attitudes towards science. These teachers eventually avoided teaching integrated science.

Another factor that influences integrated science teachers' instruction is their self-efficacy beliefs (Aydin & Boz, 2010). The teacher's efficacy beliefs are indicators of their instructional performance. Bandura (1977) defined self- efficacy in his social cognitivist theory as "beliefs in one's capabilities to organize and execute the course of action required to manage prospective situations" (p.3). With respect to integrated science teaching, self-efficacy consists of personal science teaching efficacy and science teaching outcome expectancy. Personal science teaching efficacy refers to the belief that one is capable of delivering effective and competent science instruction, while science teaching outcome expectancy refers to the teacher's beliefs about students' ability to learn integrated science. Schunk (2003), in his study stated that: even though self-efficacy is crucial to teacher achievement it is not the only important factor in that regard. He further argued that another very inextricable influence on teacher achievement is knowledge. Pajares (1992) indicated that knowledge and beliefs cannot be considered separately. In view of this one can deduce that basic school integrated science teachers who have good content knowledge and self-efficacy beliefs will also adopt positive attitudes and teach science effectively. Some earlier studies have suggested that teacher efficacy is linked to student achievement (Tschannen-Moran, & Woolfolk Hoy, 2001), student motivation (Midgley, Feldlaufer &Eccles, 1989; Lewandowski, 2005; Woolfolk Hoy, 2000), provides the foundation for teacher motivation (Adyin & Boz, 2010) and classroom management strategies (Ashton & Webb, 1986). Therefore it is important for colleges of educations to be mindful of the importance of trainee teachers' self-efficacy beliefs and attitude towards science teaching during instructions. This is because there is positive relationship between strong science content knowledge and positive attitudes and high self-efficacy towards science teaching and vice versa (Stevens & Wenner, 1996).

### *2.5.1 Teacher knowledge*

Although a still rather disputed supposition, most educational researchers agree that basic school teachers' attitudes toward the teaching of science are influenced by their knowledge. Besides the difficulty of determining attitudes about integrated science teaching, one of the reasons for the indifference in this question may be the complexity of teacher knowledge that makes it extremely difficult to represent it within one overarching framework or theory. In particular, any representation of teacher knowledge needs to reflect its socially constructed and dynamic nature. Another problem lies in the disagreement about what knowledge is of most worth in integrated science and, consequently, what knowledge concept has been examined, and in which way. Some studies have focused on teacher content knowledge and others concentrated on teacher pedagogical knowledge. However, it seems problematic to draw a line between content knowledge and pedagogical knowledge since both forms are interconnected and together shape the way integrated science is taught. A model that somewhat combines both categories of knowledge is the pedagogical content knowledge (Shulman, 1986). The concept of pedagogical content knowledge integrates the realms of subject matter, student conceptions, and teacher understandings of specific learning difficulties, teacher knowledge, and beliefs about purpose as well as knowledge of instructional strategies.

Appleton (2002) further discusses what teachers' pedagogical content knowledge in integrated science could entail: "knowledge of students, classroom management, assessment, pedagogy, curriculum, context, environment, socioculturalism, and the nature of science" (p. 394). The predicament regarding integrated science teachers' knowledge is reflected in some studies. Kumar and Morris (2005), for instance, suggest that their findings of a significant correlation of prospective teachers' attitudes toward mathematics and science with their scientific understanding should be interpreted with caution. The reason for this caution is the lack of consensus among scientists and educators about what form of knowledge (content or pedagogical) impacts scientific understanding of prospective teachers.

It has been suggested that a considerable number of elementary school teachers knowingly (Harlen, 1997; Weiss, Banilower, McMohan, & Smith, 2001) or unknowingly (Garbett, 2003) lack profound factual background in science. Furthermore, the pedagogical knowledge of prospective elementary science/maths teachers, their views and beliefs regarding their teaching methods, and the impact of those variables on their attitudes or behaviours has been investigated quite substantially. Especially in the 1990s, probably because elementary pre-service science teachers' performance in class had been described as limited and of low quality (Schoon & Boone, 1998; Tilgner, 1990), research in those subjects had been intensified. In their summary of literature in science education, Finley, Lawrenz, and Heller (1992) delineated 24 studies on teacher behaviour, attitudes, and beliefs, of which two thirds investigated prospective elementary science teachers' attitudes to science teaching alone. However, ample research shows that elementary teachers who lack content knowledge feel less confident in teaching science, and, consequently, attain less positive attitudes about teaching integrated science than teachers whose knowledge background is substantial. For example, Weiss et al (2001) reported in their extensive 'Report of the 2000 National Survey of Science and Mathematics

Education' that only 18 to 29 percent of nonspecialty elementary school teachers (grade K-6) in the US feel very well qualified to teach physical science, earth science, and life science. Similarly, a substantial mixedmethod approach study with in-service grade 3/4 and grade 6/7 teachers revealed that participants were well aware of their limited science content knowledge and, consequently, rated their confidence in teaching science rather low (Harlen, 1997). Most interestingly, though, is the fact that the studied elementary school teachers nevertheless thought they are able to teach science by using teaching skills and strategies compulsory for science, including those which would appear to require solid subject knowledge.

This apparent contradiction lends support to the idea that confidence to teach does not depend entirely on understanding of the scientific content. According to Harlen (1997), the confidence in teaching science is most likely based on teachers' general pedagogical knowledge that helps them to overcome constraints and facilitates the navigation around topics and units elementary teachers have limited content knowledge in. Garbett (2003), similar to Harlen (1997), found a positive relationship between student teachers' confidence in teaching science and their content knowledge competence. The study, which was based on 57 surveys and tests, investigated first year early childhood student teachers' attitudes by asking them to rate their own confidence in science teaching and to write about their most vivid school memory. Their actual science competence was subsequently assessed through a knowledge test with 73 multiple choice questions covering the subjects biology, chemistry, physics, and astronomy. Afterwards, the students were asked to predict the number of their correct answers in the test to examine their perceived subject knowledge competence. This study design allowed for the investigation of the actual competence as well as the perceived competence of prospective educators. Garbett's (2003) findings suggest that most of the studied teacher candidates had a poor content knowledge base when entering university. Noteworthy is that the majority of teacher candidates were not aware of their lack of content knowledge and that 60 percent thought their background knowledge is adequate to teach science at the early childhood level. As stated by Garbett (2003): “Student teachers seemed confused and ignorant of their own understanding and/or misunderstanding in science” (p. 477).

This ‘confusion’, though, probably had to do with the fact that the cohort was comprised of freshmen who attended their first lecture in the Bachelor of Education program. However, the above mentioned research corroborates the supposition that confidence to teach science depends on pedagogical content knowledge and not on subject knowledge alone. It also lends support to the notion that there may be a considerable difference between self-expressed confidence and actual competence.

## 2.6 Students’ Attitudes towards Learning of Integrated Science

Children / pupils’ commonly have a positive attitude toward all school subjects, a natural curiosity about quantitative events and some problem-solving skills when starting school (Ontario Ministry of Education, 2003). This attitude shifts, and students of both genders begin to lose interest particularly in science and academic subjects that require a more advanced knowledge of mathematics toward the end of grade six (Jones, Howe, & Rua, 2000; Simpson & Oliver, 1990). Moreover, a gender gap appears soon after, with more girls than boys disliking science and technology classes in middle school (Catsambis, 1995) and with more girls than boys opting out of science classes in high school (Watt, 2005). This trend continues in some integrated science related disciplines such as physics, mathematics, engineering and computer science in higher education with decreasing student enrolments overall and female students in particular (Canadian Association of University Teachers, 2007). Consequently, the number of young people pursuing careers in those fields is not keeping up with the demand in Western industrialized countries (Angell, Guttersrud, Henriksen, & Isnes, 2004). University and college students' indifference to the hard sciences and disciplines requiring an advanced knowledge of mathematics derives from their attitude to those academic subjects that, in most cases, is caused by several, often intertwined variables (Osborne et al, 2003).

According to these authors, it is this enmeshment of variables along with the fact that attitudes are essentially a measure of the subject's expressed preferences and feelings toward an object that makes it extremely difficult to examine attitudes toward science.

### 2.7 Students' Interest in Science

Mallam (2002) defined interest as referring to a differential likelihood of investing energy in one set of stimuli rather than others. This definition applies to situations in the classroom where the interests of students in academic areas are reflected in actions such as time and effort spent studying a particular subject, willingness to engage in additional activities involving the subject area besides that given by the teacher, and voluntarily selecting the subject for further study. Various researchers have indicated positive relationships between student interest and learning (Mallam (2002). Ziegert (2002) pointed to various research results (Gardner, 1975, 1996; Schibeci, 1944) which indicated the importance of cultivating students' learning interests about science.

Despite this evidence of the importance of students' interest in science, especially as it relates to their academic achievement, studies worldwide have revealed that interests in, or attitudes towards science decline during students' secondary years (Ziegert, 2002). What is unclear are the specific reasons for this decline. Other researchers have identified factors such as difficulty in the calculation that impact students' interest in specific subjects. For example, Strutchens, Harris, and Martin (2001) identified a significant decline in interest in physics and chemistry as students progress through secondary school because they involved a lot of calculation. He also notes that this decline is especially pronounced among girls. Analysis of results from a 'Relevance for Science Education Project (RSEP) undertaken in countries throughout Europe from 2003-2008 revealed that the number of students regarding science subjects, in particular physics and chemistry, as difficult has increased (Strutchens, Harris, and Martin (2001). There has also been a persistent decline in post-compulsory high school science enrollment worldwide over the last two decades (Ziegert, 2002).

## 2.8 Some Factors that Affect Students' Understanding of Topics in Integrated Science

### *2.8.1 How integrated science is learnt by learners*

According to Strutchens, Harris, and Martin (2001), students learn integrated science by memorizing rather than by exploring and discovering the underlying properties. Scientific knowledge learned in this way is limited and superficial. For example, if students memorize the formation of water ($H_2O$), they will be unable to distinguish between the formation of water and the formation of hydrogen ($H_2$). Eventually, these students would find it difficult in applying that limited knowledge in problem-solving (without understanding it well). This lack of understanding often discourages the students, invariably leading to poor performance in questions involving integrated science. Many factors have been proposed to explain what makes integrated science learning difficult.

First, the scientific language, which involves specific terminology, is unique and needs particular attention and understanding before it can be used meaningfully. Misuse of scientific terminology can lead to misconceptions of scientific knowledge (Bishop, 1983).

Similarly, integrated science requires visualizing abilities but many students find it difficult to perform these abilities. Visualizing shapes of elements, molecules, etc in science is very difficult for students lacking or having sharp retentive memories (Ben-Chain, Lappan, & Houang, 1989). Due to their limited scientific experiences, students may not have enough opportunities to develop and exercise their abstract thinking skills for effective integrated science learning.

Another problem is that traditional approaches to integrated science instruction do not seem to help students achieve the intended learning outcomes in the curriculum. By using just textbooks and chalkboards, classroom integrated science experiences hamper optimal learning. In the Ghanaian context, this concern is shown in the poor integrated science performance of students in public examinations (The Chief Examiners Report, 2010). There is an urgent need to change the traditional mode of integrated science instruction to one that will be more rewarding for both teachers and students. Specifically, learners must be given opportunities to personally investigate and discover integrated science to enable understanding of the subject in-depth and also with the other fields of integrated science.

### *2.8.2 Integrated science instructional approaches*

The approach used by the teacher also to a larger extent affects the building up of scientific concepts or knowledge in learners. Osafo-Affum (2001) observed that many integrated science teachers use ‘lecture’ instead of ‘teach’. Teachers give definitions;

make no use of concrete materials and practical ways to explain scientific concepts. Teachers rather give notes on integrated science just as they would do in history. Students tend to practise what is taught although Arhin (2009) blames this on the lack of science laboratories in most schools.

Fletcher (2003) repeated that indeed, irrespective of the level at which integrated science is taught, the task of the Ghanaian integrated science educator has almost always been that of a lecturer and interpreter, communicating the structure of integrated science methodically. The teaching method is simple. The integrated science educator explains, illustrates, demonstrates and in some cases gives notes on procedures and examples. The following are examples of teaching strategies used by teachers in teaching Integrated Science.

Teaching strategy is simply defined as a process oriented model that allows teachers to present ideas and concepts at many different levels to meet the needs of a variety of learners (Anderson, 2001). This can be either expository or heuristic. The expository strategy is largely direct instruction with the teacher mostly telling the learner while the learner passively listens and takes notes. Discovery teaching strategy is indirect with the teacher helping the learner to find out by posing questions, guiding, indicating sources of information and sharing ideas, problems, and solutions (Nasibi, 2003).

According to KIE (2002), the goal of teaching biology is to guarantee that learners communicate biological information in precise, clear and logical manner. This is to enable the learners apply the knowledge gained to maintain the health of the individual, family and the community, relate and apply relevant biological knowledge and understanding to social and economic situation in rural and urban settings and to impart skills to the learners that enable them to apply in the day to day life (Peat, 2000). These skills include observation, recording, drawing, classifying, communicating, measuring, inferring formulating of hypothesis and identifying and controlling variables. Therefore, teaching biology in schools aims at imparting certain skills to the learners and making him/her to be equipped in order to exploit resources in the environment without causing the destruction.

Teaching strategy are methods by which the teacher endeavors to impart desired learning experiences to learners in classroom. Walhenga (2002), states that the traditional strategy for instructing are utilized in parts of secondary schools in Kenya this technique incorporates; Demonstration, lecture method, fieldwork, practical technique, project technique discussion, discovery and enquiry. Some of the most commonly used teaching strategies are discussed as follows; Demonstration, in teaching biology involves the utilization of show or the display completed by the instructor whiles the students watch. It is mostly used in showing the students the correct use of certain science equipment that is carried out by a single teacher alone, a student, or a group of students.

#### *2.8.2.1 Demonstration*

Usman (2000), demonstration method is one of the teaching methods that involve mental skills for learning by students such as observing, measuring, classifying, formulating hypothesis, experimenting, data collection, data analysis making and conclusion. Demonstration requires creativity and conceptualization; it needs full incorporation of all skills of demonstrating as well as showing samples and making displays (Mahuta, 2013). He went further to say the demonstrator is like a mirror as he shows while students observe. The process of demonstration is a physical display of objects, models, pictures, and diagrams. When students learn through the demonstration strategy of teaching, the comprehension last longer in the child's memory. In biology, certain activities require the use of demonstration such as action of iodine on the green leaf, dissection of animals and manipulation of equipment like the microscope.

Demonstration can be used to carry out expensive or difficult experiments, which may expose students to danger. Less scope is covered since it takes time for the students to get familiar with the procedures, equipment, or material used for the exercises. This strategy has drawbacks that cannot be effective if the teacher does not involve pupils appropriately during the demonstration (Wachanga, 2002). Further in a situation where the class size is very large visibility of the details to the learners of what the teacher is doing is not assured thus become difficult for the students to acquire manipulative skills.

***2.8.2.2 Lecture method***

Another strategy that teachers used in the teaching and learning of biology is the lecture method. Lecture, is a one-way flow of communication from the teacher to the students. It is teacher-focused strategy consequently; this implies the teacher completes the teaching while the students are passive listeners just taking down notes subsequently it is alluded to as talk-chalk technique or didactic approach. This technique is to a great extent teacher centered and comprises of taking care of our information repacked with little or no class involvement. This a method that is used primarily to introduce students to a new subject, but it is also a valuable method of summarizing ideas, showing relationships between theories and practice, and reemphasizing the main points. Many teachers use this teaching method almost exclusively, as it is considered the simplest, and one can cover large amount of material in a short period of time (Abubakar, 2012).

According to University of Pittsburgh (2006), a lecture can be an effective strategy for communicating theories, ideas and facts to students. The main aim of teachers is to make sure that he/she communicates effectively with their students, in order to do so, a teacher should try to achieve clarity of delivery, clarity of expression and clarity of structure. Mani (2008) postulated some points to be noted if lecture method was to be used which are, used by mature students who could jot down few points about the lecture mostly used in the higher educational institutions. In this method of teaching biology the teacher has to understand the size of the audience, the instructional material to be used, how to maintain an effective class room environment and the interest of the students. The teacher is to organize the instruction to be given to the students so as to avoid complexity and confusion among the students and the presentation of the lessons. Oluoch (1992), contended that lecture strategy is an economical method for transmission of information to huge number of learners since it does not need a lot of facilities, it additionally empower the instructor to exhibit information in consistent and coherent within a short period of time.

#### *2.8.2.3 Excursion/ field trip strategy*

This strategy is an important component of science teaching which involves taking the students outside the classroom for the purpose of making observations and also for obtaining some specific information. These enable the learners outside the classroom setting to have first-hand understanding of what occur in our environment or the real life situation. Field trip is an outdoor type of laboratory activity or field work or learning exercise undertaken by teachers and students in certain aspects of a subject, to give students the opportunity to acquire knowledge (Obeka, 2010). Bichler (1978) is fieldwork furnishes the learner with the direct proof of first-hand scientific evidence on how they impart on a regular day-to13 day existence. The learner might be given a chance to cooperate with the specialists in a specific aspect in Integrated Science. Wakili (2007) pointed out that it is a method that involves travelling out of school environment to a place designed or selected for learning purpose , such places may be historical town, an educational environment a game reserve, herbariums, botanical garden, zoo, amusement reserve, rivers, lakes and seashores, ponds and forest. Students often have a long lasting memory when they travel and see events and places for themselves. This is usually arranged and conducted by the school in order to improve the knowledge of the students (Mahuta, 2013).

According to Aliyu, (2008) field trip is taking students out of the classroom to places where they can see concrete illustration of classroom theories. It also offers direct observation and interpretation of the substance in their natural surroundings. It requires the use of basic scientific skills that is observation, identification, classification and manipulation of substance in the natural surroundings. Field trips provides real life context for the material being taught make more sense be remembered better if students can actually see where and how they work or take place in reality.

***2.8.2.4 Practical work/laboratory activity***

This strategy involves learning by doing. It is a strategy of teaching where by tools, apparatus and instructional materials are used to enhance, stimulates the process of learning in a place known as laboratory. Laboratory work in biology involves observation, description or drawing, microscopy, dissection and experimental work

(Ezeaghasi, 2014). Reid and Shahi (2004) hold that laboratory works give the student the opportunity to experience science by using scientific research procedures and also to encourage the development of analytical and critical thinking. It also strengthen theoretical knowledge, experiencing the pleasure of discovery and development of their psychomotor skills, increasing creative thinking skills, higher order thinking skills, developing manual dexterity by using tools and equipment, allowing students to apply skills instead of memorization (Ezeaghasi, 2014). Learners are engaged in practical learning activities this includes action oriented learning directed by the students under the direction, supervision of the teacher. The teacher provides the students either separately or in the group with the material and apparatus and additionally the guideline to be followed in performing the practical. The teacher provides his/her students as individuals or in groups with specimen apparatus and the instruction to follow (Maundu, Sambili & Muthwii, 2005). Therefore this strategy encourages self-confidence in scientific investigations and exploration.

#### *2.8.2.5 Discussion*

This is another strategy of developing cognitive and affective strategies in teaching biology. This is a two-way interaction strategy. Discussion is a strategy of teaching that involves an interaction were by the teacher, students engage themselves in lively discussion of a topic, and both the teacher and students give their views on the topic. The teacher in a discussion class acts as a moderator. According to Dawuda (2014), discussion is a student centered method of teaching in which students participate actively in the in the discussion process over a subject matter or a topic from various point of view, while the teacher act as a moderator or guide. This strategy facilitates effectively flow of information from the teacher to the student, from the students back to the teacher and from one student to another (Haas, 2002).

Further Obeka, (2010) states that discussion strategy in teaching science help to increase curiosity about the subject; it enhances more positive perceptions of students about value of the subject, to get information on what to contribute during discussion students spend more time readings. According to Sanusi (2012), discussion is a variety of forums for open ended, collaborative exchange of ideas among a teacher and students or among students for the purpose of furthering students thinking, learning, problem solving, and understanding literary appreciation. Discussion facilitates higher levels of thinking, accommodates conflict, negotiation and consensus, enhance learning and longer retention. This makes students to attend to class more regularly since they usually enjoy the lesson especially when it is less formal thus motivating the learners.

#### *2.8.2.6 Discovery*

This is a teaching strategy that encourages students to be more active in their learning processes, by answering a series of questions and solving problems. It is a strategy which offers learners the opportunity to discover scientific facts, concepts and principles for themselves rather than being told. It allows learners the opportunity to discover and learn science, (Eneh, 2001). Further Mayer (2003) added that discovery strategy is based on the notion that learning takes place through classification and scheme formation. Further, Galleinstien, (2004),argued that discovery is essential as students are actively involved in the process of learning topics that are intrinsically motivating, context are often meaningful than typical classroom exercise. As the study acquires investigative and effective skills, new strategies learned in the context, and students are more likely to remember concept and information if they discover them on their own.

Enquiry strategy, enquiry as used in science teaching that refers to a way of questioning, seeking knowledge or information, or finding out about phenomena. It involves investigation, searching, defining a problem, formulating hypothesis, gathering and interpreting data and finally arriving at a conclusion. This strategy has different names given to it by different scholars; some call it problem solving, critical thinking, reflective inquiry and inductive thinking (Mani, 2008). According to Mahuta (2013) suggested that enquiry strategy provides the opportunity for the learners to seek for knowledge in a systematic and logical way, also provide the students with opportunity to examine ideas events and problems about a particular behaviour events and concepts.

Enquiry strategy of teaching the learner learn with minimum guidance from the teacher, seeks to discover and create answers to a recognized problem through procedure of making a diligent search (Haas, 2002). In this strategy of teaching, the teacher does not provide answers to the learner but he tries to direct and guides the learner to get answers accordingly, questions are raised and the students provide solutions. In enquiry situation, students learn not only theories and principles but also self-direction, responsibility and social communication. It also permits students to assimilate and accommodate information (Pine, Roth, Jones, Mcphee & Martins, 2006).

### *2.8.3 The level of learners cognitive development*

Nabie (2009) in his view described some difficulties in learning subjects that are integrated with nature. Although mention was not made specifically on scientific concepts, it is worth considering these difficulties since they relate to the learning of integrated science as well. Areas that he touched on include, learning difficulties that are characteristics of the learner, the nature of integrated science, learning difficulties arising from the school, curriculum expectation, children's ability to cope, and effects of learning theories. Explanations given on areas concerning difficulties of learning concepts by Nabie (2009) were similar to what has been described in earlier sections above. Nevertheless, an area that is worth mentioning was the learning difficulties that are characteristics of the learner.

According to Riddell, Brown, and Duffield cited in Nabie (2009), characteristics of the learner that hinder his or her scientific understanding are termed child-based learning difficulties. These include the child's health, language skills, perceptions and other scientific abilities for learning integrated science which the child may not have (Nabie, 2009). Some of these difficulties such as poor health may result in absence of the learner at school and may lose a particular concept taught on that day. As a result, these factors may tend to obstruct the building up of understanding for other topics which depend on earlier ones.

### *2.8.4 Teacher education in integrated science*

The training curriculum content for Colleges of Education and teacher training Universities offer courses like Introduction to Integrated Science Teaching. The US Conference Board for Sciences (CBS) (2000) has been examining the issue of what kind of knowledge integrated science teachers need to be well-prepared to teach. Their analysis suggested: Mastery of core concepts and principles of integrated science. Understanding of the nature of axiomatic reasoning and the role that it has played in the development of integrated science. Understanding and skill in the use of a variety of methods for studying environmental problems. Understanding of basic science concepts and their application in real life to solve problems. Knowledge of some significant modern aspects of integrated science. Ability to use computer-based dynamic drawing tools to conduct geometric investigations emphasizing visualization, pattern recognition, and conjecturing.

It is important to note, if the Ghanaian high school teacher who has some familiarity with aspects of modern integrated science, such as tiling and fractals, and with applications such as computer graphics and robotics, will convey a richer view of the subject to students. The CBMS report points out that fitting all of those topics into one college integrated science course that also treats Euclidean integrated science and axiomatic in-depth runs a clear risk of covering ground without developing depth of understanding. In terms of continuing professional development, the study by Jacobson and Lehrer (2000), point to teachers' eliciting more sustained and elaborate patterns of classroom conversations about integrated science when the teachers have enhanced knowledge of the typical milestones and trajectories in children's reasoning about space and integrated science.

In addition, research by Swafford, Jones and Thornton (1997) demonstrated that intervention programmes that enhance teachers' knowledge of integrated science and their knowledge of research-based findings on student cognition in integrated science can influence the instructional practice of increased geometrical content knowledge. Research-based knowledge of student cognition in integrated science was apparent in what was taught, how it was taught, and the characteristics teachers displayed. Concerning what was taught the teachers in this study claimed that, following the summer intervention program, they did not only spend more time teaching integrated science but devoted more quality time to instruction in integrated science. The increased quality was especially reflected in the use of rich problems and geometrical tasks. For example, a task like Alice's tessellated floor covering and Cathy's investigation of star polygons not only generated genuine mathematical questions, they also led to significant extension problems and valuable real-world and mathematical connections. Teachers' perceptions and researchers' observations also identified changes in how integrated science was taught. This instructional change was shown through their open-ended questioning and encouragement of student discourse. Teacher emphasis changed from giving answers to generating questions that probed students' thinking and engaged them in discussions that led to negotiated meanings for geometrical concepts and properties. The teachers not only stretched the students' thinking, but they also extended their understanding.

## 2.9 Factors Affecting the Learning of Science

Student and teacher comfort is indicated as the most important aspect of any school environment. If students are comfortable, then learning becomes much easier. Being comfortable is a combination of several different factors; adequate usable space, noise control, lighting, temperature and climate control, and sanitation.

The school environment is the most important area of a school because it is where students and teachers spend most of their time and where the learning process takes place. The following conditions help make the classroom a better place in which to learn. A school environment should be one in which every student feels safe. In this sense, the primary environmental policy and management objective of every school facility should be that of taking whatever steps are necessary to create a "sense of well-being." By definition, this is a healthy school environment. "Health is the state of complete physical, mental, and social wellbeing" (Berry, in Mokgaetsi, 2009). Schools are not primarily environmental showcases. Schools are special environments that exist to enhance the learning process. They are sensitively built environments housing very special segments of the population. Research proved that how the school is managed is the most critical factor in determining the quality of education for its students.

### *2.9.1 Students' attitude towards learning*

Attitudes are learned throughout life and are embodied within our socialisation process. All of us observe others and assess attitudes based on communication style (verbal and nonverbal) and behaviour. Students' attitudes toward learning can be linked to the taxonomy of learning styles. Curry, as cited in Mokgaetsi (2009) contended that students' attitude to learning is based on their understanding of the concepts of learning styles, student achievement, and motivation to explain the process of learning. Learning styles consist of a combination of motivation, engagement, and cognitive processing habits, which then influence the use of metacognitive skills such as situation analysis, self-pacing, and self-evaluation to produce a learning outcome. These concepts tend to develop two main attitudes on students towards learning; Positive attitudes and negative attitudes towards learning (Mullins, in Mokgaetsi, 2009). The negative attitude towards learning could result in students performing poorly preventing them from obtaining the required results for further studies.

### *2.9.2 School transition*

Transition programs and activities designed to inspire, motivate, and support instruction and interaction between students, teachers, and parents should be significant, extensive and ongoing for students to experience success. Brown and Armstrong (in Mokgaetsi, 2009) reported teacher perceptions about a transition period varied from student perceptions and concluded that teachers have an extensive list of situations that challenge students who make the transition to a new educational setting. Mokgaetsi (2009) noted parents who observed, guided, and interceded in their children's school activities provided better opportunities for their children to have a smooth transition to the new educational setting. Research is scarce regarding the potential of programs to assist students in Ghana in transition from one stage of the school to another school. While movement from primary school to Junior high school can be an exciting time for students, the transition is also filled with a tremendous amount of anxiety and stress for many adolescents in some countries (Hertzog and Morgan, in Mokgaetsi, 2009).

A study of Oglala Sioux in South Dakota (Bryde, in Mokgaetsi, 2009) indicated that the learners perform satisfactorily until the sixth grade. After the sixth grade, there was a decline in learner performance. This phenomenon was labeled as the 'Crossover Phenomenon,' believing that early adolescence is an extremely difficult time because the cultural differences become more evident during that stage of development, resulting in personality disturbances thus blocking achievement at school (Bryde, in Mokgaetsi, 2009).

### *2.9.3 Medium of instruction*

Competence in teaching and learning styles helps educators understand how people perceive, process and understand the information in different ways. Medium of instruction has been a serious concern in the past, especially in African countries due to the multiplicity of languages (Themane, 2000). Themane (2000) also stated that mother tongue is the basis of all teaching and learning and must be the medium of instruction because bilingualism cannot be set as the aim of teaching. In Ghana, most

JHS 3 students struggle to communicate in English and that could be one of the factors that put them at a disadvantage since that is the language used to respond to questions in the examination. This is supported by Sayed *et al.* (1991) who explained that exclusionary of mother tongue in the instructional process was being felt therefore students were forced to learn and communicate through the local language.

However, there is another study that argues that pupils who interact using the English language tend to understand it better and do well in examinations. Schools that use their mother tongue for interaction are disadvantaged as they end performing poorly in examinations. Ubogu (in Mokgaetsi, 2009) asserted that the prevalence of the use of local language means that pupils would lack a lot of vocabulary in English, which would be needed to understand teachers' lessons and the textbooks they read. In the high-achieving schools, the English Language was used as a medium of instruction while in the same areas; the local language was used together with English as the medium of instruction. In Ghana, the language policy states that English should be used as a medium of instruction from Primary Four upwards (Kafui, 2005). The use of English is important because most Ghanaian textbooks are in the English Language and English is the official language in Ghana. All tests and examinations are conducted in English therefore a working knowledge of the language is necessary. The use of the local language by the teachers created a deficiency in the pupils which made them unable to understand the textbooks they needed to use and this ultimately resulted in the low academic performance of the pupils. But the question that needs to be answered is that, can all final year students communicate, read and understand the English Language before the final examination?

### *2.9.4 School facilities*

According to Mokgaetsi (2009) thousands of schools still have poor physical infrastructure and many are dilapidated, dangerous and unfit for human habitation. There is often no water on the school site and poor sanitation thus such conditions do not only restrict the teaching and learning activities of the school but also threaten the health of learners and educators as well.

There is a strong relationship between learner performance and the quality of the facilities available to learners. Several schools do not have laboratories and the situation simply means that learners learn science and other practical subject are done by rote learning by Ralenala (as cited in Mokgaetsi, 2009). Moreover, the inequalities regarding the quality of facilities and distribution of resources are still a serious problem even after celebrating Ghana @50 and 21 years of democracy, during which the government emphasised equity. Generally, some of the factors contributing towards the poor performance of learners are lack of resources and poor facilities in most schools, but especially in rural areas. Some of the schools are dilapidated compared to those in urban areas.

Teaching and learning materials are less adequate in low achieving schools than in high achieving schools. TLMs aid teaching and learning because pupils can see and often feel what the teacher teaches. They stimulate ideas, demand an active response from the learners and provide enjoyment. Kufui (2005) concluded that most Ghanaian schools posed limited teaching material as well as inadequate textbooks. In Broom's study (as cited in Mokgaetsi, 2009) the availability and creative use of media makes pupils learn more and retain better what they learn. This in turn improves their performance. However, this situation was limited in the schools under study. In 2008, the government of Ghana pledged to eradicate all schools under trees. Currently, the situation has not changed that much, since most schools especially those that are in the rural areas, in contrast to those in the urban areas, do not have a satisfactory infrastructure. There are suggestions of how to improve the performance of learners irrespective of whether facilities and resources are available or not. This suggests that it depends on an individual educator and his/her creativity to promote high achievement. Kgosana (in Mokgaetsi, 2009) believed that some schools are entitled to good infrastructures; however, sometimes facilities without committed educators are just not good enough. He further quoted the education policy analyst specialist (Bloch) who emphasised that facilities and adequate relevant resources are important but the recipe for managing a good school also has to do with an efficient head who knows how to manage his/her staff. The problem regarding unequal distribution of resources between provinces, rural and urban areas is still intact as happening in South African by Motala and Pampalis' study (as cited in Mokgaetsi, 2009). But the situation is different in Ghana.

### *2.9.5 School social climate*

Characteristics of schools, such as the physical structure of a school building and the interactions between students and teachers, are two diverse factors that both affect and help to define the broad concept of school climate. School climate has been researched for many years and continues to be examined and redefined as a result of its significant influences on educational outcomes. The elements that comprise a school's climate are extensive and complex. As a result, the researcher has decided to concentrate on the social factors of school climate that influence the pupils' performance since the physical factors have been discussed already. In Johnson & Johnson's study(as cited in Mokgaetsi, 2009) the interactions between adults and students, students' and teachers' perception of their school environment, and academic performance Clearly, school climate is multi-dimensional and influences many individuals, including students, parents, school personnel, and the community. Additionally, school climate can significantly impact educational environments, as Freiberg (as cited in Mokgaetsi, 2009) noted, "School climate can be a positive influence on the health of the learning environment or a significant barrier to learning". Although this broad term has been researched for many years, a sole definition has yet to be formulated. But the assessment of school social climate could be explained in terms of achievement, motivation, sharing of resources, fairness, student interpersonal relations, parent involvement, and student-teacher relationship (Haynes et al, 1993).

## 2.10 Influence of Gender on the Learning of Integrated Science

Differences in the understanding of integrated science by males and females have long been studied in integrated science education. According to Siegfried (1979) research generally shows that test scores in integrated science are higher for males than females at the high school and college levels. Siegfried (1979) studied the relation of gender and integrated science understanding which focused on the level of integrated science understanding (the students' stock of knowledge) and on learning of integrated science (the flow of knowledge). He argues that studies that use the stock of knowledge as the dependent variable report a higher level of understanding for males. He explained that the difference appears sometime after the early elementary years and before college. In general, there does not appear to be a difference between male and female learning of integrated science secondary grades and college years (Siegfried, 1979).

Integrated science educators have proposed several hypotheses regarding the possible gender-related difference in integrated science knowledge and learning. Some of these studies include the possibility that integrated science is viewed by students, parents, and teachers as a discipline more appropriate for boys to study than for girls; the existence of male-female differences in quantitative ability at the high school level; and possible sex bias in teachers' attitudes and/or instructional materials in integrated science (Jackstadt & Grootaert, 1980). Findings from the study of Jackstadt and Grootaert found that students who did not gender-stereotype integrated science perform better on Test of Science Understanding (TSU) and learn more in class. In addition, students who had no preference regarding the sex of their integrated science teacher do better on the test and learn more. When gender was included as a dummy variable in their regression model, its coefficient was not significantly different from zero in any of the regressions. The absence of gender differences in TSU scores, however, stood in contrast to their finding that gender-related factors affected students' levels of integrated science understanding and their learning of integrated science.

Male and female students have different levels of difficulty in learning certain topics in integrated science (Lumsden & Scott, 1987; Watts, 1987). That is, where the male may perform well in only Chemistry topics like calculating the quantities required in the preparation and dilution of solutions under the matter, females may perform in Biology topics such as transport in mammals (Ghana Association of Science Teacher, 2017). A student's inability to perform creditably in a test of integrated science knowledge reflects certain learning difficulties associated with certain topics. Becker, Greene and Rosen (1990) posit that conventional wisdom holds that males have a relative advantage in numerical skills while females excel in verbal skills. This view has given rise to extensive literature on gender differences in learning integrated science. In a study by Ware and Lee (1985), which used 50 first-year university students in the US, findings revealed that males have higher levels of integrated science understanding as early as grade five. Males and females tend to learn the same amount during high school and college, so the gap that materialized before high school never closes during the schooling experience.

Although studies show a statistically significant gap in male and female learning of high school integrated science, the difference is typically small in magnitude-on the order of a couple of multiple-choice questions when background variables are controlled (Becker, Greene & Rosen, 1990). An exception to the findings of Becker et al. (1990) is a report by Heath (1989) that male students outperformed women by 10 tests scores in integrated science courses after controlling for the fact that women do not elect to take integrated science. According to Siegfried (1979), two-thirds of the studies related to the level of understanding with gender found that males performed statistically significantly better than females. Although there is a substantial division of opinion, in general, the empirical research seems to suggest that by the time people reach college age, men are significantly ahead of women in understanding integrated science (Siegfried, 1979).

### *2.10.1 Gender differences in teacher expectations*

Another explanation for gender differences in classroom interactions could be that teachers hold different expectations for students based on gender (Jones & Wheatley, 1990). These expectations could be related to student behaviour as well as their academic performance. One essential aspect of student behaviour is how they use their body, how active they are in class, and how they use their voice, which may be different between female and male basic students. Gender differences in the way and the frequency students interact physically among each other and in the way they use their body during quiet time as well as play time have been found as early as in three-year and five-year old children (Martin, 2008). These gender differences are, according to the researcher, partially corroborated by the pre-school teachers whose physical interactions with girls and boys differed. Martin (2008) observed that boys were more frequently physically restrained or disciplined by teachers than girls. The researcher interpreted this observation as the educators following what they perceive as a 'hidden school curriculum' that "demands the practice of bodily control in congruence with the goals of the school as an institution" (p. 206). In other words, the teachers followed what they believed is expected of them by school administration and society, which most likely is in accordance with what they themselves experienced as children and, therefore, expect to happen.

Teachers in Canada tend to hold higher academic expectations for adolescent boys than for girls in mathematics and science but lower expectations in reading and writing (Bussiere et al, 2001). On the other hand, due to the fact that more boys than girls are perceived as disruptive and disaffected and that more girls than boys are seen as diligent and unquestioning learners (Walkerdine, 1989), teachers are more inclined to expect lower academic performance from boys than from girls. Consequently, low performing female students' needs are more often overlooked than the needs of underachieving male students (Jones, 2005). By interviewing teachers along with female and male students that were identified by those teachers as either high achieving or underachieving, Jones (2005) revealed that teachers in the UK were not aware of the female underachievers in their classroom. The teachers not only perceived girls more often than boys as high achievers, they did not have a clear concept of the underachieving girl. The participating teachers not only identified male students as underachievers twice as often as female students but were convinced that a certain kind of boys were achieving lower than average, which differs from statistics of national test scores in Britain. Other examples of teachers' misperceptions found by Jones (2005) were that girls are more engaged, self-motivated, hard-working, and well-behaved than boys. Further, they are thought to be more tolerant and accepting of poor teaching than boys. Another misperception that was denied by female students is the assumption that girls, in comparison to boys, are advantaged in learning English and that they like this school subject better (Jones, 2005).

### 2.11 Measures to Improve Teaching and Learning of Integrated Science

A changing world requires a changing style of education. Young people who are being prepared for entry into adult responsibilities need to be equipped with knowledge, skills and positive attitudes to be successful in this society. Thus, integrated science teachers must continuously assess the integrated science' curriculum in terms of the current status of the academic discipline to provide students with the latest knowledge and skills necessary for taking part in integrated science activities (Becker & Watts, 2001). The primary obligation of the schools, colleges, universities and other educational institutions is believed to be to help the students "develop the capacity to think, objectively, and with a reasonable degree of sophistication about integrated science problems" (Lee, 1975, p. 39). The lack of integrated science literacy and inability to reason out clearly and objectively about integrated science issues leads to limits in taking part as an effective citizen in integrated science activities, as indicated by Banaszak (1987). However, there has been a worldwide movement to improve integrated science teaching through the use of teaching methods designed to have students actively involved in the learning process (Becker & Watts, 2001). Despite some indications of increased emphasis and interest in teaching over this period, lectures are still the most frequently used teaching strategy by US economists.

A similar survey by Benzing and Christ (1997), and Siegfried et al. (1996) consistently found that academic scientists lectured for approximately 80% of their class time. The remainder was filled with recitation, showing overheads, videos, movies, or questions and answers (Caropreso & Haggerty, 2000). It is not surprising to note the immense usage of lectures as a mode of instruction as it is a rapid way of transmitting factual information and it can be delivered in a manner that motivates and entertains students, for example, through the use of cartoons, videos, newspaper clips, and PowerPoint animations (Johnston, McDonald & Williams, 2001). A lecture can also provide interactive learning by engaging students through direct questioning or short collaborative exercises within the lecture (Johnston et al., 2001). In addition, Good and Brophy (2003) believe when lectures are presented in interesting and enthusiastic ways then they can stimulate interest and raise questions that students will want to follow up.

However, Becker's and Watts's (1998; 2001) surveys indicate that these strategies are not often used in teaching integrated science and that for the vast majority of time lectures are spent using chalk and talk. More recently, this may be whiteboard and talk, and even Powerpoint and talk. Many students expect to be engaged in the learning process and appear unwilling to sit passively through lectures. A study by Becker and Watts (1998) recommends that teachers should use a varied approach periodically involving students actively in the learning process. They posited that some students are natural-born listeners, some are talkers and discussion leaders, and some seem to learn best using group activities that feature "hands-on" demonstration of integrated science concepts and relations.

In teaching and learning integrated science, the teacher has to gain students' attention and ensure their active participation in the learning process. Discussion and case study methods of teaching integrated science are generally considered as those that ensure active participation of the learners. Visits and field studies are equally important in the teaching and learning of integrated science (Becker & Watts, 2001; Benzing & Christ, 1997). In addition to this view, Siegfried (1979) advocated: The importance of using alternative methods in teaching integrated science because "different students learn science in different ways. The best teaching strategy provides alternative learning methods" (p. 35), methods that can keep students actively involved, with both practice and feedback. Such alternative approaches recommended by Becker and Watts (1995) include games and simulations, experimental science and classroom activities, writing assignments, science in literature and case studies (p. 699).

Some studies on teaching methods used by integrated science teachers shared some similarities concerning the lecture method where lectures are combined with showing overheads, videos, cartoons and power points (Siegfried et al, 1996; Benzing & Christ, 1997; Johnston et al, 2001; Good & Brophy, 2003). In contrast to this, Becker and Watt (1998; 2001) believed that lectures are used by most teachers through the use of chalk and talk. It will therefore be interesting to explore in my study which practical methods do senior high school science teachers use to teach in Ghana.

Some studies have also indicated the use of Problem-Based Learning as a measure of improving the teaching and learning of integrated science. In a study conducted by Maxwell, Mergendoller and Bellisimo (2005) on "Problem-Based Learning and High

School Macrointegrated science: A Comparative Study of Instructional Methods" in California found out that Problem-Based Learning (PBL) is gaining support as a technique to increase subject-matter knowledge of teachers of integrated science and increase effective learning of integrated science concepts among students. A low level of knowledge of integrated science may make PBL more difficult to implement. In PBL, the teachers' role is a coach; coaches probe by suggesting further study or inquiry. They guide students toward researching appropriate topics and sources, developing appropriate lines of inquiry and producing an integrated science solution to the problem posed (Maxwell, Mergendoller & Bellisimo, 2005).

According to Ziegert (2002), service-learning takes students out of the classroom and offers them real-world, hands-on experience in applying and understanding integrated science. McGoldrick (2002) discusses several service-learning models that can be integrated into a course. The models include 1) community service, 2) action research, 3) community problem-solving seminars and 4) students-based instruction, which was used for the project.

The community service model allows students to test scientific theories against the actual population. The action research model requires that students work with an organization or community to design and implement a project to assist the organization or community. In the community problem-solving seminar model, the course is designed as a seminar in which students identify a problem within the community and work on developing a solution to the problem.

Proponents of service-based learning claim there are several benefits to implementing service-learning into integrated science (Lopez, 2009). Unlike the "talk and chalk" method, service-learning enhances integrated science literacy and the ability to use integrated science in everyday life. Students who can connect their knowledge of integrated science theory with real-world issues are better motivated to learn the material because they see the potential benefit of such knowledge; service-learning may increase diversity in integrated science classrooms (Ziegert, 2002). A study in the Maldives by Nazeer (2006) found out both teachers and students of integrated science perceived cooperative learning to be a more effective method of teaching. Also, the study revealed that students liked working in groups and appreciated getting help from other students. The results of the study showed that students' interactions and involvement in classroom activities, as well as interest and motivation to learn integrated science, increased during the implementation of the cooperative learning model.

No instructional approach can be optimal for everyone since students differ widely in their preferred style of learning (Claxton & Murrell, 1987). This means that integrated science teachers have to vary their method of teaching to enhance effective learning of integrated science. In a study in Ghana by Dare (1995), he posits that to increase students' understanding of integrated science concepts, students must not simply be motivated, but the teacher should ensure that the students are intrinsically motivated. The integrated science teacher must be versatile and flexible and learn how effectively to attend to all learning styles of students. Following the different learning styles by the authors discussed so far, Goorha and Mohan (2010) suggest that most integrated science students learn by reflecting on a concept and making observations, abstractly conceptualizing the concept by drawing on these reflections and by applying the concept through experimentation, hence the teacher should facilitate conceptualization with active experimentation medium such as case studies, a collaborative project or simulation exercise.

Modern resources in the teaching and learning of integrated science are the use of a powerful medium, the motion picture to establish the context for teaching basic concepts in integrated science. The plots and subplots in many films can be used to illustrate problems and issues that are amenable to integrated science analysis (Leet & Houser, 2003). "In addition to a course that is built around films, films (or parts of films) could be used in several ways to enhance integrated science instruction in much the same way that Tinari and Khandke (2000) describe using literature and music, respectively" (Leet & Houser, 2003). Leet and Houser, (2003) contend that many instructors use particular sequences from films to illustrate integrated science concepts in ways that make these concepts more real to their students.

Viewing the film together in class enhance class discussion and student understanding in ways that may be superior to the standard lecture-discussion and develop the skill of seeing the film analytically (Leet & Houser, 2003).The advocates of using films or parts of films to enhance the learning some integrated science concepts thought about their context in the use of films in teaching, however, in Ghana a lot of conditions could prevent the use of films in teaching. The measures mentioned above will enable teachers to cover more topics, it makes teaching interesting and students retain for long what has been taught especially the topics that they perceive to be difficult to learn. So, in a nutshell, teachers enjoy their teaching and students enjoy the lesson and also participate in what is going on in class.

### 2.12 Summary of Chapter

The review of the literature was based on exploring the topic of difficulty perceived by the students and teachers in the teaching and learning of integrated science. The review commenced with a description of the integrated science syllabus which included all topics for the three years and the mode of assessments. The concept of perception was discussed. It was understood from the discussion that perception is a process by which individuals select, organize and interpret the input from their senses (vision, hearing, touch, smell, and taste) to give meaning and order to the world around them (Jennifer and Gareth, 1996). Based on the topic under study empirical discussion of works on perception was done. The review highlighted the perceived difficulty in learning integrated science topics as well as factors that influenced difficulty in learning integrated science topics. The final part of the review focused on discussing measures in improving teaching and learning of topics in integrated science.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Overview

This chapter spells out the methodology for the study. It is dilated on the study design, study population, sample and sampling procedure, sources of data, instrumentation, and data processing and analysis.

## 3.1 Setting

The study was carried out in Nalerigu Senior High school in the East Mamprusi Municipality of the North East Region of Ghana. The East Mamprusi Municipality is one of the six (6) administrative MMDAs in the region with its capital at Gambaga.

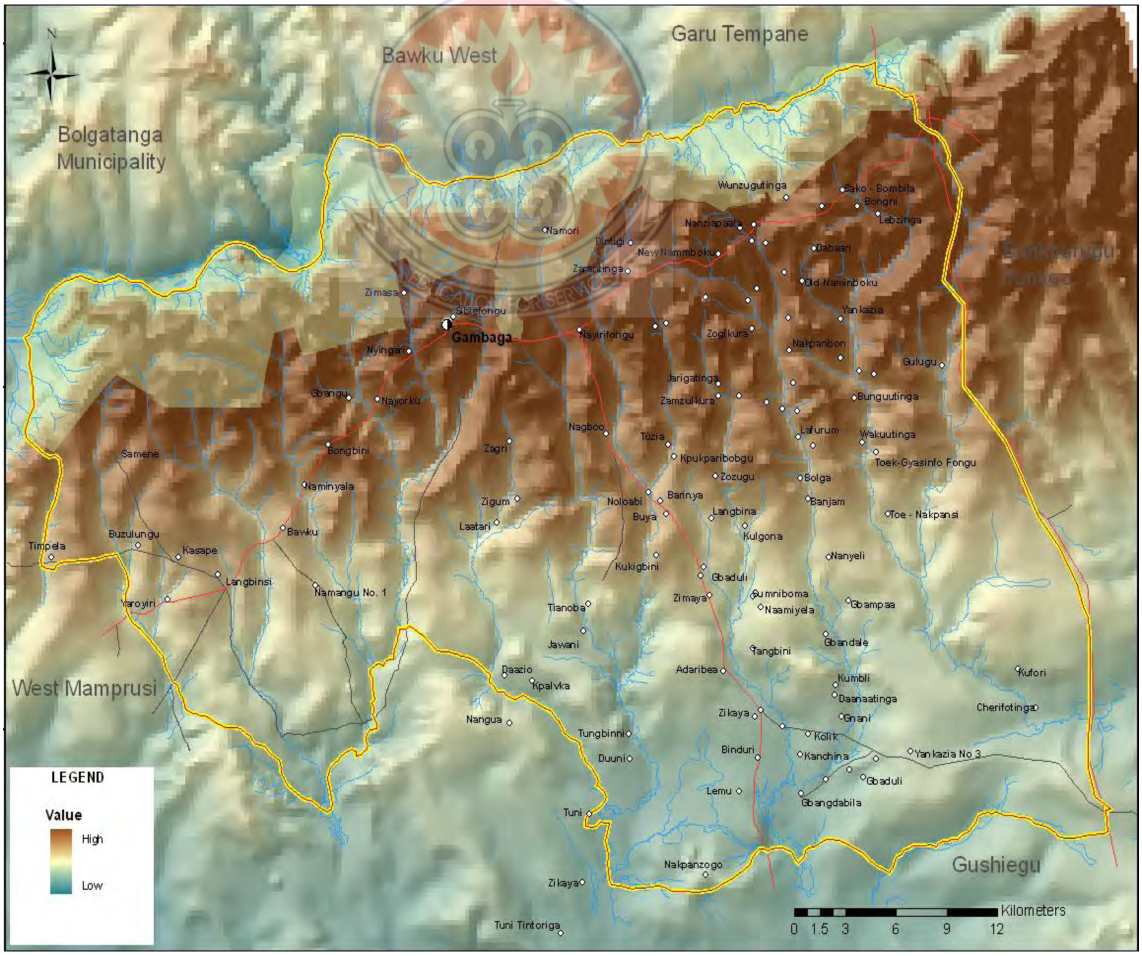


*Figure 1: The Map of East Mamprusi Municipality*

### 3.2 Research Design

A research design can be described as a detailed plan outlining how a study is carried out. It is a detailed "blueprint" or framework to collect, discuss, analyze, and interpreting data or information as well as related literature to enhance the drawing of inferences and arriving at conclusions based on the relationships between or among the variables of interest in the study (Creswell, 2003).

The researcher employed the descriptive survey design. A descriptive survey may involve collecting data to test hypotheses or answer questions concerning the current status of the subject of interest. It therefore determines and reports events as they occur naturally (Gay, Mills & Airasian, 2012). This design may allow researchers to describe situations as they are and to generalize from a sample to a population. Although Creswell (2003) upholds that a descriptive survey does not help to establish and explain relationships between variables, the design was considered most appropriate for this study because the study was interested in finding topic difficulty perceived by senior high school students.

Descriptive survey design has many merits. For instance, the design provides a more accurate and meaningful picture of an event and seeks to explain peoples' perception and behaviour based on data gathered at a particular time (Fraenkel & Wallen, 2012). This allows for in-depth follow-up questions and items that are unclear to be explained. The main advantage of descriptive survey design is that it has the potential to provide a lot of information from quite a large sample of respondents (Fraenkel & Wallen, 2012).

Despite the advantages, the descriptive survey design is plagued with some disadvantages. According to authors such as Fraenkel and Wallen (2012) and Cohen, Manion, and Morrison (2018), in a descriptive survey, there is the difficulty of ensuring that the questions answered are clear and not misleading. The reason is that survey results can vary greatly due to the exact wording of questions. As a result, it may produce unreliable results. In order to solve this challenge the instruments were validated by my supervisor. There is also the difficulty of obtaining an adequate number of the questionnaire completed and returned for meaningful analysis to be made in some cases. Notwithstanding these disadvantages, the descriptive survey design was found to be most appropriate and applicable for the study. In addressing the difficulties of a descriptive survey, administered questionnaires were collected the same day.

## 3.3 Research Approach

This study used a mixed-method approach to achieve the objectives set. Qualitative and quantitative approaches were employed to collect data for the study. Creswell (2014) defines qualitative research as an "inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting". It is a field of inquiry in its own right which cuts across disciplines. Phillips (2009) further states that qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem.

According to Leedy and Ormrod (2005), a qualitative approach to research is situated in a context and locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible: "The practices transform the world". The qualitative approach was chosen because with this approach the researcher becomes the instrument of data collection where questions are asked to generate data for analysis (Leedy, & Ormrod, 2005). One of the greatest strengths of qualitative methods according to Eli and Schroeder (2009) is that they have the potential to generate rich descriptions of the participants' thought processes and tend to focus on reasons 'why' a phenomenon has occurred. Leedy and Ormrod, (2005) posited that qualitative researchers use a wide range of interconnected interpretive practices, hoping always to get a better understanding of the subject matter at hand. In applying the qualitative approach in this study, a semi-structured interview guide was developed and vetted by my supervisor. The interviews were conducted after collecting quantitative data where the qualitative data was used to triangulate the quantitative data.

Quantitative research methods on the other hand, as explained by Creswell (2014) "is a formal, objective, systematic process in which numerical data are used to obtain information about the world, and is used to describe variables, examine relationships among variables, and determine cause-and-effect interactions between variables" .

It is thus, a formal, objective, and systematic process for obtaining quantifiable data about the world which is presented in numerical form, and analysed by using statistics to describe and test relationships. Simply put, the quantitative research method is concerned with numbers, statistics, and the relationships between events and numbers.

Quantitative methods or data collection out of a questionnaire tend to be relatively low in cost and time requirements since they enable a large quantity of relevant data to be obtained and analyzed within a limited time, the qualitative (interview and observation) analysis would offer in-depth and useful insights studying topic difficulty in Integrated science as perceived by senior high school students. The reason cited by Philips (2009), the quantitative method of using the questionnaire may limit the range of possible responses and as such, not delve deep into issues pertaining students perceived difficulty of some topics in integrated science.

Johnson and Christensen (2012) supported this view by indicating that it is wise to collect multiple sets of data using different research methods, epistemologies, and approaches in such a way that the resulting mixture or combination has complementary strength and no overlapping weaknesses. The mixed approach was therefore necessary for this study because it helps to improve the quality of research since different research approaches were used (Johnson & Christensen, 2012).

It was evident that the mixed method (quantitative and qualitative methods) was necessary for this study given the research questions posed and required exploring. The use of mixed methods made it possible to get detailed, in-depth information to describe, interpret and make an informed judgment concerning students' perceived difficulties with integrated science topics and why they find those topics difficult to learn (Creswell, 2014; Fraenkel & Wallen, 2012)

### 3.4 Research Population

The population has been defined as the universe of units from which the sample is to be selected (Bryman, 2008). Similarly, according to Babbie (1990), the population of a study is an abstract idea of a large group of many cases from which a researcher draws a sample and to which results from a sample are generalized. Agyedu, Donkor, and Obeng (2011) stated that research population is the complete set of individuals (subjects), objects, or events with common observable features for which a researcher is interested in studying. It is also regarded as the larger group from which individuals are selected to participate in a study.

For this study, the target population was senior high school students in Nalerigu senior high school in the East Mamprusi Municipality since it is the only mixed school with many of its past students sitting for the WAEC. The target population comprised 2,468 first year students, second year and third year students offering integrated science as a core subject. These figures were obtained from the various course groups in the school. The accessible population was made up of 1,774 first year and the second year students.

### 3.5 Sample and Sampling Technique

It will be very expensive and time-consuming for a researcher to study all individuals in a large population. As such, there will be the need for the researcher to select a certain number of individuals who will be representative of the population for the study. Sample refers to the segment of the population that is selected for investigation and sample frame as the listing of all units in the population from which the sample will be selected (Bryman, 2008). The selected number of students therefore formed the sample for the study. This calls for the identification and definition of the target population as the first thing to do in the sample selection process (Gay & Airasian, 2003).

The sample for the study was made up of 200 non-elective science students comprising of 125 males and 75 females. A combination of sampling techniques were used to select the sample. These were purposive and stratified sampling methods. In purposive sampling, the researcher handpicked the subjects to be included in the sample based on their judgment of their typicality or particular knowledge about the issues under study. Creswell (2003) agrees with the use of the purposive sampling technique by stressing the fact that it is important to select information-rich cases as this would help the researcher to address the purpose of the research. It was used to select students from general arts, business, and home economic classes only since the researcher excluded the elective science classes from the study because the elective science students have in-depth knowledge of the topics in integrated science since such topics are studied in details at the various science elective areas. Stratified sampling is a technique in which the population is divided into several strata and a sample is drawn from each stratum (Leedy & Ormrod, 2005). The population of the students was stratified into male and female students from the various classes before the sample was drawn.

Out of the four senior high schools in the East Mamprusi Municipality, Nalerigu Senior High School was selected since Langbinsi and Sakogu Senior High Schools are new and yet to sit for their first WASSCE and Gambaga Girls Senior High is a single sex school. The population of the students comprised of form one and form two students. The form three students were not included because they were writing their final year exams at the time the study was conducted.

The selected topics were all the topics in the first and second year integrated science syllabus since the third years were not part of the study the year three topics were not part of the topics selected.

According to Bryman's (2008), 10% of a population can be used to collect data. The students were stratified in each class in to male and females before simple random sampling was performed to obtain the sample. This was to make sure that an adequate number of female students as well as male students were represented to avoid selecting just females or males alone. This is because in some course areas males dominates e.g business and general art classes whiles females dominates in the home economic classes.

Only ten students' respondents were needed for the interview, students were selected randomly from each course area. Since all members of the class possessed similar characteristics, each student was a potential respondent and so the researcher counted the number of students in each of the selected course areas, wrote on pieces of paper '1 YES' and the remaining 'NO' according to the number of students in the course area and folded and mixed them. Each member was asked to pick one, after all, students had picked they were asked to open them. Those who picked the "YES" was used as a respondent student for the interview.

### 3.6 Research Instruments

Questionnaires, semi-structured interviews, and structured observation schedules were used to collect data for the study. The questionnaire helped to reach many respondents at a time and thus save time. It also helped to be free from the bias of the interviewer since the answers were in the respondents' own words (Bryman, 2008). The questionnaire for students was structured under four areas (Appendix A). The first section A was on demographic information; it had five items, Section B was on students' perceived difficulties of integrated science topics, Section C was on reasons that account for senior high school students' inability to understand some topics in integrated science (contains 7 items), Section D was on the measure to improve students' understanding of difficult topics in integrated science (contains 5 items).The items on the questionnaires were assigned values on a four-point Likert scale format (4-very easy to understand, 3-easy to understand, 2-difficult to understand, 1-very difficult to understand).

Semi-structured interview guides were also used to collect data from the selected students (see Appendix B). Leedy and Ormrod (2005) observed that interviews allow meeting the subjects of research which can provide detailed information set out to collect and some fascinating contextual information (though not all of which you can use). They observe again that semi-structured interviews manage to address both the need for comparable responses, that is; the same question asked of each interviewee - and the need for the interview to be developed by the conversation between interviewer and interviewee - which is often very rich and rewarding. The interview guide had eight items. The items were based on challenges in learning integrated science, causes for difficulty encountered, and suggestions on measures that can enhance effective learning of integrated science.

## 3.7 Validity of Instruments

Johnson and Christensen (2012) define validity as the accuracy of the inferences or interpretations made from test scores. Lankshear and Knobel (2004) refer to validity as the 'meaningfulness of the result' and deals with how well an instrument measures what it is supposed to measure. Citing Punch (2003), Oyetunji (2006) contended that validity talks about how candid and meticulous respondents answer questions partly based on their attitude and mindset. The elements of validity criteria included face, content, and internal validity.

### *3.7.1 Face validity*

The researcher gave the instruments to colleagues and other tutors in Gambaga College of Education and the research supervisor to establish the face validity of the instruments. They were requested to carefully and systematically scrutinize and assess the instruments for its relevance and face validity. Issues such as length of questions, framing of questions, and ambiguity were considered. The feedback from colleague tutors and the supervisor were factored into the final preparation of the instruments.

### *3.7.2 Content validity*

Content validity is a measure that gauges whether there is adequate coverage of all the research questions (Cooper & Schindler, 2008). It indicates whether the technique assesses or measures what it is supposed to measure (Ruland, Bakken & Roislien, 2007). In other words, it is a judgmental assessment on how the content of a scale represents the measures.

According to Cooper and Schindler (2008), there are two ways of determining content validity. Firstly, the designer may determine it through a careful definition of the topic of concern, the items to be scaled, and the scale to be used. Secondly, the research supervisor who is an expert may judge how well the instrument meets the standard. Based on this knowledge, suggestions of my supervisor and other lecturers who are experts in curriculum studies were sought to content validate the instruments. Their expert views were taken and used to validate the content of the instruments.

## 3.8 Reliability of Instruments

Reliability refers to the ability of research results to be replicated or repeated Bryman, (2008).The students' questionnaires were pre-tested in Walewale Secondary Technical using 30 students. The school was used for the pre-testing because senior high school integrated science students' shared similar characteristics in terms of background. That is many of the students came from the same Junior High Schools and may be from similar communities and may be speaking the same language and academic achievements (and might have attain the same grade range from the Junior High Schools) since they come from the same area in the North East Region. The reliability of the questionnaire was estimated using Cronbach's Alpha Coefficient. The reliability alpha coefficient obtained was 0.75, which according to Bryman (2008), the instrument is reliable and can be used for data collection. The reliability of the instrument for each variable exceeded 0.7 as shown in Appendix C. This was in line with that of McMillan and Schumacher (2010) who proposed that reliability needs to be 0.7 or higher. This suggests that the items were reliable for the study. Objectivity concerns itself with the ability of research findings not to be 'contaminated' by any individual or groups involved. The researcher ensured that the results were not influenced by personal feelings, interpretations of the results, or personal prejudices but purely based on facts, and unbiased. The researcher achieved this by carefully going through the procedures for entry and analysing the data.

Qualitative researchers may have their understandings, beliefs, and ideas which are present during data collection and analysis. These can affect the validity of research findings. The researcher ensured that the meanings of the data collected were not changed or influenced by his knowledge and experience. The data collected were used as collected during the transcribing, presentation, and analysis.

### 3.9 Data Collection Procedure

In conducting research, Creswell (2003) advises researchers to seek and obtain permission from the authorities in charge of the site of the study. Because of this, the researcher obtained an introductory letter from the Department of Science Education of the University of Education, Winneba to the District Director of Education of East Mamprusi Municipality to obtain permission to enter the school selected for the study. The District Director permitted the researcher to conduct the study in the selected school.

Cohen, Manion, and Manion (2004) observe how important it is for people to get prior knowledge about their involvement in a study on that note after permission has been granted to conduct the study, the researcher consequently went to the headmaster of the school to inform him of the impending interview and to seek his consent for the study. Upon arrival in the prospective school to deliver prior information to the head; the researcher was readily approved by the head of the selected school of the study area to come to the school at any time/day for the exercise.

In the school, students selected for the study were given questionnaires to complete.

Questionnaire were administered to students. Instructions on the questionnaires were read out to students and confidentiality of their responses was assured before they were allowed to read the items on their own. The researcher personally administered the questionnaire to ensure a high return rate of the completed questionnaires and also to ensure that all items on the questionnaires were answered.

All the interviews were conducted by the researcher in person and this ensured that all the appropriate follow-up questions were asked and clarifications sought. The interview process commenced by assuring participants of confidentiality of any information they would provide. Similarly, they were advised not to identify themselves at any point in the data collection process. The interview process spanned between 25-30 minutes for each participant.

The dates for interviews were agreed on by the participants for the interviews such that they would not conflict with their itinerary for the day. The interviews were recorded with a tape recorder. Participants were made fully aware that their responses would be audio-taped. In conducting the interviews, the English language was used.

This was done to make the interview process very lively and also help the participants express their views freely.

## 3.10 Data Analysis

Quantitative and qualitative data analyses were performed on the data collected. Data analysis is where the researcher continually reflects on collected data, moving deeper for understanding and representing the data, and deriving an interpretation of the larger meaning of the data (Creswell, 2013). The questionnaires were cleaned and those poorly answered ones were eliminated. The data were coded and entered into SPSS version 25. Descriptive statistics were used to analyze personal information such as sex and age of respondents.

### *3.10.1 Quantitative data analysis*

Descriptive statistics and inferential statistics were used to organize the data on the questionnaire to answer research questions 1, 2, and 3 into frequency, mean score, and standard deviation.

Students' perceived difficulties with topics were analysed by the use of percentages, mean scores, and standard deviations. The mean and standard deviation scores for the topics that the student perceived to be difficult were estimated. Since the scale was a four-point Likert-type scale format, 2.5, the mid-value was chosen as an average value to which mean scores below it were considered perceived difficulties with topics. Mean scores above the average mean score of two were considered perceived easiness.

To determine whether differences exists in the perception of topic difficulty in integrated science by gender. Inferential statistics was used to analyse data to address the hypothesis. An independent t-test was used to compare mean scores to determine if statistically significant differences existed. Lund and Lund (2012) posit that the independent sample t-test is suitable for comparing the mean scores of two independent groups.

Other reasons given by students were put under themes and discussed. Students suggested measures to improve integrated science learning under Section D of the questionnaire were also assigned values on a four-point Likert-type format (4-strongly agree, 3-agree, 2-disagree, 1-strongly disagree). Mean scores above the average score of 2 considered respondents' agreements with the statements and mean scores below the average meant respondents were not in favour of those statements. Other measures given by students were also put under themes and discussed.

### *3.10.2 Qualitative data analysis*

The analysis of qualitative data in this research followed a thematic approach based on the objectives of the study (Cohen, Manion & Morrission, 2011). The analysis involved processes of listening, reading, reasoning, reflecting, and coding the interview transcripts and drawing out major themes from the data collected for students. Interview recordings were listened critically and transcribed. The transcription involved writing the spoken words of the interviews verbatim into text data. After carefully going over the information at hand, major themes were identified and the data were discussed under these themes guided by the research. The themes included, the nature of the senior high school integrated science syllabus. The concepts of perception of difficulty of topics in integrated science, students' interest in science education, the influence of gender on the learning of integrated science, and measures to improve learning of integrated science. The interviewees were given names in the form of alphabets, to conceal the identity of the respondents. There were some names like student B or student D.

Inferential statistics was used to analyse data to address hypotheses. An independent t-test was used to compare mean scores to determine if statistically significant differences existed. Lund and Lund (2012) posit that the independent sample t-test is suitable for comparing the mean scores of two independent groups.

Transcribed interviews from the students' focus group interviews were studied and issues relating to a particular research question were grouped under that research questions. These issues were quoted to support some of the discussions.

For the hypothesis, the difference between male and female integrated science students' perceived difficulties with topics in the integrated science syllabus, was determined by comparing their mean scores of topic difficulties. An independent t-test was conducted on the mean score values of (male integrated science students and female integrated science students) was conducted to determine if there was a significant difference in perceived topic difficulty between these two groups.

### 3.11 Ethical Consideration

Ethical issues that were considered in this study were the permission to collect data, confidentiality and anonymity of participants

### 3.12 Confidentiality

The participants were assured that all the information obtained would be treated as confidential. That is, data was only used for stated purposes and no other person had access to the collected data. The names of students' were not needed on the questionnaire and respondents were informed before they answered the questionnaire

(Berg, 2001; Cooper & Schindler, 2008; Patton, 2002). This was done in order to avoid biased responses from participants. The learning atmosphere in the schools were also not disturbed during the data collection process and the data collected through questionnaires and interviews were kept confidential and made available only to persons taking part in this study. Data kept on the computer was duly protected by a secured password.

### 3.13 Anonymity

The researcher ensured that there was no way a participants who provided information was traced. This was done by not including names, addresses and name of school of participants. All these were not indicated on the formal report presented.

# CHAPTER FOUR

## RESULTS AND DISCUSSION

### 4.0 Overview

The purpose of this study was to investigate topic difficulty perceived by students of Nalerigu senior high school. In this chapter, findings from the study are presented and discussed in relation to the three research questions stated for the study. Students indicated the perceived difficult topics in integrated science and expressed reasons for their individual difficulties with some of the integrated science topics, the gender difference in the perceived integrated science topic difficulty and measures suggested by students that could be adopted to improve teaching and learning of integrated science. Discussions of the findings base on the three research questions were made through the analysis of the data obtained from the questionnaires, interview and observation conducted during the classroom interactions. The discussions focused on the demographic information about the participants and findings related to research questions.

### 4.1 Demographic Data of Respondents

The demographic data was taken to determine the age range and gender of the participants. The age range was taken to determine whether the students are within the average ages of the classes while their sex was taken to be able to determine the perceived difference in the difficulty of integrated science topics by males and females.

A total number of 200 students participated in the study. Table 4.1 shows the distribution of the number of respondents by gender.

*Table 4.1: Sex of Students*

| **Sex** | **Freq** | **% Freq.** |
|---|---|---|
| Male | 125 | 62.5 |
| Female | 75 | 37.5 |
| **Total** | **200** | **100** |

As found in Table 4.1, majority of the respondents 125 (62.5%) were males whereas 75 (37.5%) were females. Therefore, male students constituted the majority in the study.

The data on students' ages are presented in Table 4.2. It is observed from Table 4.2 that 34 (17%) of the respondents were between the ages of 10 and 15 yeas, 155 (77.5%) of the students were in the age range of between 16 and 20 years. This gives the impression that most students in senior high school in the East Mamprusi Municipality are adolescents between the ages of 16 and 20 years. Therefor majority of the students are within the national age standard for senior high school hence it is therefore expected that they will be able to cope with the demands of the integrated science curriculum.

*Table 4.2: Age group of Respondents (Students)*

| **Age** | **Freq** | **% Freq.** |
|---|---|---|
| 10-15 | 34 | 17 |
| 16-20 | 155 | 77.5 |
| 20+ | 11 | 5.5 |
| **Total** | **200** | **100** |

## 4.2 Presentation of Results in line with Research Questions

The results obtained from the questionnaires, interviews and observation are presented in line with research questions.

Research question one demanded from students the perceived difficult topics in integrated science. A questionnaire with a four-point Likert scale was used to obtain the information from the students. Students were asked to respond to a four-point Likert scale questionnaire ranging from Very Easy (VE), Easy (E), Difficult (D) and Very difficult (VD). Very Easy was coded 1, Easy coded 2, Difficult coded 3 and Very Difficult coded 4. The results in the table were presented in percentages and mean score values. A mean score value of 2.5 for an item indicated neither easy nor difficult. Mean score values less than 2.5 indicates topics were easy while mean score values greater than 2.5 indicates topics were difficult for the students.

Research question two used the same questionnaire that was used to answer research question one and demanded from students perceived difficult topics in integrated science by gender.

Research question three employed the use of a four-point Likert scale questionnaire and interviews responses from students on measures to overcome students' difficulties in those topics in integrated science perceived to be difficult.

## 4.3 Research Question 1: Which integrated science topics are perceived by students to be difficult?

Research question one sought to find out from students the integrated science topics perceived to be difficult to learn in the senior high school integrated science syllabus. The responses are depicted in table 4.3. The results in Table 4.3 indicates that out of the 39 topics in the senior high school integrated science syllabus covering only for year one and two, 19 of the topics were perceived to be difficult to learn by students. The data on topics in the integrated science syllabus at the senior high school that students perceived to be difficult to learn are presented in Table 4.3. The syllabus contains fifty topics for all the three-year groups in five thematic areas comprising of diversity of matter, cycles, systems, energy and interaction of matter. Diversity of matter has six topics in year one, three topics in year two and four topics in year three. The theme cycles has two topics in year one, two in year two and two in year three. Systems contains six topics in year one, three in year two and one in year three.

Table 4.3 shows the distribution of topics indicating either easy or difficult.On the theme DIVERSITY OF MATTER, Cells and cell division, Acids, Bases and Salts Water had mean scores greater than 2.5. The theme CYCLES had Air movement, Nitrogen, Hydrological Cycle with mean scores greater than 2.5. On SYSTEMS, Respiratory System and Food and Nutrition had their mean scores greater than 2.5. The following topics on the theme ENERGY had their mean score value above 2.5. They are, Forms of Energy and Energy Transformation, Solar Energy. Photosynthesis, Sound Energy and Nuclear Energy.

Atmosphere and Climate Change, Forces, Motion and pressure, Work and machines, Endogenous Technology, Magnetism and Biotechnology all in the theme of INTERACTIONS OF MATTER had mean scores greater than 2.5.

From the Table 4.3 Diversity of matter, cells and cell division, acid base and salt and water have their mean score values above 2.5 hence students perceived them to be difficult. The science syllabus covers three-year period of Senior High School Education for which Science teachers must work on and complete before students take their final examination. The various sections of the syllabus teach students more about the scientific world. For instance, on diversity of matter the syllabus specifies that the world has great biological, physical and geological diversity and hence the study of diversity should enable students to appreciate that there is a great variety of living and non-living things around us and in the world in which we live. However, the students perceived section five (diversity of matter) in the science syllabus to be difficult. This resonates the work of Dare (1995) which found topics in the science syllabus such as "Acids, salt and base", "Nuclear energy" and "solar energy" and others difficult for students to learn. Furthermore, Chief Examiners' Report (2005; 2006) indicated students have difficulty with the topics "Acids, salt and base".

On cycles, all topics under cycles that include air movement, nitrogen cycle and hydrological cycle all had their mean scores higher than 2.5 which means that all topics on cycles were perceived difficult by students. The science syllabus indicated that the study of cycles should enable students to recognize that there are repeated patterns of change in nature and understand how these patterns arise. Studying these cycles helps students to predict events and processes and to understand the Earth as a self-sustaining system. On this, Behar and Polat (2007) indicated that the passive nature of students in the classroom combined with the perception that the teacher is the only source of knowledge makes science as a subject unappealing and uninteresting. So, the perception of difficulty on cycle may be due to lack of adequate engagement in science activities. If teachers are suitably trained in using the recommended inquiry-based approaches, and they actually use it in their classrooms, then this may reduce this perception of difficulty in science

On systems, with nine topics, only respiratory system and food and nutrition had mean scores of 2.92 and 2.93 respectively representing the students perceived difficult topics in that theme.

Topics such as forms of energy and energy transformation, solar energy, photosynthesis, sound energy and nuclear energy had mean scores of 3.23, 3.89, 2.89, 3.0 and 3.12 respectively. These topics on the theme energy were perceived to be difficult by the students. Strutchens, Harris, and Martin (2001) identified a significant decline in interest in physics and chemistry as students' progress through secondary school because they involved a lot of calculation. He also noted that this decline was especially pronounced among girls. Analysis of results from a 'Relevance for Science Education Project (RSEP) undertaken in countries throughout Europe from 2003-2008 revealed that the number of students regarding science subjects, in particular physics and chemistry, as difficult has increased (Strutchens, Harris, and Martin (2001).

Topics such as electrical energy and electronics were perceived not to be difficult by the students and these topics have certain similarities. On the theme Interaction in nature, all but Ecosystem, Infections and diseases as well as Safety in the community are the only topics perceived by students to be easy.

However, topics such as atmosphere and climate change, forces, motion and pressure, work and machines, endogenous technology, magnetism and biotechnology were perceived to be difficult by the students with 3.73, 3.20, 3.89, 3.89, 3.73 and 3.58 as their respective mean scores. Lopez (2009), indicated that this difficulty may be due to problems in the perception and thinking of students. Lopez analysis of the nature of perceived difficult topics led him to propose that this difficulty may be caused by the complexity of ideas and concepts existing at three different levels: macro and tangible, micro, and representational or symbolic. Using the concept 'water' to explain these levels; this concept can be taught at the macro level where students can observe the properties of water. It can also be taught at the micro-level where, for example, students are taught that water consists of molecules of hydrogen and oxygen. At the representational level, these molecules can be represented as a symbol $H_2O$.

These multiple ways of representing the same concept are common in secondary-level science courses, especially chemistry and physics. Johnston (2012) proposed that the interaction of these three levels may cause overworking of the working memory hence causing difficulty in conceptualizing various areas in science. Although the spiral nature of the curriculum should allow the gradual progress of learning concepts from concrete (macro-level) to abstract (micro and representational), very often in science teachers have to use all three levels in a single lesson.

***Table 4.3: Distribution of topics in SHS Integrated science syllabus Students' Perceived to be difficult to Learn in themes***

| TOPICS | SCORES | | | | | |
|---|---|---|---|---|---|---|
| | VE | E | D | VD | MEAN | SD |
| **DIVERSITY OF MATTER** | | | | | | |
| Introduction to Integrated Science. | 0.0 | 71.5 | 28.5 | 0.0 | 1.98 | 1.0 |
| Measurement | 63.3 | 19.6 | 17.1 | 0.0 | 1.01 | 1.2 |
| Diversity of living and nonliving Things | 0.0 | 58.9 | 14.5 | 26.6 | 1.90 | 1.1 |
| Matter | 0.0 | 65.8 | 7.6 | 26.6 | 1.89 | 1.1 |
| Cells and cell division | 0.0 | 0.0 | 12.0 | 88.0 | 3.05 | 1.2 |
| Rocks | 0.0 | 63.3 | 16.5 | 20.2 | 1.90 | 1.2 |
| Acids, Bases and Salts | 0.0 | 0.0 | 12.0 | 88.0 | 3.56 | 1.1 |
| Soil conservation | 14.5 | 45.5 | 23.5 | 16.5 | 1.41 | 0.9 |
| Water | 0.0 | 14.5 | 58.9 | 26.6 | 2.81 | 0.8 |
| **CYCLES** | | | | | | |
| Air movement | 0.0 | 14.5 | 58.9 | 26.6 | 2.88 | 0.9 |
| Nitrogen cycle | 0.0 | 0.6 | 7.6 | 91.8 | 3.89 | 1.0 |
| Hydrological Cycle | 0.0 | 0.6 | 7.6 | 91.8 | 3.89 | 1.0 |
| **SYSTEMS** | | | | | | |
| Skeletal System | 0.0 | 65.0 | 3.3 | 31.8 | 1.98 | 1.2 |
| Reproduction and growth in Plants | 3.1 | 52.3 | 5.1 | 39.5 | 1.94 | 1.0 |
| Respiratory System | 0.6 | 5.1 | 28.5 | 65.8 | 2.92 | 1.2 |
| Food and Nutrition | 5.1 | 5.7 | 67.7 | 21.5 | 2.93 | 1.1 |
| Dentition, feeding and digestion in mammals | 2.5 | 56.5 | 36.1 | 4.9 | 1.90 | 1.1 |
| Transport-Diffusion, Osmosis and Plasmolysis | 3.2 | 64.4 | 6.3 | 29.2 | 1.21 | 1.2 |
| Excretory system | 0.6 | 58.2 | 7.6 | 33.6 | 1.92 | 1.0 |
| Reproductive Systems and growth in mammals | 6.9 | 45.9 | 29.1 | 18.1 | 1.94 | 1.1 |
| Circulatory System | 3.1 | 43.2 | 9.5 | 44.2 | 2.09 | 1.0 |
| **ENERGY** | | | | | | |
| Forms of Energy and Energy Transformation | 0.0 | 5.1 | 10.1 | 84.8 | 3.23 | 1.0 |
| Solar Energy | 0.6 | 2.5 | 5.1 | 91.8 | 3.89 | 1.0 |
| Photosynthesis | 5.1 | 10.6 | 28.5 | 55.8 | 2.89 | 1.2 |
| Electronics | 7.6 | 20.3 | 25.9 | 46.2 | 2.23 | 0.7 |
| Electrical Energy | 18.3 | 34.3 | 12.0 | 35.4 | 1.32 | 1.0 |
| Sound Energy | 5.1 | 13.9 | 22.1 | 58.9 | 3.0 | 0.9 |
| Nuclear Energy | 4.4 | 4.5 | 29.1 | 62.0 | 3.12 | 0.9 |
| **INTERACTIONS OF MATTER** | | | | | | |
| Ecosystem | 0.0 | 45.0 | 36.1 | 18.9 | 2.31 | 1.1 |
| Atmosphere and Climate Change | 0.0 | 4.4 | 6.4 | 89.2 | 3.73 | 0.9 |
| Infections and diseases | 0.6 | 55.2 | 7.6 | 36.2 | 1.55 | 1.2 |
| Forces, Motion and pressure | 0.0 | 0.0 | 16.5 | 83.5 | 3.20 | 1.0 |
| Safety in the Community | 14.6 | 40.0 | 18.8 | 26.6 | 1.34 | 0.9 |
| Work and machines | 0.0 | 0.6 | 7.6 | 91.8 | 3.89 | 1.0 |
| Endogenous Technology | 0.0 | 0.6 | 7.6 | 91.8 | 3.89 | 1.0 |
| Magnetism | 0.0 | 0.0 | 12.0 | 88.0 | 3.73 | 1.1 |
| Biotechnology | 5.1 | 7.0 | 3.2 | 84.8 | 3.58 | 0.9 |

Source: Field Survey, 2021

### 4.4 Research Question 2: 1. What is the difference in the perceived difficulty of integrated science topics by males and females?

In answering research question 2, which is also the hypothesis, the difference between male and female integrated science students' perceived difficulties with topics in the integrated science syllabus, was determined by comparing their mean scores of topic difficulties. An independent t-test was conducted on the mean score values of (male integrated science students and female integrated science students) was conducted to determine if there was a significant difference in perceived topic difficulty between these two groups. The results are represented in table 4.4.

From Table 4, cells and cell division, acid base and salt, water, air movement, nitrogen cycle, hydrological cycle, respiratory system and food and nutrition, forms of energy and energy transformation, solar energy, photosynthesis, sound energy and nuclear energy, atmosphere and climate change, forces, motion and pressure, work and machines, endogenous technology, magnetism and biotechnology were perceived to be difficult by the students with their respective mean scores greater than 2.5 for both male and female students with their mean difference ranging from 0.0 to 0.89. The difference between female and male students perceived difficulty of the integrated science topics which has a range of 0.0 to 0.89 may be insignificant to affect a difference in the perceived difficulty of the integrated science topics by males and females.

***Table 4.4: Comparison of Topic Difficulty by males and females***

| TOPICS | FEMALE MEAN | MALE MEAN | MEAN DIFFERENCE |
|---|---|---|---|
| **DIVERSITY OF MATTER** | | | |
| Cells and cell division | 3.4 | 3.0 | 0.4 |
| Acids, Bases and Salts | 3.62 | 3.42 | 0.2 |
| Water | 2.89 | 2.56 | 0.33 |
| **CYCLES** | | | |
| Air movement | 3.0 | 2.80 | 0.2 |
| Nitrogen cycle | 3.90 | 3.80 | 0.1 |
| Hydrological Cycle | 3.89 | 3.89 | 0.0 |
| **SYSTEMS** | | | |
| Respiratory System | 2.93 | 2.90 | 0.03 |
| Food and Nutrition | 2.94 | 2.90 | 0.04 |
| **ENERGY** | | | |
| Forms of Energy and Energy Transformation | 3.25 | 3.02 | 0.23 |
| Solar Energy | 3.89 | 3.67 | 0.22 |
| Photosynthesis | 2.91 | 2.80 | 0.11 |
| Sound Energy | 3.20 | 2.99 | 0.21 |
| Nuclear Energy | 3.23 | 3.10 | 0.13 |
| **INTERACTIONS OF MATTER** | | | |
| Atmosphere and Climate Change | 3.89 | 3.02 | 0.87 |
| Forces, Motion and pressure | 3.67 | 3.12 | 0.55 |
| Work and machines | 3.92 | 3.23 | 0.69 |
| Endogenous Technology | 3.91 | 3.86 | 0.05 |
| Magnetism | 3.76 | 3.66 | 0.1 |
| Biotechnology | 3.62 | 3.49 | 0.13 |

Source: Field Survey, 2021

Research question two sought to find out the difference in perceive topic difficulty in integrated science by males and females. The results in Table 4.5 shows the perceived topic difficulty in integrated science by males and females. It is clear from the table that both genders perceived the same topics to be difficult except that the mean scores of the male students perceived difficulty is less than that of the females with the mean score difference ranging from 0.0 to 0.89. The integrated science topics that were perceived to be difficult had their mean scores greater than 2.5.

The results in Table 4.5 sought to answer the null hypothesis which indicates that "There is no gender difference in students' perceive difficulty in integrated science topics". Table 4.5 shows that the t-stat of 0.839 is less than t-critical 1.665 at alpha (α) value of 0.05 meaning there is no significant difference of students perceive difficulty of topics in integrated science by males and females hence the researcher fail to reject the null hypothesis.

***Table 4.5: Independent T-test for male and female students***

| | Female Students | Male Students |
|---|---|---|
| Mean | 2.599474 | 2.422368 |
| Df | 74 | |
| t Stat | 0.839108 | |
| t Critical | 1.665707 | |

The study found no significant difference in students perceive difficulty of topics by males and females. With reference to gender, this is in line with the findings of Ogunkola and Fayombo (2009) that there was no significant statistical difference in Barbadian secondary school students' science achievement based on their gender. It is also consistent with the findings of Ogunkola and Samuel (2011) that there was no significant statistical difference in Barbadian lower secondary school students integrated science perceived topic difficulty by gender.

This finding is contrary to the findings by Ware and Lee (1985), which used 50 first-year university students in the US, findings revealed that males have higher levels of integrated science understanding as early as grade five. Males and females tend to learn the same amount during high school and college, so the gap that materialized before high school never closes during the schooling experience.

Although studies show a statistically significant gap in male and female learning of high school integrated science, the difference is typically small in magnitude-on the order of a couple of multiple-choice questions when background variables are controlled (Becker, Greene & Rosen, 1990). An exception to the findings of Becker et al. (1990) is a report by Heath (1989) that male students outperformed women by 10 tests scores in integrated science courses after controlling for the fact that women do not elect to take integrated science.

The Ontario Ministry of Education, (2003) indicated that pupils' commonly have a positive attitude toward all school subjects, a natural curiosity about quantitative events and some problem-solving skills when starting school. This attitude shifts, and students of both genders begin to lose interest particularly in science and academic subjects that require a more advanced knowledge of mathematics toward the end of grade six (Jones, Howe, & Rua, 2000; Simpson & Oliver, 1990). A contrary view from the findings above indicates that gender gap appears soon after students proceed in education, with more girls than boys disliking science and technology classes in middle school (Catsambis, 1995) and with more girls than boys opting out of science classes in high school (Watt, 2005). This trend continues in some integrated science related disciplines such as physics, mathematics, engineering and computer science in higher education with decreasing student enrolments overall and female students in particular (Canadian Association of University Teachers, 2007). Consequently, the number of young people pursuing careers in those fields is not keeping up with the demand in Western industrialized countries (Angell, Guttersrud, Henriksen, & Isnes, 2004).

## 4.5 Research Question 3: What measures could be implemented by teachers to improve on students understanding of their perceive difficult topics in integrated science?

Research question three sought to find out from students measures that could be implemented to improve upon the teaching and learning of SHS integrated science. On the science students' questionnaire, students were asked to respond to a four-point Likert scale items. There were five items with responses ranging from Strongly Agree, Agree, Disagree to Strongly Disagree (see Appendix A). These five items were based on some reported measures in the literature (Becker & Watts, 2001; Maxwell, Mergendoller & Bellisimo, 2005) that could be used to improve teaching and learning of science. The data on measures to overcome students' difficulties with some topics in the senior high school integrated science syllabus are presented in Table 4.6.

Majority of the students with a mean score of 1.87 responded that teachers should simplify complicated diagrams, and frequent use of practical examples by teachers M=1.56, when teaching perceived difficult topics. Students who took part in the focus group interview put premium on the need for science teachers to use more practical situations to explain some of the difficult concepts.

'Teachers must use some of the students and other local situations to cite examples so that the students can remember the things he or she has taught easily. The teacher must also use some current issues in the country to explain some of the concepts we find difficult to learn' (Student A). Ziegert (2002); McGoldrick (2002) and Bergstrom (2009) have found that learning is enhanced when students get real-world and hands-on experience in applying and understanding science issues. For example, when a teacher is introducing concepts “ecosystem” he/she could create an ecosystem in the classroom by asking students to bring some items to class. The students also reiterated that the use of practical examples could be facilitated through the use of group assignments, class discussions and experiments, educational trips and inviting resource persons to reinforce the teaching of particular concepts such as environment.

Again, over 58% of students agreed that teachers should simplify complicated diagrams. Teachers could make this simple when group assignments are given to students to work on those topics. For students to know how to draw and explain some of the complicated diagrams, individual student could be asked to draw such diagrams in class for others to see and comment.

The students (13.1%) indicated that teachers should use practical examples in their lessons. They further indicated that embarking on field trips in teaching some of the topics could help immensely. Field trip is an outdoor type of laboratory activity or field work or learning exercise undertaken by teachers and students in certain aspects of a subject, to give students the opportunity to acquire knowledge (Obeka, 2010). Similarly, Bichler (1978) observes that fieldwork furnishes the learner with the direct proof of first-hand scientific evidence on how they impart on a regular day-to day existence. The learner might be given a chance to cooperate with the specialists in a specific aspect in Integrated Science.

Also, 11% of the students responded on the frequent use to laboratory experiences. Laboratory work is a strategy of teaching where by tools, apparatus and instructional materials are used to enhance, stimulates the process of learning in a place known as laboratory. Laboratory work in biology involves observation, description or drawing, microscopy, dissection and experimental work (Ezeaghasi, 2014). Reid and Shahi

(2004) hold that laboratory works give the student the opportunity to experience science by using scientific research procedures and also to encourage the development of analytical and critical thinking. It also strengthens theoretical knowledge, experiencing the pleasure of discovery and development of their psychomotor skills, increasing creative thinking skills, higher order thinking skills, developing manual dexterity by using tools and equipment, allowing students to apply skills instead of memorization (Ezeaghasi, 2014).

Some students 8.9% also mentioned teacher education in integrated science. In line with this, Jacobson and Lehrer (2000), point to teachers' eliciting more sustained and elaborate patterns of classroom conversations about integrated science when the teachers have enhanced knowledge of the typical milestones and trajectories in children's reasoning about space and integrated science.

***Table 4.6: Students' Responses on Measures to Overcome Students' Difficulties with Some Topics in the SHS integrated science Syllabus***

| | M | SD | % Responses |
|---|---|---|---|
| Teachers should simplify complicated diagrams | 1.87 | 0.9 | 58% |
| Frequent use of practical examples | 1.56 | 0.89 | 13.1% |
| Embarking on fieldtrips often in teaching of some topics | 1.67 | 1.0 | 11% |
| Frequent use of laboratory experiments | 1.34 | 1.11 | 9% |
| Teacher education in Integrated science | 1.33 | 0.7 | 8.9% |

In addition, research by Swafford, Jones and Thornton (1997) demonstrated that intervention programmes that enhance teachers' knowledge of integrated science and their knowledge of research-based findings on student cognition in integrated science can influence the instructional practice and increased geometrical content knowledge. Research-based knowledge of student cognition in integrated science was apparent in what was taught, how it was taught, and the characteristics teachers displayed.

Students also shared their thoughts on how some positive changes in the attitude of their teachers could enhance the learning of some perceived difficult topics. They stressed that adequate teacher preparation on difficult topics, and spending more time to explain difficult concepts to students. A study by Becker and Watts (1998) recommends that teachers should use a varied approach periodically involving students actively in the learning process. They posited that some students are natural-born listeners, some are talkers and discussion leaders, and some seem to learn best using group activities that feature "hands-on" demonstration of integrated science concepts and relations. This supports the students claim.

Students expressed dislike to writing notes dictated to them and saw this as time consuming and prevented detailed explanation of concepts. This is how a student recounted on dictation of notes: "Teachers should give less bulky and incomprehensible notes and rather give notes that summarize but give the key point; simply they should do more explanation and not dictating of notes"

Dictation of notes has been found to be dominant in most senior high school teaching in Ghana and had been noted to be one of the contributing factors to students' difficulties with some topics in science (Dare, 1995; Yidana, 2007). This means that teachers should rather give more explanations and key points to students.

Provision of a standard textbook for the study of senior high school science attracted a lot of comments from students. Students were of the view that if the Government could select good and experienced science tutors to come up with a textbook, it would lessen their difficulties with some of the topics. According to the students, provision of a prescribed textbook as in the case of science by the Ghana Association of Science

Teachers (GAST) for science students will prevent dictation of notes, and offer both teachers and students more time to have discussion of topics.

## 4.6 Discussion of Findings

The findings of this study indicate that certain science topics are perceived to be more difficult than others, and so issues related to the teaching of these topics may be a major contributor to the difficulties experienced by students in the learning of integrated science generally. It was found that many of the areas of science that students experience difficulties with are in the subject areas of physics and chemistry.

The students in the focus group interview also indicated that the teaching strategies generally used by teachers may actually contribute to students' perceived difficulty of integrated science topics. This may not only mean that the teachers have a thorough grounding in these content areas, but also that they are of the view that their teaching methods are appropriate enough for the students to grasp the subject matter. The findings of this study indicate that a wide range of difficulty levels were obtained for the various topics identified. Most students generally found the highest levels of difficulty in physics and chemistry concepts such as: acid, base, salts, work, machines and solar energy. The biology areas of excretory system, infectious disease etc were found to be comparably easier. The interview supported these findings since the students generally thought that biology concepts were more interesting and easier to study than physics and chemistry concepts. They indicated that biology concepts were more realistic and relevant to them compared to many concepts in physics and chemistry which tended to be very abstract.

Many factors have been proposed to explain what makes integrated science learning difficult. First, the scientific language, which involves specific terminology, is unique and needs particular attention and understanding before it can be used meaningfully. Misuse of scientific terminology can lead to misconceptions of scientific knowledge Bishop (1983). Similarly, integrated science requires visualizing abilities but many students find it difficult to perform these abilities. Visualizing shapes of elements, molecules, etc in science is very difficult for students lacking or having sharp retentive memories (Ben-Chain, Lappan, & Houang, 1989). Due to their limited scientific experiences, students may not have enough opportunities to develop and exercise their abstract thinking skills for effective integrated science learning.

Another problem is that traditional approaches to integrated science instruction do not seem to help students achieve the intended learning outcomes in the curriculum. By using just textbooks and chalkboards, classroom integrated science experiences hamper optimal learning. Analysis of the focus group interview indicated similar findings. There was general agreement among the students that although science was an interesting subject, it could be quite difficult at times especially because of the teaching strategies used. Biology was comparably less difficult than physics or chemistry. It was more interesting and easier to study because it mainly involved studying the human body while many of the concepts taught in physics and chemistry were abstract and not experienced in everyday life. In the Ghanaian context, this concern is shown in the poor integrated science performance of students in public examinations (The Chief Examiners Report, 2010). There is an urgent need to change the traditional mode of integrated science instruction to one that will be more rewarding for both teachers and students. Specifically, learners must be given opportunities to personally investigate and discover integrated science to enable understanding of the subject in-depth and also with the other fields of integrated science.

There are varieties of other reasons why students, especially at the secondary level, may perceive topics in integrated science as difficult in comparison to other subject areas. It may be due to how the students perceive the subject based on their experiences with it, or even from information about the subject from other persons. Behar and Polat (2007) also pointed to misconceptions about integrated science phenomena possessed by students as contributing to the difficulty of certain integrated science topics. Chiappetta and Koballa (2006) defined misconceptions or alternative conceptions as ideas about phenomena that students bring to the classroom that does not correspond well with the scientific knowledge to be taught. They added that these alternative conceptions are tenacious and resistant to change by conventional teaching strategies. So, these misconceptions may, according to Behar and Polat (2007), cause misunderstandings in certain integrated science topics. This may especially be the case if the teaching strategies used by teachers are not adequate to allow for conceptual change.

A related argument put forward by Behar and Polat (2007) concerns the many terms and symbols used in the teaching of various science concepts. Many such terms are new to the students and so cannot be linked to their cognitive structures which, according to Behar and Polat, may also cause information overload in the working memory. In addition, some terms are known by students, but in a different context and with a different meaning to that used in science. An example is a concept of 'work'. Confusion may result which adds to the perception of the difficulty of the area of content.

Key factors in facilitating an effective learning environment in the science class are the teaching strategies used by teachers. As early as 1910, John Dewey criticized integrated science teaching of the day as giving too much emphasis to the accumulation of information rather than to an effective method of inquiry (Lopez, 2009). Unfortunately, this argument appears to be as relevant today as it was then. Many times, teachers use the excuse of overloaded science curricula to explain their reliance on strictly didactic methods of teaching. Though these claims may have some merit, these teaching strategies may in effect, portray the subject as difficult to many students. Behar and Polat (2007) alluded to this when they identified the passive roles of students in the classroom and their perception of the teacher as the only source of knowledge, as contributing to the perceived difficulty of integrated science topics.

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# CHAPTER FIVE

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### 5.0 Overview

In this concluding chapter, overview of the research problem and methodology, and the key findings of the study are presented as well as the recommendations and suggestions for future research are pointed out.

### 5.1 Summary of the Study

The problem that prompted this study was senior high school science students' poor performance in science in WAEC's organized examinations in Ghana. Some factors had been suggested for students' poor performance in science lessons such as learning styles, environmental factors, students' study time among others (Walstad, 2002). One factor which could also contribute to low performance of integrated science students but appears to have not been given much attention in science education research is topics that students find difficult in learning. The WAEC Chief Examiner' Reports (2012-2016) indicate that some senior high school science topics pose difficulties to students.

Evidence from science education literature indicates that science teachers have some difficulties with some topics in science (Dorman, 2002; Guerrien, 2002). These reports raise questions about what science topics do students perceive to be difficult that offered science in Northeast Region was categorized into a low performing school based on individual performance in WAEC examinations. Students in all classes except elective science students were randomly selected to take part in the study. This was done after Nalerigu Senior High school was purposefully selected.

Descriptive survey design has many merits. For instance, the design provides a more accurate and meaningful picture of an event and seeks to explain peoples' perception and behaviour based on data gathered at a particular time (Fraenkel & Wallen, 2012). This allows for in-depth follow-up questions and items that are unclear to be explained. The main advantage of descriptive survey design is that it has the potential to provide a lot of information from quite a large sample of respondents (Fraenkel & Wallen, 2012).

## 5.2 Key Findings

1. It was found in this study that Nalerigu senior high school students in the East Mamprusi Municipality perceived some topics in the science syllabus as difficult. These topics were: work and machines, endogenous technology, hydrological cycle, solar energy, forces, motion and pressure, magnetism, acids, base and salts, forms of energy and energy transformation, cell and cell division and Food and nutrition.
2. The findings of this study indicate that certain science topics are perceived to be more difficult than others, and so issues related to the teaching of these topics may be a major contributor to the difficulties experienced by students in the learning of science generally. It was found that many of the areas of science that students experience difficulties with are in the subject areas of physics and chemistry. This is supported by the research of Johnston (2012) which theorized that difficulties may be caused by complexity due to ideas and concepts existing at micro, macro and symbolic levels. These multi-level conceptual frameworks appear to be more common in physics and chemistry than in biology. This is especially the case since concepts at the micro and symbolic levels are normally very abstract

3. It was found in this study that students gave varied reasons for their difficulties with some of the topics. Some of the reasons included, lack of prescribed text books, and teachers should use more practical examples in their teaching.
4. The study revealed some measures students suggested to improve the teaching and learning to topics in integrated science: some of the measures included teachers simplifying complicated diagrams, used frequent laboratory experiments and frequent use of practical examples as well as use varied teaching strategies during instructions.

## 5.3 Conclusion

It can be concluded from the results of the study that science students in senior high schools perceive some topics difficult to learn. Some of these topics are “Acids, Bases and Salts”, “Transport-Diffusion, Osmosis and Plasmolysis” and electrical energy” and “electronics”. These topics are part of the topics the WAEC Chief Examiners’ Reports (2010-2011) indicated as posing difficulties to senior high school science students, hence this study has brought to light actual topics in the syllabus students find difficult and what reasons accounted for such difficulties.

The study found no significant difference in students’ perception of difficult topics based on their gender. With reference to gender, this is in line with the findings of Ogunkola and Fayombo (2009) and Ogunkola and Samuel (2011) that there was no significant statistical difference in Barbadian secondary school students’ science achievement based on their gender.

Students gave varied reasons that accounted for their difficulties with some topics in the science syllabus.

Some of the measures that students' suggested to improve on the teaching and learning of the topics have been reported in the science syllabus and some literature, however, the study could not find out whether teachers are using these methods.

Two possible reasons were identified in this study. The first has to do with the nature of many science concepts taught in the senior high schools. These concepts are very abstract in nature and many times little effort is made to present them to the students in a concrete way, e.g. with the use of models, which may lead to better understanding of the abstract concepts. More of these concepts are in the physics and chemistry areas of integrated science compared to biology areas. The second focuses on the teaching strategies used in the integrated science classes. In this study, even the students called into question the teaching strategies used that are, according to them, 'boring' with very little effort being made to present the material in an interesting and relevant way.

The science departments of senior high schools in collaboration with the Ministry of Education must plan programs and interventions that not only show the importance of science in national development, but also exposes students to the possibilities of meaningful and lucrative careers in science. Attention must also be paid to the male students who this study indicated as having an even lower level of interest than female students.

## 5.4 Recommendations

The following recommendations are offered based on the findings of the study.

1. Workshop and in-service training programmes should be organized for teachers to improve their content and pedagogical knowledge on the topics perceived to be difficult and strategies to teach such topics.

2. Students should discuss with teacher about the standardised text books that they should use which could help them understand better their perceived topics that are difficult.
3. Headmasters, curriculum officers, and teachers should reacquaint themselves with the inquiry-based approaches recommended for science instruction and do their part in seeing that the curriculum is implemented using these approaches.
4. The teachers must be made to step up and use the strategies that they were trained to use. Only then will students see relevance and meaning in science concepts even though they may be abstract.

### 5.5 Suggestions for Future Research

Based on the findings of the study, the following suggestion for further research is made.

The finding of the study was inconclusive because the teachers' classroom activities were not observed to substantiate their ways of teaching or the methods they employ during their classroom presentation to ascertain if it could be the reason for students perceived difficulty of the topics.

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# APPENDICES

## APPENDIX A

## QUESTIONNAIRE FOR STUDENTS

This questionnaire aims at finding out difficulties students have with some senior high school Integrated science topics. This exercise is purely academic and therefore your response to the items will be treated with utmost confidentiality, therefore do not write your name on the paper. You are kindly requested to respond as frankly as you can. Thank you for your cooperation.

**SECTION A: BACKGROUND OF STUDENTS**

Please tick (√) the appropriate response

1. Programme:…………………………………………………..

2. Form…………………………………………..

3. Gender: Male [ ] Female [ ]

4. Age…………………………………..

**SECTION B: STUDENTS PERCEIVED DIFFICULTIES OF INTEGRATED SCIENCE TOPICS**

Tick (√) the appropriate response to how easy or difficult you find the following topics and their sub topics.VE-very easy E-easy D-difficult VD-very difficult.

| DIVERSITY OF MATTER | VE | E | D | VD |
|---|---|---|---|---|
| Introduction to Integrated Science. | | | | |
| Measurement | | | | |
| Diversity of living and nonliving Things | | | | |
| Matter | | | | |
| Cells and cell division | | | | |
| Rocks | | | | |
| Acids, Bases and Salts | | | | |
| Soil conservation | | | | |
| Water | | | | |
| **CYCLES** | | | | |
| | **VE** | **E** | **D** | **VD** |
| Air movement | | | | |
| Nitrogen cycle | | | | |
| Hydrological Cycle | | | | |
| **SYSTEMS** | | | | |
| Skeletal System | | | | |
| Reproduction and growth in Plants | | | | |
| Respiratory System | | | | |
| Food and Nutrition | | | | |
| Dentition, feeding and digestion in mammals | | | | |
| Transport-Diffusion, Osmosis and Plasmolysis | | | | |
| Excretory system | | | | |
| Reproductive Systems and growth in | | | | |

mammals

Circulatory System

**ENERGY**

| | VE | E | D | VD |
|---|---|---|---|---|
| Forms of Energy and Energy | | | | |
| Transformation | | | | |
| Solar Energy | | | | |
| Photosynthesis | | | | |
| Electronics | | | | |
| Electrical Energy | | | | |
| Electronics. | | | | |
| Sound Energy | | | | |
| Nuclear Energy | | | | |

**INTERACTIONS OF MATTER**

| | VE | E | D | VD |
|---|---|---|---|---|
| Ecosystem | | | | |
| Atmosphere and Climate Change | | | | |
| Infections and diseases | | | | |
| Forces, Motion and pressure | | | | |
| Safety in the Community | | | | |
| Work and machines | | | | |
| Endogenous Technology | | | | |
| Magnetism | | | | |
| Biotechnology | | | | |

**SECTION C: REASONS THAT ACCOUNT FOR SENIOR HIGH SCHOOL STUDENTS' INABILITY TO UNDERSTAND SOME TOPICS IN INTEGRATED SCIENCE.**

For each of the statements below, please indicate the extent of your agreement or disagreement by placing a tick in the appropriate column to show your impression about the issues on the teaching and learning of integrated science at the SHS. SA- Strongly Agree, A – Agree, D- Disagree and SD- Strongly Disagree.

| | SA | A | D | SD |
|---|---|---|---|---|
| Inadequate coverage of the syllabus with respect to topics affects my understanding of some aspects of integrated science. | | | | |
| My teacher does not make use of teaching/learning aids in the course of lesson delivery to enhance understanding of science topics. | | | | |
| Textbooks available to students lack enough activities to consolidate scientific concepts taught by the teacher. | | | | |
| Approaches adopted by teacher in the teaching of scientific concepts were effective to aid understanding of concepts. | | | | |
| Exercises given by teachers were not enough for students to practice on all aspects of integrated science to consolidate concepts taught. | | | | |
| The nature of scientific concepts taught by the teacher does not promote further search on the part of students to enhance their understanding of these concepts taught. | | | | |
| The content of integrated science syllabus is bulky | | | | |

**SECTION D**

Measures that could be put in place to enhance effective teaching and learning of difficult topics in integrated science.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………..

**SECTION E: MEASURES TO ENHANCE STUDENTS' UNDERSTANDING OF TOPICS TAUGHT**

What measures would suggest your integrated science teacher put in place to ensure that you can understand what he/she teaches in class?

| | SA | A | D | SD |
|---|---|---|---|---|
| Teachers should simplify complicated diagrams | | | | |
| Frequent use of practical examples | | | | |
| Embarking on fieldtrips often in teaching of some topics | | | | |
| Frequent use of laboratory experiments | | | | |

What other measure(s) would you suggest to improve the learning of difficult topics in integrated science?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

# APPENDIX B

## INTERVIEW GUIDE FOR STUDENTS

1. When did you start studying integrated science?
2. What is your performance in integrated science at your level?
3. What problems do you encounter in studying integrated science?
4. What are the causes in thee integrated science?
5. Could you comment on whether there exist differences in the integrated science topic difficulty perceived by male and female students?
6. With respect to science and non-science elective student, comment on whether there exist differences in thee integrated science topics difficulty.
7. Mention some measures that could be implemented to enhance the effective teaching and learning of Integrated Science topic prescience to be difficult.

# APPENDIX C

## RELIABILITY DATA ON THE QUESTIONNAIRE

Reliability Statistics

| **Variables** | **Cronbach's Alpha** | **Number of Respondents** |
|---|---|---|
| Students | 0.73 | 30 |