UNIVERSITY OF EDUCATION, WINNEBA

FACTORS THAT INHIBIT THE FORMATION OF BASIC SCIENTIFIC CONCEPTS BY STUDENTS

HENRY KOFI WOSOR

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

JANUARY,2016

DECLARATION

Student's Declaration

I, **Henry Kofi Wosor**, declare that this dissertation, with the exception of quotations and references contained in published works which have all, to the best of my knowledge, been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, to any institution anywhere for the award of another degree.

Signature: …………………………….

Date: ………………………………….

Supervisor's Declaration

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

Supervisor's name: …………………………

Signature: …………………………….

Date: …………………………….

DEDICATION

This project work is dedicated to my family who stood by me both physically and emotionally throughout the period of this program.

ACKNOWLEDGEMENTS

All thanks to God Almighty for protecting me throughout the duration of the program and making me who I am today. I am deeply grateful to my supervisor, Prof. KolawoleRaheem of the Institute for Educational Research and Innovation Studies (IERIS), University of Education, Winneba, Ghana for the suggestions, constructive criticism, encouragement and support given to me in supervising this piece of work.

I much appreciate the emotional support given to me by my family which encouraged me throughout this work.

I am sincerely thankful to the Headmaster and the entire staff of Keta Senior High Technical School for their encouragement and support. Without the cooperation of the students, this work would not have been successful and so I say thanks to you all. May God richly bless you all.

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ABSTRACT

This research sought to improve science concept formation of Senior High School students by bringing to light the factors that inhibit science concept formation in Keta Senior High Technical School students and proposing solutions to the factors. The research was conducted using one hundred and ninety three students, four science teachers and two science laboratory technicians all of Keta Senior High Technical School. Questionnaire was administered to the one hundred and ninety three students and the four science teachers and the two science laboratory technicians were interviewed. Observation was made in eight science lessons and tables drawn for results obtained. One of the main findings is that a number of students have negative perception and attitude towards science and this affects their focus and adversely, how they form science concepts. Most of the integrated science lessons are not taught using laboratory experiments and hands on models and this also affects good concept formation. Inflexible teaching methods such as lecturing are also a contributing factor. Inadequate pedagogical content knowledge of the science subject masters is also a major cause. Some other factors include inadequate assessment of students and monitoring of performance by teachers which was as a result of the large population of students and few subject handlers. In-service training is recommended for the science teachers to enhance their pedagogical content knowledge. It is also recommended that enough science teachers be made available for teaching of integrated science in the schooland that the school administration refurbish the science laboratory and equip the laboratory with appropriate teaching aids, apparatus, glassware and chemicals for use during instructions.

CHAPTER ONE

1.1 Overview

This chapter contains the background to the study which elaborated on the extent of the problem under investigation. It points out the research questions that this research is dedicated to solving. The limitations of the study and the delimitations of the problem are all included in this chapter.

1.2 Background of the study

Science in the form of integrated science is a compulsory subject studied in the basic schools as well as the senior high schools in Ghana. The introduction of integrated science as a compulsory subject in the schools in Ghana is to instill some important basic necessities into students such as, curiosity, experimentation, correct recording of data, reasonable deduction making, etc. These basic necessities that science instills in its learners is deemed very important for the development of the nation.

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

In view of this, the Ghanaian government has made science and technology the pivot of its development plan (Ghana National Association of Teachers, 1996). As a result, it is therefore envisaged in the Vision 2020 policy document of Ghana that, the nation would be at a better position in the development of science and technology where production of finished products would characterize the economy leading to reduction in unemployment rate.

Important as science has become in the current stage of development, it is undeniably one of the most difficult subjects when students consent is sought. This observation was confirmed in the Chief Examiner's report (2013) that 'the paper met its standard and the questions were straight forward and was also within the scope of the candidates but standard keep unreasonably falling with no commendable strength. The chief examiner's report made mention of the fact that students find it difficult responding to basic life science problems. This may be attributed to poor concepts formed or in some cases no concept at all formed by students of integrated science which may be due to some challenges.

Certain challenges face both teachers and students in teaching and learning of integrated science which inhibits the formation of science concepts by students, Bingimlas (2009). These challenges may include concept development, methods of teaching, teaching and learning materials, syllabus structure, teaching laboratories, availability of reference materials, etc. Once the student does not form basic concepts and develops negative attitude towards the subject, they become helpless.

According to World Bank (2004), the most widely recognized challenge to school improvement comes from deeply entrenched instructional practices that make students memorize a great deal of information with the limited purpose of reproducing it in examinations. In many schools, science is taught with the conventional method of teaching and listening by teachers and students respectively. This method of teaching makes it difficult for most students to understand, grasp and apply scientific principles to their daily lives. As such, they end up memorizing just for the purpose of examinations.

1.3 Statement of the problem

It has been observed by the researcher that students especially non science students' performance in integrated science is continuously falling. The analysis of 2014 WASSSCE results of Keta Senior High Technical School revealed that the percentage pass was 83.06% as against 99.74% of 2013 in which cases D7 and E8 are passes. This shows a significant decline in the performance in integrated science revealing that as much as 84 out of the 486 students presented in 2014 had F9 and as much as 169 had D7 and E8 in integrated science. However, this is the best school performance of integrated science in the Municipality. This presumes that the situation is far worse in the other senior high schools in the Keta Municipality.

Having followed the flow in tests and terminal examination scripts of students of Keta Senior High Technical School where the researcher teaches, the decline in performance stems from the fact that most of the students get into the exam hall with little or no science knowledge. This was evident in totally wrong answers students gave to simple life science questions.

As such, this study will focus on finding some of the factors that are responsible for the low performance of students in integrated science in Keta Senior High Technical School.

The problem of low performance in integrated science may be a result of little or no science concept formed by students which in turn is caused among other things by one or more of the following;

1. Inflexible teaching methods science teachers use in teaching.

2. Little or no practical attachments to lesson.
3. Unavailability of relevant reference materials in the subject domain.
4. Little or no use of models and other teaching aids (Teaching and Learning Materials)
5. Students' individual performance not monitored by science teachers because of the large class sizes.
6. The perception of students that science is difficult and generally boring and loss of interest in the subject.

1.4 Purpose of the study

The purpose of the study was to investigate into some of the factors that inhibit the formation of basic scientific concepts by Senior High School students in the Keta Municipality. This study was also conducted to find out the possible factors that negatively affect presentations of science teachers and science concept development of students and to provide possible solutions for improved performance.

1.5 Objectives of the study:

The objectives of this study includes the following

1. To find out students' attitudes and perceptions about integrated science and its effect on their science concept formation.
2. To find out whether science teachers teach using laboratory experiments to aid concept formation
3. Finding out the teaching methods used by the science teachers and its effect on science concept formation.
4. To find out whether science teachers have good pedagogical content knowledge to aid science concept formation of students.

1.6 Research questions:

This research work seeks to answer the following questions:

1. What are the perceptions and attitudes of students towards integrated science and how does this affect performance in the subject?
2. Do the science teachers use laboratory experiments in teaching to aid science concept formation?
3. Which methods do the science teachers use in presenting their lessons and are the aiding science concept formation for the students?
4. Do the science teachers in Keta Senior High Technical school have good pedagogical content knowledge?

1.7 Significance of the study

This research is aimed at giving a clearer picture of the reasons why there is decline in the performance of students in integrated science. Possible solutions to the reasons will be sought for improved performance. Findings from this research will be relevant in guiding science teachers to present science lessons using methods that enhance formation of relevant science concepts by students for better understanding and applicability of science.

1.8 Limitations of the study

The research was limited to Keta Senior High Technical School in the Keta Municipality in the Volta Region of Ghana. The participants comprised of only second year students of the school. The second year students were chosen because they have had ample experience in the study of integrated science in the school and can better comment on the subject matter and also because they are the next candidates of the final Examination.

Six out of the thirteen classes in form two were used and four science teachers were interviewed and two laboratory technicians.

1.9 Delimitations of the study

This research did not include all the classes in form two. Although there are several other factors that affect concept formation, this piece of work was intended to finding out the effect of interest and attitude of students on formation of science concepts as well as the effect of practical attachment to lessons. The pedagogical content knowledge of the science teachers is also researched. It did not focus on non science students but generalized the research to sampled classes including science classes. Although there are several other factors that affect concept formation, this piece of work is only limited to the few described in the research questions above.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

In this chapter, science and its importance is explained, concept as defined by different authors is reviewed; the characteristics of concepts and the conditions under which concepts are formed are discussed. Other relevant reflections about science concept are discussed.

The chapter is discussed under the following headings;

- Science and implications to society
- Concept
- Types of concepts
- Concept formation
- Factors affecting concept formation
- Conceptual change and how to facilitate it

2.2 Science and implications to society

Jegede (1980) defined science as a body of knowledge and process of acquiring knowledge. He emphasized that science is the major instrument for solving problems of society. According to the Ghana Education Service Integrated Science teaching syllabus (2010), the most basic aim for teaching integrated science is to equip the student with basic problem solving abilities within his/her immediate environment through analysis and experimentation. This basic aim of integrated science learning requires that students do not only learn science for examination purposes but learn to apply scientific concepts in problem solving in their environments.

Woolnough (1991), states that the most rationale for science course speaks of pupils learning to do science as scientists do. This implies that the science teacher in his own field must know the subject both experimentally and theoretically, (Hill, Ball & Schilling 2008). DeBoer (2000) is also of the view that students of science have to grasp the science concept to be able to manipulate parameters in their environments and apply scientific methods in solving problems of society. All the perspectives of science learning suggest that students need to form relevant concepts to be able to understand and apply the science they learn in their environments for its relevance to be felt.

2.3 Concept

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

According to Roets as cited in Sarfo (2009), 'the opinions of people are articulated by way of words, images, signs, symbols, and concepts'. Roets (1995) further explains that science concepts are the symbols, impressions and knowledge representing concrete objects and abstract ideas in the field of the natural sciences. Treagust and Harrison (2000) explained concepts as mental representations that, in their simplest form, can be expressed by a single word, such as plant or animal, alive or dead, table or chair, apple or orange. Concepts can act like building blocks for more complex or even abstract representations.

Escalas andBettman (2005) also defines concept as a symbolic image with a particular meaning that can be manipulated by means of linguistic symbol. According to Escalasand Bettman (2005), a concept may be represented by a word e.g. atom, mass, volume, density. Some of the concepts serve as platforms for the development of other concepts. An example is density which can be expressed as mass per unit volume of a substance where mass and volume themselves are concepts. As such the term subconcepts and superconcepts were introduced.

Arends (1991) also established that science concepts are mental organizations about the world that are based on similarities among objects or events. They are ideas generalized from particular instances. According to Arends (1991), the generalizations are based on certain similarities that concepts have. These similarities are referred to as critical attributes of the various concepts. In science, every concept e.g. atom is defined and described based on its critical attributes. These attributes and qualities that make us refer to something as an atom differentiates atoms from other concepts such as molecules.

The development of good logical framework helps students in forming good science concepts. When students have good science concepts, they perform better in their science exams and even the other subjects. It is often seen that performance in science reflects the performance in other related subjects areas.

Child (1981) is also of the opinion that concepts are best defined by their characteristics or attributes. He enumerated seven of these characteristics;

a. Concepts are generalizations, which are abstracting particular sensory events, and critical attributes. They are not the actual sensory events but merely representations of some aspects of these events in the mind.

b. Concepts are dependent upon previous experience such as home background, educational opportunity, and emotional perceptional connections.

c. Concepts are symbolic in human beings in form of words, numbers, chemical symbols and physical formulations.

d. Concepts can form 'horizontal' or 'vertical' organizations. For example, horizontal classification can be things such as reptiles (snakes, lizards and crocodiles) which belong to the same major group of animals simply because they posses attributes in common. Vertical classification can be due to the presence of hierarchies or categories, which increase in complexity as one, proceed through the classification. For example cats, bears, panthers and seals, which are all flesh-eating mammals.

e. Concepts are terms or abstract words emanating sub-consciously by extension or intention. These are concepts, which have common agreement and acceptance or having special significance with no universal acceptance. For example concepts which have extensional use are those words whose meanings have widely acknowledged meanings. Concepts with intentional use are those concepts, which vary from person to person due to personal or subjective experience of an individual. In view of this it will be prudent for a research to investigate how concepts that have intentional use impede the formation of basic scientific concepts by teacher trainees.

f. Concepts may be irrational, because their origins are obscure and based on unusual methods of concept formation from reality.

g. Concepts formed without conscious awareness; these are values established by our culture, which in one way or the other influence our daily conduct of life formed as habits from childhood without our realizing it. For example, prejudices, dislike for certain foods, attitudes towards religion may be implanted in a person for life. (Sarfo2009,p 13-14)

2.4 Types of Concepts

According to Sternbergeand Ben-Zeev (2001) there are at least five forms of expressing concepts. These forms are; Concrete concepts, Abstract concepts, Verbal concepts, Non-verbal concepts and Process concepts.

They explained that concrete concepts can be seen, touched, or heard. In other words they have some direct sensory input for examples, plant, computer hardware and dog. In contrast, abstract concepts are thought to have no direct sensory input unless by metaphor or analogy for example, chemical reactions and friction. Verbal concepts are often thought of as classes of ideas or objects that are best understood and used using language for example, chemical bonding and equilibrium. These examples may also be classified as abstract concepts since they have no direct sensory input. Therefore, types of concepts may overlap. Non-verbal concepts are often thought to be best understood; making mental pictures to represent their critical attributes and examples are, the atom and electrons. The process of painting mental pictures (models) to aid learning and production is often referred to as visualization or modeling. Examples of non-verbal concepts include perimeter, area, volume, and mass. Process concepts represent mechanisms such as photosynthesis or an atomic reaction.

In Science, JegedeandOkebukola (1991) contend that concepts exist in two kinds, empirical and theoretical. Empirical concepts are observable or demonstrable and may be defined operationally. They can be measured relatively, for example diffusion, freezing, evaporation, pressure, density, speed, velocity, acceleration, potential energy, etc.

Theoretical concepts are non-observable and do not lend themselves easily to perception and are not measurable directly. For example, atoms, cell, genes, protons etc. Abdullahi (1983) emphasizes that every individual builds his or her world on concepts. They come in all types and some are much more significant than others. As one learns and experiences new things, he or she draws upon and increases his or her conceptual “store houses” and this increases knowledge.

2.5 Concept Formation

Human Beings will constantly put old concepts to use and in the process, frequently extend them and acquire new, related ones (Sarfo, 2009). It is good to know that concept acquisition, formation or development has no end. This is so because at any time in a person’s life, a new concept can be acquired provided the person is psychologically tuned. According to Novak (2010), the chain of concept usage, enlargement and revision is continuous as long as we are able to think.

Everyone learns concepts, whether they like to or not. Concepts enrich as well as extend and order our psychological worlds. Many concepts such as table are, acquired because they have functional value; useful for something we need or use or want to do. The process of acquiring and using new concept is described as concept formation.

According to Sarfo (2009), Concept formation is the process of integrating a series of features that group together to form a class of ideas or objects. He explained that developmentally, a younger child might define a bird as any object that flies in the air. The first time this child sees an airplane in flight, he may point to the sky and say, "Bird!" The observant parent or caregiver might correct the child by saying, "No that's an airplane. Birds fly but they have feathers. Airplanes fly but they don't have feathers." (Sarfo 2009,p 18).This in effect means that the old concept is modified to suit the experience of the child hence forming a new concept of airplane.

According to Roets (1995), the formation of concept in the cognitive structure is not purely a result of direct observation and past experience, but cognitive process such as organization; interpretation and combination of thoughts. Therefore concept formation and development of thought go hand in hand and there is gradual progress from naïve egocentrism to adult logic and objectivity. The implication is that the way a person thinks invariably affects the way the person forms concepts. Arrends (1991) describes concept formation as the acquisition of conceptual skills in one's cognitive framework. This means that concept formation is an interpretation of understanding of what have been experienced. Individuals internalize their experience in a way which is partially their own. Dirkx (2001) made mention of the fact that learners construct their own meanings and these personal ''ideas'' influence the manner in which information is acquired. In view of this it is obvious that the students' already existing concepts, experiences, logic and objectivity will affect how they form scientific concepts. As such, it is relevant for the subject masters to discover the already existing concepts and modify them in the acquisition of a new one.

From another perspective, a concept is formed when certain qualities and relationships are seen repeated in a number of successive experiences. Through several trials you can identify what qualities and relationships make a given concept (Arends, 1991). The implication is that students make observations of events and give their own interpretations to the observations. The teacher can however guide the students to make better and more scientific deduction from observations. This requires the students doing enough practical work in the form of laboratory experiments and hands on models.

Sternberg and Ben-Zeev(2001) intimated that one way to promote concept formation is to preview the different concepts students will encounter during the school year or school day or a lesson as cited in Sarfo (2009p. 15). They suggested the following strategies;

a. Teachers are to present learners with the definition of the different types of concepts, telling them which type they will see most and least often in class.

b. Teachers are to provide learners with examples of important concepts of each type taken directly from their textbooks, class syllabi, and/or outlines.

c. Teachers are to help students to develop a firm sense of the critical attributes that define individual concepts, making clear that each concept (i.e., separate) may share some critical attributes with other concepts. Writing the critical attributes on one side of a flash card and the concept on the other side may help them to collaborate with others or go off by themselves to learn the attributes. The concept flashcards may also help students to retrieve the concept from memory.

2.6 Factors that affect concept formation

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

2.6.1 Vocabulary

Henderson and Wellington (1998) succinctly put it that, “The quality of the classroom language is bound up with the quality of learning.” (p. 36). Wellington and Osborne (2001) further explains that “language development and conceptual development are inextricably linked. Thought requires language and language requires thought” (p. 6). These extremes are enumerating the importance of vocabulary to learning and concept formation.

Oxford (2003) also reports that language proficiency adds additional meaning to already acquired concepts. His focus is on both imagery and language. He also recognizes that the two stages, imaging and verbalizing, may occur simultaneously, especially in older children. As children learn to increase their verbal conceptual bases, their ability to comprehend written material also increases.

With reference to science education, Wellington and Osborne (2001) underlines that research findings indicate that language, in all its forms, matters to science education. In particular, it is not just the language in itself but rather what educators do with language. This is because what educators do with the language inadvertently affects how the learner uses the language and that is fundamental to the learning of science. With countries like

Ghana where English is learnt as a second language, the difficulty many students may face is differentiating between the everyday meaning and scientific meanings of words.

Henderson and wellington (1998) exposed this by saying "For many pupils the greatest barrier to learning science is the language barrier" (p. 35). One of the major reasons why language becomes a barrier to Limited English Proficiency (LEP) learners is because scientific terms, whether technical or non-technical, are unique in nature and they are seldom encountered in other contexts or in English as a Second Language instruction. According to them, the meanings the words hold in everyday English is not exactly the same as the scientific meaning. An example of his explanation can be seen in the scientific term "force". Coercion intending to influence action is referred to as force. So a student might say "don't force me" with a meaning. Scientifically, force will be defined as pull or push on a body and mathematically expressed as product of mass and acceleration. Another example is "work". Work is used in everyday life to represent any task that is done. Scientifically however, work is done when force is moved through a distance. As such a man holding a 5kg rice bag is seen doing no work scientifically.

According to Kim (2007), one of the key factors in helping LEP students achieve greater progress in learning science is the role played by the science teacher in lowering the language barrier. This is because according to her, language is a great barrier to students' learning.

Some school of thought asserts that thoughts and ideas are associated with words. Different languages promote different ways of thinking and language does not completely determine thought but does influence it (Gozzi, 1989). This implies that limited vocabulary means limited cognitive activity.

Language is important in many cognitive activities, such as memory and thinking. O'malley, and Chamot (1990) also reported poor vocabulary and command of English Language as major problem to concept formation. By this, it is obvious that the proficiency of students in English language can be a barrier to their science concept development.

Kim (2007) advocated for teaching of life sciences in local languages. She emphasized that thought begins in the local language and so when students are thought in their local languages, they will be able to connect to the concept being taught and make representations mentally of it. Teaching science in local languages have advantages over teaching it in second language but most of the local languages lack appropriate vocabularies for scientific terminologies.

2.6.2 Practical work

In another development, Sirestarajah as cited in Sarfo (2009), reported that ‘practical work forms an integral part of physical science. In his work in the Republic of South Africa, he reported that most schools in Venda had no laboratories for practical work. Teachers use the telling method which makes students learn by rote without understanding concepts. As such, they cannot apply their knowledge to real-life situations. He further on suggested that when science is taught through experiments with improvised apparatus, students’ learning occur in various domains of science education. Meaningful learning leads to the understanding of scientific concepts, and students construct their own knowledge, apply it to any situation and enjoy learning the subject' as cited in Sarfo (2009, p 27)

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

2.6.3 Culture and Environment:

Some learners have difficulty understanding scientific concepts because they do not have the necessary conceptual, logical and linguistic background (Gagliardi, 1997). Other environmental factors that determine who the student has become are his social and emotional learning and upbringing. The language and culture certainly affect his characteristics, personal habits, and preset ways of thinking. The parents, specific mentors, relatives, peer opinions and interactions also affect his character and might influence personal beliefs. For example, various cultures provide culturally specific explanations for particular phenomenon.

Some researchers found that some children's conceptions of the universe are intertwined with elements of theology and mythology that were passed on to them by adults, this even affects the beliefs of even highly educated adults –a way of presenting cultural traditions. Cobern (1996) acknowledged the fact that various modes of social and cultural interactions are present during concept formation. The implication of the above is that socio-cultural interactions may affect the formation of scientific concepts by students.

2.7 Conceptual change and how to facilitate it

Zirbel (2001) contends that learning is a mental process that depends on perception and awareness on how additional stimuli and new ideas get integrated into the old knowledge database (a process Piaget called 'assimilation'), and on how, through reasoning (a previously acquired mental mechanism), the entire database gets re-organized which results in alterations of the mental structures and the creation of new ones (a process called 'accommodation'). Zirbel (2001) continues that adding new information is the first part of learning and so the whole leaning process involves the integration, re-organization and creation of new mental structures. This implies that, whenever one refers to an object that is not present or an activity that is not going on; the impression of these must be created in the mind of the person.

Conceptual change according to Treagust andDuit (2003) is the process in which a person changes his or her conceptions by capturing new conceptions, restructuring existing conceptions or exchanging existing conceptions for new conceptions.

In the constructivists view, knowledge is a dynamic conceptual means of making sense of experience rather than a passive representation of the world. They stress that each person must individually construct meanings of words and ideas if they are to be truly useful (Treagust&Duit, 2003).

The key features in the constructivists' view of learning according to Sarfo(2009, p. 30) are:

a. The student's head is not empty

b. There are interactions between pre-existing ideas and new experiences and phenomena

c. Learners attempt to make sense of new experiences and phenomena by constructing meanings which is a continuous and active process

d. Learners do not therefore, have to only assimilate new concepts but also develop, modify and change existing ones.

According to the constructivists':

- Learning outcomes depend not only on the learning environment but also on the knowledge that the learners possess.
- Learning involves the construction of meanings. Construction of meaning is influenced to a large extent by the existing knowledge.
- Construction of meaning is a continuous and active process.
- Meaning, once constructed, is evaluated and can be accepted or rejected.
- There are patterns in the types of meanings learners construct due to shared experiences with the physical world and through natural language.

With reference to this ideology, it is obvious that students come into science classes with some meanings about how the world works. This may be wrong or partially right. It is therefore the duty of the teacher to be able to find out the various conceptions of the students and modify them by bringing new experiences that will prove the already existing concepts defective for the student to modify or change the existing concept.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter contains the research design which focuses on the plan and sampling procedure, the research method; which describes the way the subjects were selected and the type of information obtained from them, types of instruments used to gather information and how the data was analyzed and the design of the interview guide.

3.2 Research Design

According to Yin, (2013) a research design is the plan, which describes how the samples are going to be obtained and what will be done with the samples to reaching conclusions about the research problems. Appropriate research design is required for satisfaction of research questions under investigation. In the search for appropriate design, various research designs were encountered but for this research the researcher opted to use qualitative case study.

According to Reason and Heron (2006),this method of research concerns itself with the present phenomena in terms of conditions, practices, beliefs, processes, relationships or trends invariably. Reason and Heron (2006) describes ‘descriptive research’ as research that is devoted to the gathering of information about prevailing conditions or situations for the purpose of description and interpretation. This type of research method is not simply amassing and tabulating facts but includes proper analyses, interpretation, identification and comparisons of trends and relationships.

The case study method helped in collecting rich qualitative data about classroom processes such as instructions, teacher-student interaction, students' encounter with subject matter and teachers' pedagogical content knowledge and tactics.

3.3 Population

The research focused on obtaining detailed information about some of the factors that impede the formation of basic scientific concepts by Keta Senior High Technical School students. There are a total of eleven senior high schools in the municipality. The biggest in terms of population is Keta Senior High Technical School. The school has population of about two thousand, five hundred made up of thirteen classes of seven clusters (programs) in every year batch. It happens to be the only grade 'A' school in the municipality.

The total number of students in the second year is about seven hundred and twenty (720). Stratified random selection made available one hundred and ninety three (193) students for this survey.

The teacher population of the school is one hundred and nine (109). Out of this number, thirteen of them are teachers of various branches of science. Four out of the science teachers were used for the research work.

There are only two science laboratory technicians and all the two were interviewed.

3.4 Research Method

Educational research can be classified based on purpose, method, whether as quantitative or qualitative (Amedahe & Gyimah 2002). While quantitative research tends to emphasize numbers, measurement, experiment, numerical relationships and description, qualitative research focuses on understanding and meaning through verbal narrations and observations. Moreover, quantitative research involves measurement of variables, assessing the relationships or impact of variables, testing hypothesis and applying results to a large number of people. Qualitative research on the other hand, involves learning about the views of individuals, assessing a process over time, generating theories based on participants' perspectives and obtaining detailed information about a few people or research sites.

Both Quantitative and qualitative method are used in this study. Information was gathered from students of Keta Senior High Technical School about the conduct of science lessons, interests and perceptions of scientific knowledge. The views of students were sought and frequencies of responses analyzed. Qualitative information was gathered by interviews of four teachers and two laboratory technicians and their responses discussed.

3.5 Sample

The sample included second year students of Keta Senior High Technical School. There are seven departments in the school namely; general science, agricultural science, business, home economics, visual arts, technical and general arts.

- one class was selected each from six department in form two for the questionnaire
- Random selection was done to select one class from departments with multiple classes for example, science has A, B and C.
- All the students in the selected classes at the time of the survey were involved in the investigation.

- The numbers in each class varied slightly since the population density of some classes are greater than others

3.6 Research Procedure

In the first place, permission was sought from the Headmaster of the school. In the letter for the permission, I explained the objectives of the research clearly and the classes that will be involved.

Secondly, the head of Science Department of the school was informed about the objectives of the research and his cooperation was solicited. The questionnaires were then distributed to all the students of the selected classes and it was administered by the researcher. The procedure to the filling of the questionnaire was explained thoroughly to the respondents by the researcher. Their responses were collected soon afterwards.

The consent of the four science teachers was sought for observation of two lessons of each of them. The researcher sat at the back of the class whiles science lessons were going on. Strengths and weaknesses observed on the part of students and teachers during the science lesson were recorded.

Four science teachers were orally interviewed and their comments were noted. The two laboratory technicians were also met and interviewed about the condition and use of the science laboratories for integrated science lessons. Their comments and suggestions were well noted for discussion.

3.7 Ethical Issues

The ethical measures that were undertaken included consent from the headmaster of the school and the head of science departments. The second year students who were purposefully sampled were also informed and assured of anonymity.

3.8 Instrument

The data gathering instrument used in this research was a questionnaire distributed to students of the selected classes in the school. The questionnaire contained statements that are intended to finding the interests and attitudes of students towards integrated science and its lessons. The questionnaire used is found in Appendix A. Part of the questionnaire was intended to finding out whether students find it relevant studying integrated science and also about the conduct of science lessons in the school.

The researcher also sat in the science classes and took notes regarding the extent to which the students participated in science lessons in an observational schedule. The way science teachers in the institution presented their lessons was observed and the schedule scored on strengths and weaknesses, the observational skills and the listening skills of the students, problem solving abilities of the students and the general teaching methods adopted by science teachers was observed. The observational schedule used can be found in appendix B.

Interviews were conducted on four teachers at different times to find out what comments they have on various interview items. Two laboratory technicians were also interviewed about the use of the laboratory for integrated science and their comments were recorded. The results of the two interviews can be found in appendix C and D.

Observations and interviews were conducted in a naturally occurring environment that is, during science lessons in the school premises. There was neither measurement of variables nor experimentations, therefore, the qualitative research method was employed where the participants were interviewed and observed in their natural classrooms settings. This research work used multiple tools to collect data which revealed valuable information about why students have difficulty in science concept formation. The tools used involved questionnaire, interview and observations.

3.9 Validation of the Instrument

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

3.10 Reliability of the Test

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

- Parallel Forms Reliability. Theoretically, there are many ways to measure a given property. A person could measure the width of a residential sidewalk with different yardsticks, metre sticks or tape measures. Each measuring device is a parallel form of the other measuring device.
- Test –retest Reliability; It is correlating the scores for the first administration with the scores from the second administration.
- Split-half Reliability. Is the technique used to estimate the reliability of a onetime teacher- made test. (Amedahe&Gyima2002)

The reliability of the result was estimated by using the test-retest reliability to find out how reliable the responses of the correspondents were. The results were found to be reliable because the participants provided similar answers and there were similarities in the errors that were made in the studies. When the response was piloted in two of the classes, the responses in simple percentages are similar.

3.11 Problems encountered

The problems that emerged during the research were as follows:

- ‘Hawthorne effect’ was observed on the part of the observation. Hawthorne effect (also referred to as the observer effect) is a type of reactivity in which individuals modify or improve an aspect of their behavior in response to their awareness of being observed. Both the teachers and the students knew that they were being observed and so it appeared there was slight modification of attitude.
- Some of the students never filled questionnaires and were helped and this is likely to bias the choices they made. This was observed by double shadings.

- There was an instance where an impromptu social gathering was called and this interrupted the exercise and affected the number of questionnaire submitted by students.

3.12 Data Analysis

In conducting research to investigate the students' understanding of science concepts, raw data such as student's answers in interviews are organized by a set of categories that are developed in the spiral interpretation process. The final interpretation has to be made on the basis of the categories so that responses that have been put into a particular category are interpreted in the context.

The observations and interviews are also interpreted in a similar way and used to buttress some of the deductions from the questionnaire. This makes meaningful deductions to be made about some of the factors which inhibit the formation of basic science concepts by Keta Senior High Technical School students.

3.13 Procedure and Rationale for Data Analysis

The single frequency count statistical analysis was used to compile the recurrence of the responses to the questionnaire and observation. The responses were analyzed using qualitative strategies such as categorization, interpretation, noting patterns or themes and clustering of beliefs and values (Gerber 1996). The researcher focused on finding out the following trends;

- Trends on interests and attitudes of students towards the study of integrated science.
- Practical orientation or otherwise of the instruction and its effect on performance.
- Availability of teaching and learning resources and their use during instruction.

Also, quantitative analysis was done where tables were drawn from the participants' responses and percentages calculated and discussed using a comparison of the percentages. It became necessary to use the quantitative analysis since constructing tables and plotting graphs from the responses made it easier to make a comparison of the percentages that were calculated. In view of this both qualitative data analysis and quantitative data analysis were used.

Results from the interview were also discussed qualitatively. The trend of responses were analyzed and summarized to give meaningful reasons to the extent of the problem.

3.14 Quantitative data analysis

Each response given by the participants in the questionnaire was categorized and put on tables and the frequency of responses and percentage of responses were calculated for each item. The frequencies and percentages of the various responses given to the questionnaires were calculated and a discussion was done using a comparison of the percentages. Graphs were also drawn to highlight the percentages of responses to the questionnaires to make analysis easier.

3.15 Qualitative data analysis

The interview questions were geared towards the practical orientation of lessons and general problems of science teaching and learning. The responses to the interview questions on different items were discussed by the clustering of beliefs held by science teachers and the laboratory technician. Each respondent was assured of anonymity and hence spoke freely about the conduct of science lessons in the school. This revealed valuable information about the teaching and learning of integrated science in the school.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Overview

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

4.2 Table of results

Tables were made of the frequencies and percentages of respondents who answered the questionnaire under department, gender distribution, glades' in BECE and the other questionnaire items. A table was drawn as well for the scores on various items of the eight lessons observed. Tables of some excerpts of the observation are also included in this section.

Table 4.1 was drawn for the departmental distribution of the respondents.

Table 4.1: Departmental respondents

Department	Frequency	Percentage (%)
Science	43	22.3
Business	31	16.1
General Arts	30	15.5
Technical	28	14.5
Agric	25	12.9
Home Economics	36	18.7
Total	**193**	**100**

As stated in chapter three, one class is selected each from the six clusters (departments). For departments having more than one class, random selection was done to select one. Bar graph was drawn to show the pictorial representation of departmental distribution of respondents in table 4.1.

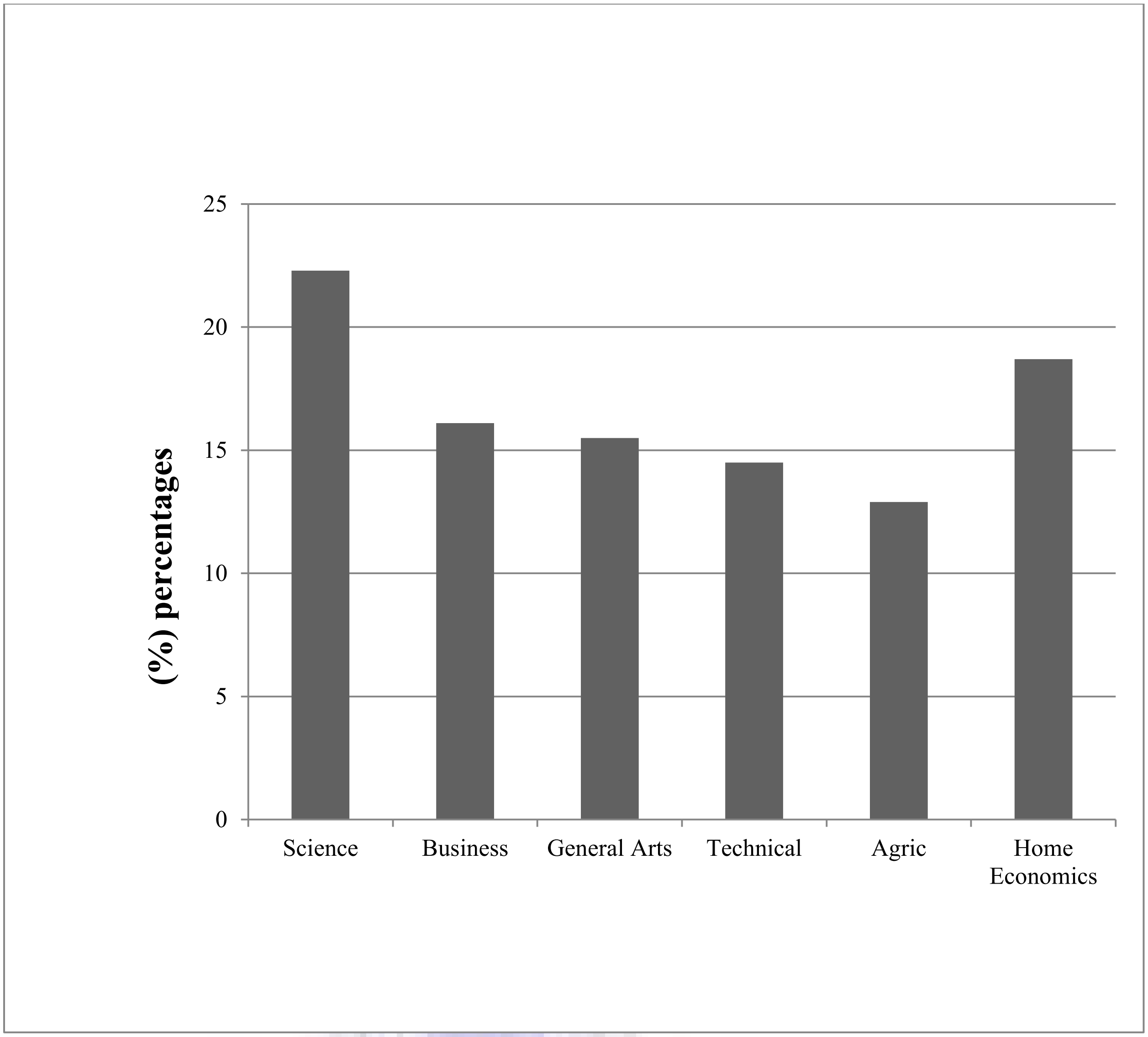

Fig 4.1: Percentage Departmental distribution of the respondents.

From the graph, it is obvious that the least number of respondents (12.9 percent) came from the agricultural science class and the largest number of respondents (22.3 percent) came from the science class.

The gender of the respondents was asked and the result tabulated in table 4.2.

Table 4.2: Gender Distribution

Gender	Frequency	Percentage (%)
Male	112	58.0
Female	80	42.0
Total	**193**	**100**

From table 4.2, 58 percent of the respondents are males and 42 percent are females. It can be seen that there are more male respondents than female respondents. Even though the margin is not that wide, it is a notable fact.

A pie chart was drawn to give a clearer picture of the gender distribution of respondents.

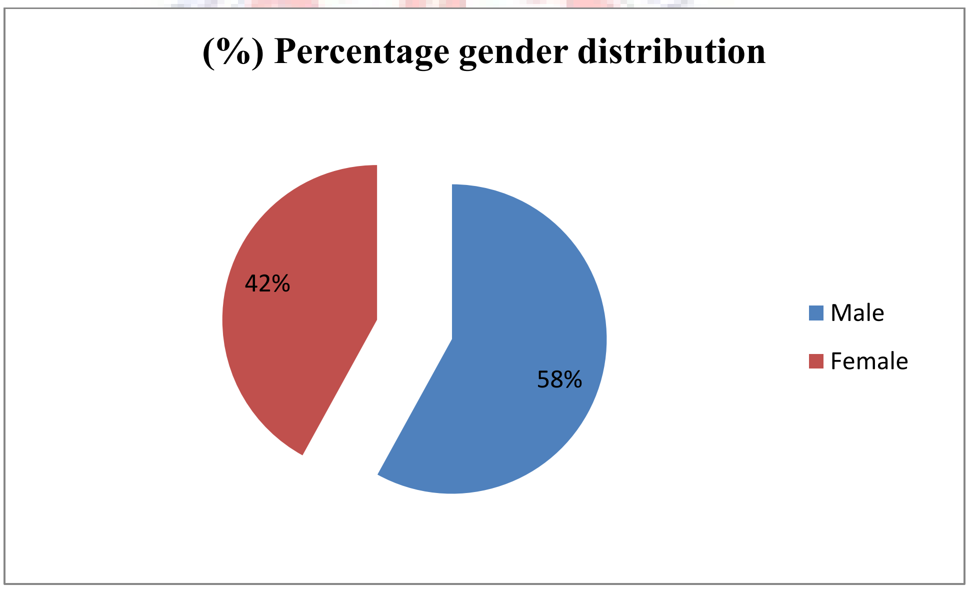

Fig 4.2: Gender distribution of respondents

Respondents' grades in integrated science in BECE were asked and the response put in a table. This information is supposed to give a brief background of the respondents in the performance in integrated science.

Table 4.3: Grade of respondents in BECE

Grade	Frequency	Percentages (%)
1	25	13.0
2	74	38.3
3	69	35.8
4	16	8.3
5	4	2.1
6	1	0.5
7	1	0.5
8	1	0.5
9	2	1.0
Total	**193**	**100**

Table 4.3 describes the frequency of response to the question, 'what was your grade in integrated science in Basic Education Certificate Examination (BECE)?'

From table 4.3, it can be inferred that most of the students came to the school with good grades in integrated science. This is because from the table, as much as 87% of the students had grades between 1 and 3, 8.3% had grade 4 and 4.7% had grades below 4. This science performance of the students in the Basic Education Certificate Examination is above average.

For clarity, bar graph was drawn to represent the respondents' grades in integrated science in BECE.

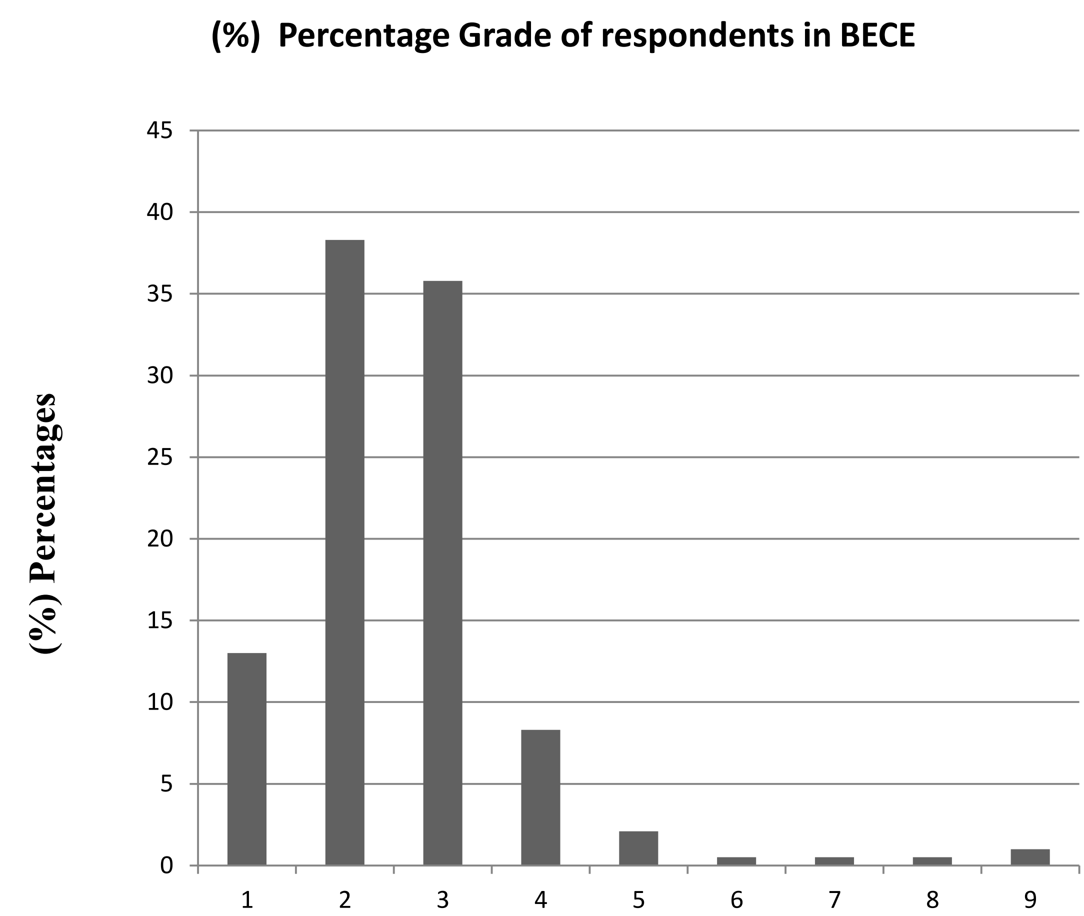

Fig 4.3: Bar graph showing Grades of respondents in BECE

The grade with the highest frequency is 2 as can be seen from figure 4.3. This is followed by grade 3. The grade with the third highest frequency is 1. The mean grade for the respondents is 2.61.

Various questions were asked about the perceptions and attitudes of respondents towards integrated science and its study. The responses given by the respondents were tabulated.

Table 4.4: Frequency Distribution of responses to questions about Interest and Attitude to science learning

Questions	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
I Have Integrated Science On My Private Time Table	3	5	17	77	91
I am regular in science lessons	0	2	14	48	129
I am punctual in science lessons	2	10	13	54	114
I love to pursue science in tertiary	30	27	50	31	55
Science is generally interesting	8	4	23	79	79
Science should be a compulsory subject	13	19	10	44	107
I apply science lessons every day	4	6	46	80	57
Science is relevant to life	1	2	10	56	124
I have enough materials for science study	19	33	39	64	38

Table 4.4 summarized the frequency of responses to various questions that describe the interest, perception and attitude of students towards integrated science and its study. The various questions and the frequency of the various responses are described in the table.

The percentage distribution of the various responses given by the respondents as summarized in table 4.4 is computed and put in a table.

Table 4.5: Percentage (%) Distribution of responses to questions about Interest and Attitude to science learning

Questions	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
I have integrated science on my time table	1.55	2.59	8.81	39.90	47.15
I am regular in science lessons	0.00	1.04	7.25	24.87	66.84
I am punctual in science lessons	1.04	5.18	6.74	27.98	59.07
I love to pursue science in tertiary	15.54	13.99	25.91	16.06	28.50
Science is generally interesting	4.15	2.07	11.92	40.93	40.93
Science should be a compulsory subject	6.74	9.84	5.18	22.80	55.44
I apply science lessons every day	2.07	3.11	23.83	41.45	29.53
Science is relevant to life	0.52	1.04	5.18	29.02	64.25
I have enough materials for science study	9.84	17.10	20.21	33.16	19.69

Table 4.5 gives the percentage distribution of responses to various questionnaire items that describe interest, perception and attitude of students about the study of science.

Bar graph was drawn to represent the percentage responses given to the questions relating to perception and attitude to integrated science.

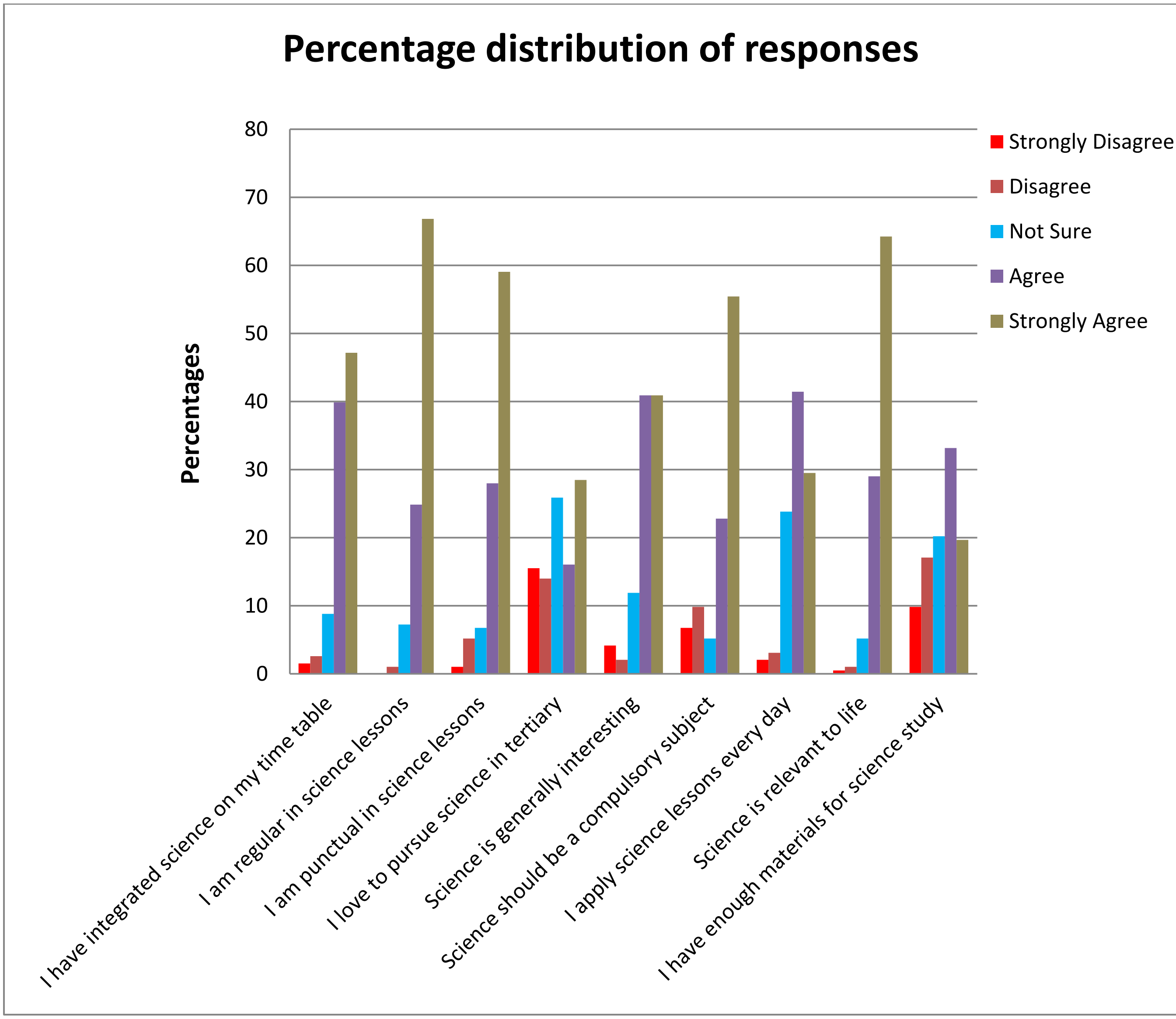

Fig 4.4: Bar graph showing percentage of various responses to the questionnaire items summarized in table 5.

From fig 4.4, it can be observed that more positive responses were had for responses to items about regularity of respondents and the relevance of science to life. High frequency was also observed for punctuality of respondents in science lessons. Highly negative response was observed for response to the item ‘I will like to pursue science in my tertiary’. Also, enough of the students declined having enough materials for the study of science. A strongly negative response was also had when the respondents were asked whether science should be made compulsory to all students. These responses revealed much about the general perception, interest and attitude of the students towards science.

A table was drawn to represent the response to the question; will you avoid science when given the option?

Table 4.6: Will you avoid science when given the option?

Response	Frequency	Percentage
Yes	52	26.9
No	141	73.1
Total	193	100

52 respondents out of 193 representing 26.9 percent reported that they will avoid science when given the option and the rest 73.1 percent will not avoid science when given the option from table 4.6.

A pie chart showing the response to whether respondents will avoid science when given the option was drawn. This is to help visually contrast the percentage of responses.

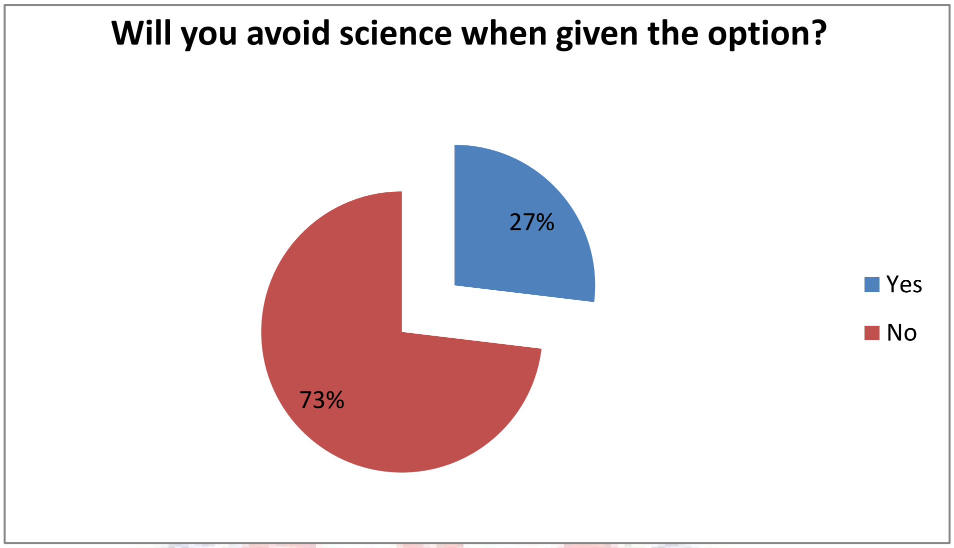

Fig 4.5: Pie chart representing response to question 'Will you avoid science when given the option?'

The time respondents spend on studying integrated science in a week was sought and the responseswere tabulated.

Table 4.7: Time spent on studying science in a week

	Frequency	**Percentage**
Less than 1 hour	73	37.8
Between 1 and 2 hours	87	45.1
Between 2 and 3 hours	25	13.0
More than 3 hours	8	4.1
Total	**193**	**100**

Bar graph representing the time spent on studying integrated science privately in a week against the percentage of respondents was drawn.

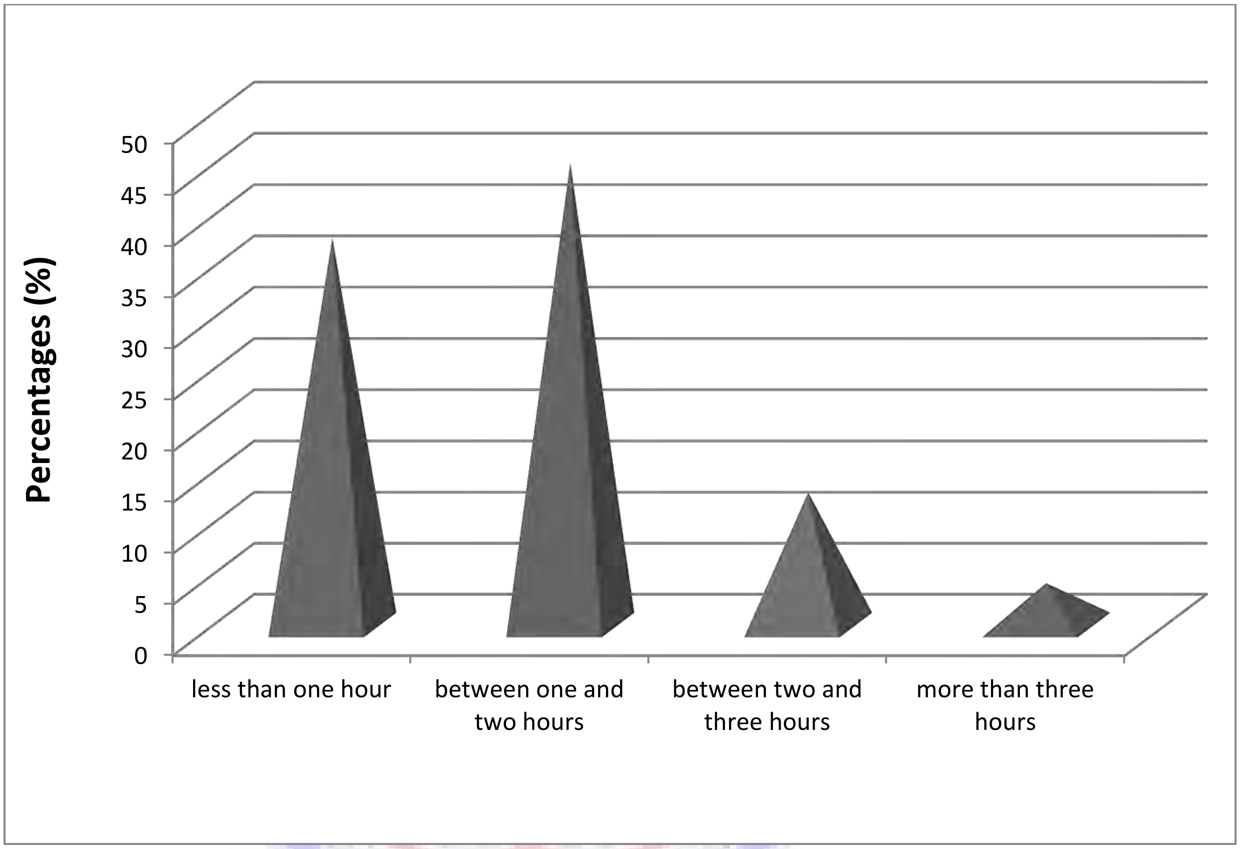

Fig 4.6: Bar graph showing Time respondents spend on studying integrated science in a week.

Most of the respondents spend less than two hours in studying integrated science in their private studies in a week. Only few of the respondents spend more than two hours on studying integrated science in their private studies in a week.

Respondents were asked question about the conduct of science instruction and assessment in the school. The frequency of responses given to questions relating to quality of teaching experience and assessment were tabulated.Table 4.8 summarized responses to questions about the quality of science instruction in the school.

Table 4.8: Frequency distribution of response to questions about Quality of Science Instruction

Questions	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Punctuality Of Science Teachers	30	41	27	71	24
Science Teachers Are Vocal	13	18	46	87	29
Science Teachers Use Practical Means	46	32	42	45	28
We frequently Visit Science Laboratories	119	31	13	15	15
Science Teachers Explain Concepts Thoroughly	23	25	43	85	17
Science Teachers Relate Well With Students	18	16	45	74	40
Science Teachers Give Frequent Exercise	65	50	33	32	13
Science Teachers Give Homework Frequently	94	46	28	20	5

Table 4.8 revealed negative responses to questions relating to assessment. From the table, 94 of the respondents strongly disagreed to science teachers giving homework frequently. A more negative response was had for visitation of science laboratories when as much as 119 respondents strongly disagreed to frequent visitation of the science laboratories.

Table 4.9 describes the percentage distribution of responses summarized in table 4.8 above.

Table 4.9: Percentage Distribution of response to Questions about Quality of Science Instruction

Questions	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Punctuality Of Science Teachers	15.54	21.24	13.99	36.79	12.44
Science Teachers Are Vocal	6.74	9.33	23.83	45.08	15.03
Science Teachers Use Practical Means	23.83	16.58	21.76	23.32	14.51
We frequently Visit Science Laboratories	61.66	16.06	6.74	7.77	7.77
Science Teachers Explain Concepts Thoroughly	11.92	12.95	22.28	44.04	8.81
Science Teachers Relate Well With Students	9.33	8.29	23.32	38.34	20.73
Science Teachers Give Frequent Exercise	33.68	25.91	17.10	16.58	6.74
Science Teachers Give Homework Frequently	48.70	23.83	14.51	10.36	2.59

From the table, with regard to visitation of science laboratories, only 7.77 percent strongly agreed. It can be intuited that this number consists largely of science students. As much as 61.66 percent strongly disagreed to the assertion.

Bar graph was drawn to show the percentages of the various responses summarized in table 4.9.

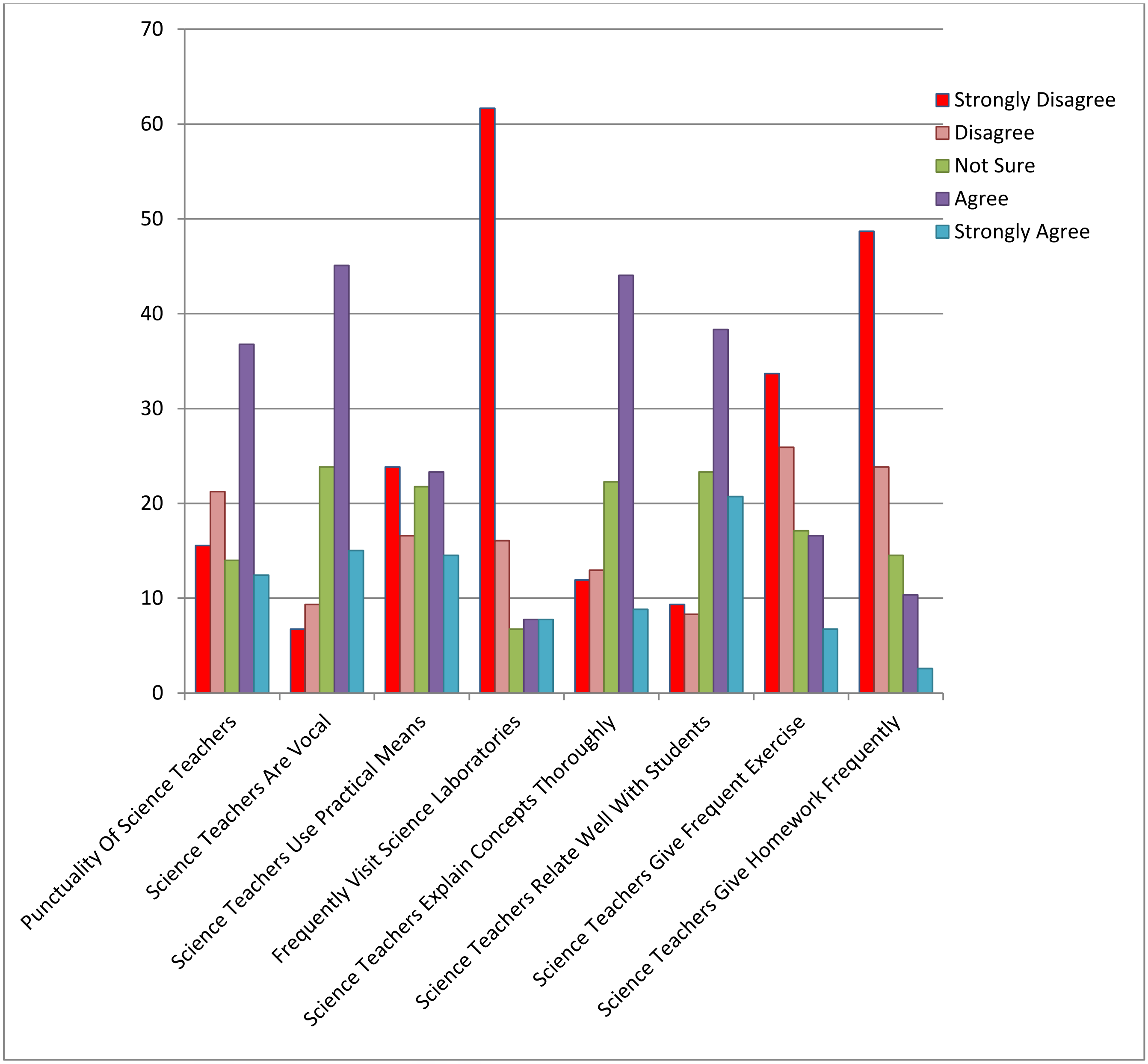

Fig 4.7: Bar graph showing percentage response to questions about quality of instruction.

During the observational schedule of eight lessons, the strengths and weaknesses observed on instruction are summarized in a table with the It can be observed from the responses that strongly negative responses were given to questions relating to visitation of the science laboratories as well as assessment. Students' responses are not very positive towards instructional items. This suggests that there is probably some frequency of scores

Table 4.10: Frequency of scores obtained during observation of instruction

Observational Item	Scores				
	5	**4**	**3**	**2**	**1**
1.Effective and relevant introduction linked with Relevant Previous Knowledge with teachers		2		4	2
2.Sysmatic and sequential presentation adapted to the level of students			4	4	
3.Mastery of subject matter demonstrated through teaching	2	5	1		
4.Proper and effective use of language	2	3	2	1	
5.Use of varying feedback techniques			1	7	
6.Effective use of teaching/learning resources			1	6	1
7.Clearly explained task settings			2	3	3
8.Regular monitoring of individual/whole class performance			2	5	1
9. Adequate subject content coverage		3	3	2	
10.Active students participation and involvement			3	5	

It can be observed from table 4.10 that quality of instruction is below average since the average score calculated is 2.625. There is limited students' involvement and limited use of learning resources. Although there were relatively good scores for subject mastery and effective use of language as well as subject matter coverage, the other very important items that affect concept formation seem to have scored low marks for the lessons observed. This is likely to affect concept formation negatively.

During the observational schedule, observations were made on students, strengths and weaknesses recorded and tabulated.

Table 4.11: Summary of Observation on Students

Observational Item	Scores				
	5	**4**	**3**	**2**	**1**
1. Students participation in science lessons.			3	5	
2.Students problem solving skills			2	6	
3.Students listening skills		1	3	4	
4.Student ability to ask relevant questions		2	2	4	
5. Students ability to provide correct explanation to questions in science lessons.		1	2	3	2
6. Students level of concentration in science lessons.			2	4	2

From table 4.11, it can be seen that students' participation in lessons is also generally below average since most of the scores were 2 and 3. The average score for the items in table 4.11 is 2.179. This suggests that students' participation is very minimal and this will affect how concepts are formed.

4.3 Discussion of Results:

The results summarized in the tables and graphs above are thoroughly discussed under various subheadings here. This is to bring out common trends that are hidden in the results.

4.3.1 Background of students:

According to the constructivists view on learning, learning outcomes depend on the knowledge that the learners' posses and the construction of meaning is influenced to a large extent by the existing knowledge. Therefore, if the existing knowledge in science is poor, it will impact negatively on the way the students learn science. As such, since the background of the students revealed that many of them came with good grades it is expected to impact positively on the way students learn science.

Ali, T. (2012) supported the constructivists view by saying, 'Secondary-level science courses require significant prerequisite knowledge and understanding of very basic concepts' (p. 8). In his research where he employed very reputable subject handlers to teach a group of students to find out about misconceptions, he discovered that the problem with difficulty in understanding science is directly linked with the topic sequencing in the syllabi. He is of the view that the foundation topics that the students need are not taught first and well enough and this creates gap between the existing knowledge and the concept taught.

Respondents have good background in science but the results of tests, exercises and examinations of the students revealed that many of them lack prerequisite skills to understand many science concepts. According to the interview responses in appendix C, the science teachers unanimously agreed that there is problem with output of integrated science which is caused by the poor science concept formation.

4.3.2 Perception and Interest of students to Integrated Science

From table 4.4, as much as 180 out of the 193 respondents agreed that science is relevant to life. This represents 93.27 percent of the students from table 4.5. When I tried to enquire verbally few ways by which they feel the relevance of science, they mentioned its application in electricity and electrical gadgets, cars, airplanes, etc. This means that they only believe in the industrial application of science which are the very obvious one and not trivial applications in grinding of pepper, washing, etc. Nonetheless, great percentage of the respondents agrees to the relevance of science to life and hence will dedicate to understanding it. Only 5.18 percent are not sure and 1.56 percent disagreed.

Interestingly, 158 students feel that scientific knowledge is interesting representing 81.86 percent from table 4.5. This shows a significant decline between perception and interest. 11.41percent of respondents perceive science as relevant to life but have limited interest in its study.

Harackiewicz, Barron, Carter, Lehto & Elliot (1997) established a strong connection between interest and performance. From their research both students that had interest in subject mastery and students that had interest in performance performed much better than those that do not have any interest. As such, although a larger percentage have interest, the significant percentage that lost interest account for the decline in performance.

The reason for the decline of interest in integrated science may be that the general science learning atmosphere is not favorable. From the observational schedule, it was realized that most of the teachers do not introduce the lessons using relevant previous knowledge. This completely alienates students of the new concept and has the tendency to decline interest in the subject. The average score of the observation on instruction and students revealed that science teachers do not use various instructional techniques that enhance students learning. Students are passive listeners to the instruction of the teachers and only few of the students interact with the science teachers.

As much as 78.2 percent of the respondents from table 4.5 agreed that science should be made compulsory for all students. This represents a total of 151 students. The rest of the 42 students representing 21.8 percent of the students are either not sure or disagreed. The number of students that did not agree to this assertion implies that they do not have much or any interest in the subject. For the very few that may have, it can be said that the school and classroom environment does not favor the learning of the subject hence making them not to prefer learning it as a compulsory subject. As such, this great percentage of students that do not find the study of science necessary and do not see the relevance of science and will not apply scientific principles to their daily lives.

When the respondents were asked whether they will avoid science if given the chance, as much as 26.9 percent said yes representing 52 students out of the 193 students questioned in table 4.6.

This number of respondents that reported to avoid science when given the option is so large, even larger than those that do not agree to science as a compulsory subject to all students. It can be seen from the table that 5.16 percent of respondents agree to science learning as compulsory subject and probably find it interesting but do not make any headway in elevating their grades as such, they will avoid science when given the chance. These discoveries are pointing fingers to quality of instruction since some have the interest but attitude is negative. The psychological effects of not wanting to read science will deter students from learning of the science and focusing of mind during science lessons. This will affect the formation of science concepts since formation of models and mental representations of what is being taught leads to science concepts formation and this demands attention and focus.

It is therefore not surprising when only 44.56 percent of the respondents will love to pursue science in tertiary. 25.91percent of respondents are not sure if they will pursue science in tertiary and the 29.53 percent of the respondents will not pursue science in tertiary according to table 4.5. This decline in desire to pursue science is envisaged. The greater numbers of respondents who want to pursue science are obviously coming from the science class.

Generally, it can be seen from the responses so far that large numbers of the students do not follow science lessons. From the observational schedule, it was observed that most of the subject masters have mastery of subject matter and demonstrate it through their teaching. They also use effective language to communicate with the students. However, most of them do not set clear tasks and do not use teaching and learning materials. The instructional approach is teacher centered and minimized student participation and involvement.

As such, it can be said that about 26% of the respondents have negative perception about science and this affects their focus on formation of relevant science concepts and hence may affect their performance.

4.3.3 Attitudes of students towards integrated science lessons and study.

Generally interest affects attitude. Respondents who have interest in integrated science are likely to have positive attitude towards the subject. When respondents were asked whether they are regular in science lessons in table 4.5, as much as 91.71 percent reported that they are regular in science lessons representing 177 respondents. Only 7.5 percent of the respondents are not sure representing 14 students and 1.4 percent of the respondents are not regular representing 2 students. This reveals that the greater number of respondents is regular in science classes. How punctual the respondents are in science lessons was sought by the response to the question 'I am punctual in science lessons'. To this question, 87.05 percent of the students representing 168 students out of the 193 students questioned reported that they are punctual. 6.7 percent are not sure and 6.22 percent are not punctual representing 13 and 12 students respectively.

From the response to punctuality and regularity of the students, it can be seen that some students come late into the lessons by which time concepts have been developed. They will come in but probably not follow the lesson and this will affect good performances and decline their interest. During the observation, it was observed that students especially those who sit behind do not participate in the lessons. This is evident in the responses they give when teachers ask them questions. The negative attitude shown by some of the respondents is evidence of the fact that they do not form good science concepts.

Sarfo(2009) in his research about finding factors that impede concept formation in teacher training in Ghana realized close alliance between interest, attitude and performance. In the research they observed that majority of the teacher trainees do not have interest in science and also have negative attitude towards science learning and as such perform poorly since they do not have relevance science concepts formed.

According to Ali (2012), research in science education has established that students' level of success in learning science is inherently linked with their positive attitude towards science learning that in turn is attributed to the level of motivation they bring to learning the subject. According to Ali, students' motivation in science learning plays a pivotal role in promoting conceptual change and engaging in deep and reflective thinking which are instrumental in enhancing students' science achievements.

When the respondents were asked whether they have enough materials for science study according to table 4.4, up to 47.2 percent of them reported not having enough materials for science study. This means that a large number of the students do not have relevant materials of their own to reference anytime they want.

In academic work, one cannot do well without resources required for subject study. If the students complain of having inadequate materials in the form of science notes, textbooks, quick reference cards, etc. it will affect their performance negatively. The school has a large library complex which from the researchers own investigation has all the books the students need to perform well in science but most of the students do not make use of this resource.

When the respondents were asked whether they have integrated science on their time table, 87.05 percent of them reported having integrated science on their private time table. From the table, 8.81 percent are not sure and 4.14 percent do not have integrated science on their time table at all. This implies that as much as 12.96 percent of the respondent only study science when they feel like or maybe when there is an assessment.

When respondents were asked how much time they spend on studying science in a week according to table 7, 37.8 percent spends less than one hour and 45.1 percent spends between 1 and 2 hours. It can be seen from table 4.7 that many of the respondents that study science do so in less than 2 hours a week. This distribution can be seen clearly on the bar chart shown in fig 4.6.

The time respondents spend on learning integrated science in their private study is not time enough to revise concepts taught in four different parts of a subject. It can be inferred that students read integrated science just to keep up with studies but not to build up concepts since they probably do not follow lessons when taught in class due to lateness or style of presentation.

It can be seen from the responses that significant number of respondents have negative attitude towards the study of science and this is a major factor directly affecting performance. Hence, one can conclude that the effect of poor concept formation is due to negative attitude of students towards the subject. This agrees with the conclusion Sarfo(2009), had.

4.3.4 Quality of teaching experience:

49.23 percent of the respondents reported that their science teachers are punctual according to table 4.9. 13.99 percent are not sure and the rest said their science teachers are not punctual. It can be seen from this distribution that some classes do not have science teachers regularly visiting them. If the period is forty minutes in a week and the teacher does not visit few times, the orderly presentation and the finishing of the syllabus will be handicapped and hence the teacher might not present the lesson well since he has syllabus to catch up with thereby affecting the concept development of the students and performance eventually.

Upon interview, some of the science teachers reported that some classes do not have science teachers and that, they only help when they have time. Some complained that there are clashes in the time table and hence they have to switch between classes. Survey revealed that the school at the time of the research is deficient in science teachers and so some of the classes do not have science teachers.

About the relationship between science teachers and students, 59.07 percent of the respondents admitted that science teachers relate well with students and 23.32 percent are not sure with only 17.62 percent reporting bad relationship between students and science teachers. This means that the general atmosphere of science learning is good.

As much as 60.11 percent of the respondents report that science teachers are vocal. 23.83 percent are not sure and 16.07 percent asserted that science teachers are not vocal. During the observational schedule, it was realized that the science teachers were vocal enough. Some of the students do not focus during lessons and when asked questions, complain that they did not hear what the teacher said and this observation was made from those sitting at the back. From the observational schedule, it was discovered that subject masters have mastery over their content and communicate properly and effectively in language. The science teachers do not however set and explained tasks to students. Most of the science teachers also enter the classrooms with only their markers. No reference cards or teaching aids are used. The lessons are purely theoretical and this does not help students much in concept development.

During the observational schedule, enough observation was made which reveals that teaching is generally teacher centered. Most teachers alienate students by the way they introduced the topics. Even though enough of them present the lesson sequentially, it is not adapted to the level of the students and this has the tendency to put students off about the subject. As such, the concentration of students becomes very low. This was evident when the teacher asked questions about what he said almost instantly and no one responds.

According to Adesoji (2008), ability to solve problems in science could be enhanced by introducing a good teaching strategy. In his study of the effectiveness of problem solving method in teaching of some selected chemistry topics, where he used students of different academic levels, he realized that using the same method to teach them yielded results with no significant difference. As such, good teacher presentation can yield performance no matter the cognitive level of the students. Hence negative effect on concept formation is ultimately caused by the style of presentation.

4.3.5 Practical orientation of the lessons.

When respondents were asked whether science teachers use practical means in teaching, 37.83 percent reported yes and 40.41 percent reported no from table 4.9. The rest are not sure. This reveals that the science teachers are not practical oriented. Greater numbers of them only use the chalk and talk method of presentation which does not involve the student. During the observational schedule, it was observed that students participation and involvement is very low in most of the lessons. This makes students to provide entirely wrong answers to questions when asked. Examples of answers provided by students can be seen in appendix E. In fact the answers most of the non science classes gave to science questions supposed that they were only guessing.

Upon interviews, the teachers complained that they have only 40mins to present a whole lesson for a week and introduction of practical consumes a lot of time. This is evident in the subject matter coverage. The masters are more determined to cover more of the syllabus than thorough explanation for concept development of the students as can be seen on the scores of the observation in table 4.10.

The response to whether they visit lab frequently revealed the following; 78.24 percent of the respondents reported never visiting science laboratories. 6.74 percent are not sure and 15.54 percent visits the laboratory frequently. It can be seen that the science laboratory is not at all visited by non science students since the small number that reported having been visiting the lab can be inferred to be of majority science students.

When the science teachers were interviewed, it can be seen that the science teachers do not orient lessons practically and hence do not go to the lab. This was confirmed by the laboratory technicians' responses to whether they hold integrated science classes in the laboratory. No teaching aids or models are also used.

Due to the low practical attachments to lesson and short time allocation for science lessons, the science teachers do not explain concepts thoroughly for students understanding. This will only help the very good students and is reflected by their response since 24.87 percent said science teachers do not explain concepts thoroughly and 22.28 percent are not sure with the rest 52.85 reporting that concepts are thoroughly explained. If there were frequent visitation to the science laboratories or other teaching aids were used, concepts will be better explained and understood by students. As such, even though it is said that there is opportunity available for all students to use science equipment, this seem only theoretical.

Laboratory apparatus and chemicals in the school are not enough. The laboratories are not having the capacity to accommodate the students. Also, the equipments in the laboratories are not replaced regularly. Due to this, the science teachers resort to chalk and talk methods of presentation. The few resources available are not also adequately used by science teachers. This makes lessons more theoretical than practical to the students.

4.3.6 Assessment frequency

Students gave entirely wrong answers to questions when asked and do not provide correct explanation to questions in science lessons. This could be dependent on the level of assessment. When respondents were asked, 59.59 percent of the respondents reported that they do not have frequent exercises. 17.10 percent are not sure and only 23.32 percent reported having enough exercises. When asked about frequency of assignments, 72.53

percent of the respondents reported that they are not given enough home works. 14.56% are not sure and only 12.95% agreed to having been given assignments. The few numbers that responded positive to the assessment items means that few of the teachers give assessments but majority of the science teachers don't.

The low level of assessment by science teachers reveals that there is low feedback to the instructors and hence performance of students cannot be monitored by teachers. When the teachers' were interviewed, they complained about the large numbers of students they handle. As such, usually, students are assessed once in a long while and predominantly by examination. Assessment could be done in class by various feedback techniques. The teachers do not use varying feedback techniques as seen in the observational.

4.3.7 Poor class participation

Observations made from science lessons revealed that majority of the students did not actively participate in science lessons. The students remained passive and only participated in notes taking. They seldom asked questions during science lessons and gave totally wrong answers to some basic questions.

Students show complete ignorance as far as some topic areas are concerned. This observation is predominant especially in chemistry and physics domains of the subject. Although the students have well equipped library where they can make research, they never go there to read and therefore give completely strange answers to questions which suppose that they are only guessing. The implication is that they lacked the appropriate library skills as well as research skills. The students did not actively participate in or concentrate in the science lessons. The students were seldom provided with the opportunities to physically interact with instructional materials and also were not given the opportunity to engage themselves in varied kinds of activities.

4.4 Answers to research questions

Research question one: What are the perceptions and attitudes of students towards integrated science and how does this affect their science concept formation and performance?

From tables 4.4 and 4.5, it is observed that there was decline in perception and the general attitude of students towards science learning is negative. Although greater numbers of the respondents seem to have interest in science and see it relevant, a relatively large number of them have negative attitude towards science study. This was more obvious in their response to the questions 'will you avoid science when given the option, and do you have enough materials for science study?' This significant number that have negative attitude towards the subject account for the decline in performance which is caused by poor concept formation by a number of the students..

This observation agrees with the study of Sarfo (2009), about the factors that impede science concept formation during teacher education in Ghana. In his research, he discovered much misconception in the teacher trainees. When their interest and attitude was sought, it was revealed that most of the students do not want to study science as compulsory subject and hence have limited interest and hence negative attitude towards the subject. He therefore established that one of the factors that impede science concept formation during teacher training in Ghana is lack of interest and negative attitude towards the subject.

Research question two: Do the science teachers use laboratory experiments to aid science concept formation?

The responses to the questionnaire items relating to laboratory visitation received the highest negative response. During the observational schedule, the lowest score was for the item 'opportunity available for students to use science equipments. During the interview of the teachers, Abel Nyatuame (pseudonym) revealed that;

> "*Science performance in the school is not good and needs improvement. The main causes I thing are the time allocation for presentation. We have only forty minutes per week to present our lessons. This is so limited enough that you cannot do practical. I quite remember I only took integrated science students to the science laboratory twice even then, I could only show them laboratory apparatus".*

The response from Abel (pseudonym) revealed that the subject masters are not bent on using the laboratory for integrated science lessons. Upon the interview of the laboratory technicians, BuameEdzordzi (pseudonym) also reported;

> "*Integrated science lessons are not held in the science laboratory. Only science students are brought. The subject masters don't request bringing them around and moreover, there are no enough chemicals they can use for lessons. This is because the laboratory apparatus and chemicals are not replaced regularly".*

These responses of the science masters and the laboratory technician reveal that science laboratories are not used for integrated science lessons. This will affect how abstract concepts are formed by students especially the non science students who don't get to go to the laboratory at all.

This finding agrees with the conclusions of Sirestarajah (1995) who spoke extensively about the importance of practical work in the physical sciences. He argued that the physical sciences and practical work are interwoven enough that no physical science lesson will be more successful than when it is done using practical work in the laboratory. According to him practical work supports relevant science concept formation and helps students to apply their knowledge in other related areas.

The finding corroborates what Kirschner (1992) said about the importance of practical work in concept formation. He spoke about the extreme importance of practical work in facilitating concept formation. His emphasis is on guided discovery method usage in the practical work which prevents focus of students on irrelevant parts of the practical work and focuses their mind on the concept at hand.

Iqbal, Nageen and Pel (2008, p 281) also emphasized the importance of laboratory practical in concept development. In their research, they investigated experimental approach to science learning and found out that experiment attracts students regardless of gender, geographical location or level of interest. In their research where they investigated effects of exploratory and discovery based approach of learning, they discovered that practical work boosted up the interest of all students no matter their geographical location or gender or level of cognitive development and affected output in the affirmative. He therefore concluded that practical work supports science concept development and helps improve performance in science.

Research question three: Which method does the science teachers use and / are the methods effective?

From the responses of the students and the interview conducted to science teachers, it was revealed that no teaching aids are used. From the observation of instruction, there was minimized student participation, proper and effective use of language, mastery of subject matter and adequate subject matter content. The observation of students revealed low students concentration, low students participation, low problem solving skills and low listening skills of students. All these revealed that the teachers use the chalk and talk method. This method does not help in science concept formation and hence it is more ineffective than otherwise.

Sarfo (2009) also had a similar observation. In his observation, he realized that most teacher trainees are only passive listeners of science lessons whiles the teachers present their lessons in a form of a lecture. This makes learning boring to students and declines their interest in the subject and hence does not help them in forming any concept.

This agrees with the contention of Arrend (1991) that instructional methods that make learners observe are more effective in concept formation. He argues that concepts are formed by learners through observation of experiences. The repeated observations are coined into concepts that are represented by the trend of observation because according to him, the learner has to internalize the concept for himself.

Research question four: Do the science teachers have good pedagogical content knowledge?

From the scores of the four lessons observed, instruction scored less than average i.e. 2.625. This means that the science teachers can be said not to have good pedagogical content knowledge. From the observation, the teachers scored high marks for content knowledge and effective use of language. However, very low marks were obtained for introduction of lesson, systematic presentation adapted to the level of students, varying feedback technique, clearly explained task setting and many other vital parts of instruction. These level of pedagogy only helps very good students and does not help average or below average students in concept formation. Research into the background of the science masters also reveals that most of them are non professional teachers. This is evident in the methods they employ in teaching which does not enhance good concept formation of their students.

This is supported by Wellington and Osborne (2001) who underlines that, it is not just the language of science as used by the science teachers that enhances concepts but rather what educators do with language. According to them, science teachers need to play around science language as masters of the subject to bring learning to the level of the student.

Tina (2007) also supported that by saying learning should be adapted to the level of the student. In all domains of pedagogy, the student is at the centre of learning. This is because all other factors must act on the student for the desired behavior to be observed. Good content knowledge alone does not guarantee good impact but rather good pedagogical content knowledge. This will enable the teacher to bring the content knowledge down to the level of comprehension of the students.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

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

5.2 Summary of major findings:

- A number of students hold on to the perception that science is difficult and hence have negative attitude to the study of science which prevents them from forming relevant science concepts during science lessons
- Science teachers do not use laboratory experiments in teaching to enhance science concept formation.
- Most of the science teachers use the conventional method of teaching in which the teacher teaches and the student listens which is ineffective
- Majority of the science teachers have inadequate pedagogical knowledge which interferes with their presentation skills and affects concept formation of students.

5.3 Conclusions:

The research revealed that a number of integrated science students at the Keta Senior High Technical School have negative perception about science and this affects their attitude to the subject

Most of the science lessons in the Keta Senior High Technical School are not practically oriented because of limited learning resources and this makes science concept formation difficult for students.

Most of the science teachers use the traditional method of teaching which is ineffective

A number of the science masters have limited pedagogical content knowledge even though they have good content knowledge.

5.4 Recommendations

Based on the findings from the study conveyed at the Keta Seniior High Technical School, it is recommended that;

- Science teachers should be educated on the importance of using science laboratory for experiments to enhance students' science concept formation.
- Science laboratory should be upgraded with necessary facilities for integrated science lessons.
- Science masters should be given in-service training to improve their pedagogical content knowledge.

- The number of science teachers in the school should be increased to meet the needs of the students for better learning.
- More time should be allocated to the teaching of integrated science.
- More integrated science assignments should be given to the students and the assignments properly monitored by subject masters. This will enable the students to read the subject on their own.

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APPENDIX A

QUESTIONAIRE OF FINDING PROBLEMS IMPRESSIONS OF STUDENTS ABOUT SCIENCE TEACHING AND LEARNING

SECTION A-DEMOGRAPHICS

Please tick one appropriate option as applied

1. Gender Male [ ] Female [ ]
2. Course Science[ ] business [ ] Home Econs [ ] Visual Arts [ ]

Technical [ ] General arts [ ] Agric [ ]

3. What was your grade in Science in BECE? 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ] 7 [ ] 8 [ ] 9 [ ]

SECTION B-ATTITUDES, INTERESTS AND PERCEPTION OF STUDENTS

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

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
1. I have integrated science on my private time table					
2. I am regular in science lessons					
3. I attend science classes punctually					
4. I will like to pursue a science course at tertiary					
5. Science is generally interesting					
6. Integrated science must be compulsory for all students					
7. I apply my science lessons in everyday life					
8. Science knowledge is relevant to life					
9. I have enough books and materials for science					

10. If you were given the option, will you avoid integrated science? Yes [ ] No [ ]

11. How much time do you spend learning integrated science during your private study in a week?

Less 1hr [ ] between 1 and 2 hrs [ ] between 2 and 3hrs [ ] above 3hrs [ ]

SECTION C- QUALITY OF TEACHING EXPERIENCES

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
1. Science teachers are punctual and regular					
2. Science teachers **organize** lessons effectively					
3. Science teachers are vocal					
4. Science teachers use practical means of teaching					
5. We frequently visit science laboratories					
6. Science teachers explain concepts thoroughly					
7. Science teachers relate well with students					

8. We are given exercises frequently in science					
9. We are given science homework frequently					

APPENDIX B

CLASS ROOM OBSERVATION SCHEDULE ON SCIENCE TEACHERS

	5	4	3	2	1
1.Effective and relevant introduction linked with Relevant Previous Knowledge with teachers					
2.Sysmatic and sequential presentation adapted to the level of students					
3.Mastery of subject matter demonstrated through teaching					
4.Proper and effective use of language					
5.Use of varying feedback techniques					
6.Effective use of teaching/learning resources					
7.Clearly explained task settings					
8.Regular monitoring of individual/whole class performance					
9Adequate subject content coverage					
10.Active students participation and involvement					

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

OBSERVATION SCHEDULE ON STUDENTS DURING SCIENCE LESSONS

	5	4	3	2	1	Remark
1. Students participation in science lessons.						
2.Students problem solving skills						
3.Students listening skills						
4.Student ability to ask relevant questions						
5. Students ability to provide correct explanation to questions in science lessons.						
6. Students level of concentration in science lessons.						
7. Opportunity available for students to use science equipments.						

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

APPENDIX C

Table 12: Summary of the response of four teachers (pseudonyms) to various interview questions

"What will you say about the general performance of integrated science in your school?"

Abel Nyatuame	Belinda Gati	Cate Bleboo	Daniel Ewunu
It is generally not good and needs improvement. The performance keep going down every year and is frustrating.	It is not too bad but if care not taken, it will get worse looking at the trend	It used to be better than it is now. It need much improvement talking about four five years ago	It is just average and needs improvement. It is not really the best

"What will you say about the time you are given to teach integrated science lessons?"

Abel Nyatuame	Belinda Gati	Cate Bleboo	Daniel Ewunu
There is inadequate time for presentation. You can't finish with all you have to do within the time allowed	The syllabus is voluminous and cannot be covered within the stipulated time. I usually don't finish the syllabus even though I do my best	Time is so much limited.	You cannot do all you want within the 40 minutes time allowed.

"Which teaching method do you use to present your lessons?"

Abel Nyatuame	Belinda Gati	Cate Bleboo	Daniel Ewunu
I do explain as much as I could	I use discussion methods	I present the lesson and give notes alongside	I teach and give enough examples since there is no time

"Do you have hold integrated science classes in the science laboratories?"

Abel Nyatuame	Belinda Gati	Cate Bleboo	Daniel Ewunu
I haven't taken integrated science students to the laboratory before because the laboratory is used more specially for the science students	I do hold my lessons in the laboratory when it is free but we don't do practical. We don't go frequently anyway	The laboratory is not large enough to accommodate the students so I don't worry to use it	There is nothing much integrated science students will do in the laboratory so I don't use it.

"Do you use any teaching aid in your presentations?"

Abel Nyatuame	Belinda Gati	Cate Bleboo	Daniel Ewunu
Once a while when I think it is needed	When we go to the laboratory, I do explain using some aid	Not really	Much of what we do is theoretical so I don't use them much

APPENDIX D

Table 13: Summary of responses given by two laboratory technicians (pseudonyms) to various interview questions

Interview Questions	AblaKuma	BuameEdzordzi
1. Do you have integrated science lessons in the laboratory?	Once a while	Not at all it is only science students that are brought
2. Any reason for response above?	Students break up apparatus whenever they come around and replacement is hard	The subject masters don't request bringing them around and moreover, there are no much chemicals they can use for lessons
3. Is the laboratory in shape for experiments? Do you have enough laboratory equipments?	A lot of equipments are needed but the administration only buys them for final exams	Not at all. A lot of materials are needed in the laboratory if the laboratory should be effectively used
4. Any reasons for the response to question 3?	The ones that need replacement are not being replaced when I request	Chemicals and glassware are only bought during WASSCE examinations
5. Do you have any teaching aids?	Few of them	Aside the old periodic table and some few models, there is nothing else
6. What will you say about funding of the laboratory?	Funding is very poor	The school is not ready to fund scientific works because they think it is expensive

APPENDIX E

Sample responses students gave to integrated science questions

Questions	**Responses**
What type of bond is present in HCl	Ionic
Name three subatomic particles	Protons, electrons and neucleus
What is radioactivity	It is when one radio is more active than another
What is a saturated solution	Is a solution that contains more solutes
Define moment of a force	It is when force moves an object through a distance