UNIVERSITY OF EDUCATION, WINNEBA

PERCEPTIONS OF SENIOR HIGH SCHOOL TEACHERS AND STUDENTS ON TOPICS IN THE INTEGRATED SCIENCE SYLLABUS

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DECLARATION

Candidate's Declaration

I, **HENRY EGYEI-MENSAH**, hereby declare that except for references to other people's work which have been duly cited and acknowledged, this thesis is the result of my own work and that no part of it has been presented for another dissertation in the University or elsewhere.

Signature: …………………………………….

Date: …………………………………………

Supervisor's Declaration

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

Signature: …………………………………….

Date: …………………………………………

DEDICATION

I dedicate this research work to my mother Gladys Nancy Ofosu and My late father, Engineer Supi Paul Egyei-Mensah.

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ABSTRACT

This study explored students' and teachers' perceptions of integrated science topics in the Senior High School integrated science syllabus. The objectives of the study were, to identify perceived difficult topics in the Integrated science syllabus among students, and their teachers, reasons by teachers for the perceived difficult topics to teach and a comparism of students' perceived topic difficulty based on gender. To achieve this, the descriptive survey method was employed in the collection of data from 207 SHS three (3) students and their 18 integrated science teachers in two schools within the Cape Coast Metropolis who were purposively sampled for the study. The instruments used were questionnaires for both teachers and students. Data collected was analysed through the application of t-test, mean, standard deviation, and percentages, using the statistical package for social science (SPSS). The study revealed that biotechnology, endogenous technology, atmosphere and climate change, hydrological cycle, and nuclear energy were the most perceived difficult topics to understand by students. Integrated science teachers expressed reasons for some perceived difficult topics to teach. The study also established no significant difference in topics perceived to be difficult by male and female students. Both students and teachers expressed diverse levels of perceived difficulty in integrated science topics in the syllabus. The study therefore, recommended that the Management, Science heads of departments and Integrated science teachers of the sampled schools should review and simplify identified difficult topics in the integrated science syllabus for easy teaching and understanding by teachers, and students. It was also recommended that as much as possible all stakeholders should help to provide adequate teaching and learning support for integrated science to help in the teaching and learning process so as to improve students' performance.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter is about the background to the study, the statement of the problem, purpose of the study and the research objectives. The chapter also presents the research questions, research hypothesis, significance of the study, assumptions that were made in carrying out the study, delimitations, limitations and organization of the study.

1.1 Background to the Study

Science as a subject can be linked to the various disciplines of all students across the educational ladder, and it is imperative to train students for transition to adulthood and for admission into an ever-increasing technological workforce (Fradd & Lee, 1995; Gurganus, Janas & Schmitt, 1995; Patton, 1995). Science education can help students understand their physical environments and develop a multicultural world scope of scientific phenomena. Thus, science is a pivotal enterprise upon which nations depend, in-order to progress technologically.

Science as a discipline, therefore, is being accorded much emphasis in its education because of the significance and impact on life and the society with respect to climate change and environmental awareness in recent times. The development of a nation depends largely on the scientific expertise of the citizenry in contemporary times. These suggest that such skills cannot be acquired from an isolated subject but rather from multi-dimensional disciplines unified under the name integrated science. Integrated science is therefore a combination of all the pure sciences with the incorporation of technology and learnt as a single subject to ensure that the individual acquires the much-needed basic skills in solving societal problems (Leliveld, 2002; Abbey et al., 2008).

The main objective of integrated science education in Ghana as enshrined in the Senior High School curriculum is to prepare students to acquire scientific skills and principles for their own benefit and the society at large (Ministry of Education, Science and Sports, 2012). According to Agusiobo (2003) curriculum is an organised framework that spells out the content that children are to learn and the process through which the activities set for them should be conducted. Therefore, curriculum can be seen as all experiences that students have under the guidance of the school in a school system. An analysis of the goals of integrated science curriculum reveals that students' continual poor performance in integrated science would make the realization of these goals unachievable, and it would risk Ghana's socio-economic growth and development ultimately. Abbey et al. (2008); Adeyemo (2011) and Davis (2010) and d reported that nations that wish to progress in science and technological development for their societal advancement need to invest enough in science education.

Ghana's vision of the National Science, Technology and Innovation Policy (February, 2010) is: "to support national socio-economic development goals with a view to lifting Ghana to a middle income status by the year 2020 through the perpetuation of a science and technology culture at all levels of society, which is driven by the promotion of innovation and mastery of known and proven technologies and their application in industry and other sectors of the economy (Ministry of Environment, Science and Technology, 2010)" (Azure, 2015, p. 50). The policy has its basic objectives among others as:

(i) to seek to master scientific and technological capabilities by a critical mass of the products of all institutions; (ii) to accelerate the promotion of innovation through the development and utilisation of modern scientific and technological capabilities to provide the basic needs of the citizenry and to compete ably in the global market; (iii) ensure that Science, Technology and Innovation (STI) support Ghana's trade and export drive for greater competitiveness; and (iv) to promote science and technology culture Ministry of Environment, Science and Technology 2010 (Azure, 2015).

Integrated Science at the SHS level is treated as a core subject with the intention that all students would be privileged to some amount of scientific literacy by the end of their secondary education. That notwithstanding, students' current performance in integrated science is not the best (Appiah & Beccles, 2022). This scenario is evident in Ghana as many SHS students embark on remedial classes after the final year especially in Integrated Science. The factors responsible for the aforementioned observation are not extraordinary in nature.

Okhiku (2005) observed that poor performance in SHS Integrated Science is as a result of poor quality of teachers, large class sizes, and differences in terms of students' ability levels, lack of well-resourced laboratories and overloaded Integrated Science syllabus. Sert, Diken and Darcin (2008) explained that, the concepts learnt in Integrated science as compared to other subjects, integrated Science has more interrelated topics inherent in the natural or pure sciences (i.e., Physics, Chemistry, Biology).

This peculiar nature of Integrated Science as a subject makes it unique and that a student can be good in Integrated Science if only the fundamentals of the pure Science subjects (i.e. Chemistry, Biology & Physics) are well understood. Many integrated science teachers handling the subject in most secondary schools are experts in an aspect of science, not in the entire science education (Omosewo, 2009). These teachers, may be handicapped with regards to appropriate instructional strategies for teaching and often employed the lecture method. Consequently, such specialized science teachers engage in out-of-field teaching when entrusted with integrated science.

According to Ingersoll (2002), out-of- field teaching is when a teacher is made to teach subjects apparently outside his/her specialization or with inadequate training and qualification. It is therefore imperative to ascertain some of the possible perceptions on the science topics by both students and teachers in this respect. There are several factors for which students, particularly at the SHS level, may perceive integrated science as difficult when compared to other subject areas. It may be as a result of how the students perceive some topics in the subject following some experiences with it, or information surrounding the subject as claimed by others.

Johnston (1991) suggested that, the perceived difficulty of some science topics, indicated that it may be due to problems in perception and thinking of students. He, therefore, attributed this difficulty to some complexity in the ideas and concepts prevailing at three different levels: macro and tangible, micro and representational or symbolic. Johnston subsequently, proposed that the interaction of these three levels may cause overburdening of students' working memory, leading to difficulty in conceptualizing various topics in the integrated science curriculum. Although the adoption of spiral curriculum in the education system should allow for gradual progress of learning concepts from concrete (macro level) to abstract (micro and representational), very often science teachers are compelled to use all the three levels in a single lesson delivery.

Perception as part of mental processes or skills engaged by human beings involves the cognitive domain of learning where an individual tries to make sense out of a situation or something (Agogo, Ogbeba & Darmkor-Ikpa, 2013). According to Ortese, Yaweh and Akume (2006) the perceptions of students are inundated with some challenges such as motivation, interest, attention, creativity, thoughts and self-concepts. This is in consonance with the observation by Agogo (2003) that what appears to be difficult to an individual is relative since the concepts of what is easy or difficult changes from one person to another. Consequently, the issue of concept difficulty exists and has a remote toll on the performance of students in science (Awere, 2018).

1.2 Statement of the Problem

The key aims of the Senior High School Integrated Science Syllabus (2010) as proposed by the Ministry of Education (Ghana) is fundamentally geared towards students' attainment of scientific knowledge, development of practical skills and attitude. It appears that in some of the Senior High Schools one teacher is allocated for the teaching of integrated science as pertained to the Junior High Schools. Conversely, most integrated science teachers are subject specialists per their training from the University and may have some challenges beyond their specialty in their bid to teach integrated science holistically.

There has been a report from Mfantseman Girls Senior High School in the Central Region of Ghana where the school's management gave an ultimatum to an Integrated science teacher to either teach all aspects of integrated science (i.e. Biology, Physics, Chemistry & Agric. Science) as a whole or leave the school. The science teacher failed to live up to expectation and was eventually released from the school (Personal observation, December 2021). According to the report the science teacher in question preferred to teach an aspect of science (e.g. biology) and assigned notes to be copied by students with little or no explanation for the other aspects. Such a teacher may perceive some topics in the integrated science syllabus as difficult and may skip or scratch the surface which can impede students' understanding and result in poor performance.

Currently, the Ghana Education Service has no straitjacket policy on how integrated science as a subject should be taught, although teachers are mandated to teach their areas of specialization. Thus, in some SHS management engages one teacher to teach all aspects of the subject whiles' other schools prefer aspects teaching by four teachers, and still other schools engage two teachers. According to some of the science teachers integrated aspect of the subject is experienced by how the concepts in the topics are connected in the learning by students and not how it is taught (Personal observation, December 2021). Allport (1996), reported that the way we judge or evaluate something portrays our perception about it in that regard. Thus, wrong perception of science concepts by a student or teacher may imply that teaching was done scantly and inappropriately. That notwithstanding, the performance of SHS students in WASSCE integrated science has not been very good over the past decade (Appiah & Beccles, 2022). According to a study conducted in the Tamale Metropolis of Ghana by Appiah and Beccles (2022), three main factors were identified as suspects to the low performance of SHS students in WASSCE integrated science.

These factors were teacher attitude, student attitude and the school environment. The study further reported that some teachers were not qualified enough to teach integrated science, and have low practical ability and cannot handle some topics in the integrated science syllabus very well. One teacher respondent was quoted as saying *"Teachers are also to be blamed for poor performance of students in Integrated Science because they cannot handle the practical aspect very well example preparation of gases*".

WASSCE percentage pass rate of students in Integrated science from year 2013 to 2022 are shown in Table 1.

Table 1: WASSCE integrated science pass rate in Ghana from 2013-2022 (A1-C6)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Pass rate(%)	50.94	26.29	23.63	48.48	42.52	50.52	63.17	52.53	65.70	62.45

Source: (WAEC, 2022)

From Table 1, the integrated science average pass rate over the past decade was found to be 48.62%. The implication is that about 51.38% of candidates may have to re-sit every year or be denied direct entry into tertiary institutions in Ghana. Low performance of SHS students in WASSCE Integrated science is, therefore, not a recent issue but it dates back to 2006 (Education, 2015). WASSCE Integrated Science pass rate in Ghana has subsequently not been consistent; it keeps on fluctuating and that, the results are not very good (Appiah & Beccles, 2022). The WASSCE grading system uses A1 to signify a score of 100-80 implying excellent, B2 is a score of 79-70 stands for very good, B3 is a score of 69-65 interpreted as good, C4, C5 and C6 is a score of 64-60, 59-55, 54-50 respectively which is interpreted as credit. Again, D7 and E8 represent a score of 49-45 and 44-40 respectively and are interpreted as pass. Lastly, a score of 39 and below is tagged as F9 and referred to as fail (WASSCE, 2022). Admission into tertiary institutions following completion of SHS in Ghana, therefore, requires candidates to pass in the four core subjects (English, Mathematics, Social studies and Integrated science) with grades not below C6 (Credit) and the appropriate electives pertaining to the programme of choice. Furthermore, the statistics for WASSCE Integrated Science as one of the four core subjects in 2017 revealed that 125,204 (42.52%) candidates obtained A1-C6, 84,851 (30.73%) obtained D7-E8 whilst 76,693 (26.75%) obtained F9 (WAEC, 2017). The reality is that about 57.48% candidates were supposed to go through re-sit in order to gain direct admission into the

Tertiary institutions. From 2013 to 2015, students' performance remained as low as 34.33% averagely (WAEC, 2015). According to the Chief examiner's report for integrated science there was a rise in 2018 WASSCE student performance, from 43% pass rate in 2017 to 51% pass rate in 2018 (WAEC, 2018). However, in 2017, the Chief examiner for Integrated Science WASSCE, stated clearly that performance that year was poor and continued to stress year after year that there was more room for improvement. According to the Chief examiner's reports (WASSCE 2013 - 2022) summary of candidates' weakness found were; poor knowledge of scientific terms, lack of understanding of the demands of questions, lack of practical experience, conventions as applied in science, also lack of transfer of knowledge from one aspect (eg. Agricultural Science) to the other (e.g. Biology), inadequate preparations, lack of practical work and lack of completion of syllabus. The Chief examiner (WASSCE) subsequently gave some suggested key remedies as follows: teachers need to cover the entire integrated science syllabus and expose students to simple practical work. The science teacher, may however be able to carry out the aforementioned suggestions by the Chief examiner, if the topics in the integrated science syllabus are not perceived as difficult. Although, not many studies have delved into SHS teachers' and students' perception of difficulty on the topics in the integrated science syllabus, yet available literature suggests the existence of a relationship between teachers' perception on topics in a subject and the performance of their students (Mahajan & Singh, 2005).

Therefore, issues like students' and teachers' perceptions of difficulty of the topics in the integrated science syllabus remain a concern for educational administrators, stakeholders, parents, and students (Baidoo-Anu, 2017). There was therefore a need to conduct research into the perception of teachers and students on topics in the integrated science syllabus that has contributed to the low performance of SHS students in Ghana.

1.3 Purpose of the Study

Based upon the problem statement, the study was to explore Senior High school integrated science topics which are perceived to be difficult to teach by teachers and difficult to understand by students, whether the perception is gender related or teacher expertise-related and how to address such observed difficulties to improve students' performance.

1.4 Research Objectives

The main research objectives of the study were to find out:

1. The integrated science topics that Senior High School students perceive as difficult to learn.
2. (a) Whether SHS integrated science teachers have difficulty in teaching some topics in the syllabus,

   (b) and the reasons for such difficulty.
3. Whether there were differences in the integrated science difficult topics perceived by SHS students and teachers.
4. Whether there were differences in the integrated science topics difficulty perceived by SHS students based on gender.

1.5 Research Questions

To guide the study, the following research questions were posed:

1. What topics in the integrated science syllabus are perceived as difficult to learn by SHS students?
2. (a) What topics in the integrated science syllabus do SHS teachers perceive as difficult to teach,

   (b) and what are the reasons for the difficulty?

3. Is there significant difference in the topics perceived to be difficult by SHS students compared to their teachers?
4. Is there significant difference in SHS students' perceptions of difficult topics based on their gender?

1.6 Research Hypothesis

The following null hypothesis was tested at the end of the study:

There is no significant difference in the integrated science topics perceived to be difficult by SHS male and female students.

1.7 Significance of the Problem

The findings of this study will benefit those, who in future would pursue further studies on perceptions of students and teachers in integrated science.

It would help authors of SHS integrated science textbooks to write concise integrated science textbooks. The study will also be a useful guide to integrated science teachers on students perceived difficult topics and also guide curriculum developers on how to bridge the existing gap in science education. The results of the study will also be useful to our educational training institutions, in the designing of curriculum for training prospective integrated science teachers for the SHS level. The outcome of this study again will inform the management of the sampled schools and Ghana Education Service in general whether to engage one teacher to teach integrated science as a subject or teachers with specialty in the various aspects of the subject. It will also inform the Ghana Association of Science Teachers (GAST) in educating integrated science teachers on effective teaching of the so-called difficult topics in the integrated science syllabus during their teacher development workshops and seminars.

1.8 Assumptions of the Study

In pursuing this study, the following assumptions were made. It was assumed that selected SHS for the research operated with GES recommended syllabus in the teaching and learning of integrated science and that one teacher teaches integrated science as a core subject. It was also assumed that the selected students' respondents for the study have treated about 70% - 80% of the topics in the integrated science syllabus.

1.9 Delimitation of the Study

There are a number of subjects taught and learnt at SHS that could be explored but this research was restricted to topics in the integrated science syllabus. The study also focused on SHS 3 integrated science students and their teachers, because it was assumed that by the third year in SHS, integrated science students would have had enough content exposure with respect to the topics in the syllabus.

1.10 Limitation of the Study

The study should have considered all the SHS integrated science students and teachers in the Central Region. However, the focus was on only 18 integrated science teachers and 207 SHS students from two Senior high schools in the Cape Coast Metropolis. This is because at the time of carrying out the study, most schools were not done with the syllabus. It was observed that only two mixed SHS in the Metropolis had completed the syllabus and were writing mock examination. Again, some student respondents were seen communicating among themselves in the classroom during the filling of the questionnaires. This prompted the researcher to call them to order to ensure independent responses.

1.11 Definition of Terms

Academic Performance: Students' achievement/result in West African Senior High School Certificate Examination at the end of an academic program in a school.

BECE: Basic Education Certificate Examination

NaCCA: National Council for Curriculum and Assessment

GES: Ghana Education Service

SHS: Senior High School

SHTS: Senior High Technical school

Integrated Science Syllabus: Science syllabus designed in 2010 for use in senior high schools by the GES.

Student: Refers to a learner or someone who attends an educational institution to acquire knowledge and skills

Teacher: Refers to a person who provides education for pupils (children) and students (adults).

WASSCE: West African Senior High School Certificate Examination

1.12 Organization of the Study

The rest of the study was organized as follows: Chapter two treated the literature review of the study. By considering: Concept of Perception and its influence on learning, the role of science education in Senior High Education in Ghana, Perception of difficult science topics, the nature of the SHS Integrated science teaching syllabus, Students' attitude towards the study of science, Teacher's role in Achieving Curriculum objectives in integrate science. Relationship between teachers' and students' perception, Attitude of students towards science practical activities and Empirical Frame work.

Chapter three dealt with the methodology, research design, population, sampling and sampling procedures, instrument used for the study, data collection and data analysis. Chapter four includes the results and discussion of the study. Chapter five is about the summary of key findings, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter presents the review of related literature to the study with regards to important aspects of the study. For the purposes of the study, the review was organised under the following sub–headings:

(a) The nature of the SHS Integrated science teaching syllabus

(b) Theoretical Frame work underpinning teaching and learning of integrated science,

(c) Concept of perception and its influence on learning

(d) The role of science education in Senior High Education in Ghana

(e) Perception of difficult science topics

(f) Students' attitude towards the study of science

(g) Teacher's role in achieving curriculum objectives in integrate science

(h) Relationship between teachers' and students' perception.

(i) Attitude of students towards science practical activities

(j) Empirical Frame work

2.1 The Nature of the SHS Integrated Science Teaching Syllabus

Farrant (2005) defines a teaching syllabus as an outline of statement which determines the aims, objective, rationale, content, prescribed learning activities and possible tools for evaluation with respect to a specific subject as contained in the school curriculum. Integrated science at the SHS level has the following aspects; physics, biology, chemistry, agriculture science and technology. The integrated science syllabus covers three-year period of Senior High School Education. Each year's work embraces five themes namely: Diversity of Matter, Cycles, Systems, Energy and Interaction of Matter. The five themes form the five sections of the syllabus for each of the three years' work.

2.1.1 The aims of the SHS Integrated Science syllabus

We encounter daily challenges that require us to apply scientific knowledge or information to help us outwit all the possible huddles on our path as we journey through life on this earth. Following, the modern life style we are beset with, it also requires of us to be abreast with some level of general scientific literacy as a citizen of a Country. Every person in Ghana needs some science education in order to develop a scientific mentality and culture to deal objectively with phenomena and practical issues; prevent dependency on superstition or myths for explanation to natural phenomenon. It will also help to construct and build the present and the future on practical scientific ideas.

The syllabus is designed to help the student to:

1. solve basic problems within his/her immediate environment through analysis and experimentation
2. keep a proper balance of the diversity of the living and non-living things based on their interconnectedness and repeated patterns of change.
3. adopt sustainable habits for managing the natural environment for humankind and society
4. use appliances and gadgets effectively with clear understanding of their basic principles and underlying operations
5. explore, conserve and optimize the use of energy as an important resource for the living world
6. adopt a scientific way of life based on pragmatic observation and investigation of phenomena.

7. search for solutions to the problems of life recognizing the interaction of science, technology and other disciplines.

2.1.2 Scope of the Integrated Science syllabus content

The syllabus is a continuation of what was taught at the junior high school. It is therefore designed to cover fundamentals of the pure sciences in addition to some topics in Health, Agriculture and Industry. The course offers a body of knowledge and skills needed for everyday living and also provides prerequisite foundation for the study of other subjects and for those who may wish to further their education and training in science related careers. Specific issues covered in the syllabus are as follows:

1. Science for all students
2. Science as an active inquiry process
3. Science and the satisfaction of individual needs
4. Science as a profession
5. Science and culture.

The basic aim for the adoption of this syllabus is to enable students to appreciate and accept the connection between seemingly different scientific topics and be able to integrate ideas from various scientific sources in solving personal and societal problems. The five themes selected for this subject are: Diversity of matter, Cycles, Systems, Energy, and Interactions of matter. This body of concepts has been chosen to help build a foundation upon which students can rely for further study. Although the content of the syllabus is organized into five themes, the topics under each theme should not be viewed as separate blocks of knowledge. In general, there are no clear boundaries between these themes. There may be topics common to different themes in the syllabus. The implication is that, the teacher should strive very hard to demonstrate the relationship between themes whenever possible for students to understand such relationship. Another distinctive feature of the syllabus is the spiral nature of the content in the curriculum. This involves revisiting of concepts and skills at different learning stages with increasing degrees of difficulty thereby allowing the learning of scientific concepts and skills to be matched to student's cognitive development to facilitate gradual mastery of skills.

2.1.3 Pre-requisite skills and allied subjects for the Integrated

The outline of the syllabus requires that students would have average performance in Science and Mathematics at the Basic level and should be offering Core Mathematics and English language alongside, at the SHS level. This implies that students would have acquired some skill and knowledge that will enable them to understand the concepts and principles in the topics to be studied.

2.1.4 Duration of the course/ period allocation

The SHS integrated science course is designed to cover three years with a total of five periods a week, each period should last for 1hr (60mins). The time allocation and the recommended structure for theory and practical are shown in Table 2.

Table 2: Duration of the Course/ Period Allocation

Year	Theory	Practical	Total
1	3	2	5
2	3	2	5
3	3	2	5

Source: SHS Integrated Science Teaching Syllabus, (2010).

2.1.5 Organization of the Syllabus

The integrated science syllabus has been structured to cover three-year duration of Senior High School Education. Each year's work consists of the five themes which are: Diversity of Matter, Cycles, Systems, Energy, and Interaction of Matter. The five themes form the five sections of the syllabus for each of the three years' work. Details of the coverage of themes are as follows:

Section 1 Diversity of matter

Section 2 Cycles

Section 3 Systems

Section 4 Energy

Section 5 Interaction of matter

The details of the structure of the Integrated science syllabus is shown in Table 3.

Table 3: The Structure of the SHS Integrated Science Syllabus

SECTION	SHS 1	SHS 2	SHS 3
DIVERSITY OF MATTER	Unit 1: Introduction to Integrated Science. Unit 2: Measurement Unit 3: Diversity of living and non-living things. Unit 4: Matter Unit 5: Cells and cell division Unit 6: Rocks	Unit 1: Acids, Bases and Salts Unit 2: Soil conservation Unit 3: Water	Unit 1: Metals and Non-Metals Unit 2: Exploitation of minerals Unit 3: Rusting Unit 4: Organic and Inorganic Compounds
CYCLES	Unit 1: Air movement Unit 2: Nitrogen cycle	Unit 1: Hydrological Cycle Unit 2: General principles of farm animal production	Unit 1: Life Cycles of Pests and parasites Unit 2: Crop Production
SYSTEMS	Unit 1: Skeletal System Unit 2: Reproduction and growth in Plants Unit 3: Respiratory System Unit 4: Food and Nutrition Unit 5: Dentition, Feeding and Digestion in mammals Unit 6: Transport-Diffusion, Osmosis and Plasmolysis	Unit 1: Excretory system Unit 2: Reproductive Systems and growth in mammals Unit 3: Circulatory System	Unit 1: The Nervous System

Table 3 Cont'd

ENERGY	Unit 1: Forms of Energy and Energy Transformation Unit 2: Solar Energy Unit :3 Photosynthesis Unit 4: Electronics	Unit 1: Electrical Energy Unit 2: Electronics Unit 3: Sound Energy Unit 4: Nuclear Energy	Unit 1: Light Energy Unit 2: Heat Energy Unit 3: Electronics
INTERACTIONS OF MATTER	Unit 1: Ecosystem Unit 2: Atmosphere and Climate Change Unit 3: Infections and diseases	Unit 1: Magnetism Unit 2: Forces, Motion and pressure Unit 3: Safety in the Community Unit 4: Endogenous Technology Unit 5: Biotechnology Unit 6: Work and Machine	Unit 1: variation and inheritance

Source: SHS Integrated science teaching syllabus, 2010

2.2 Theoretical Framework Underpinning Teaching and Learning of Integrated Science

Integrated science as a core subject at the pre-tertiary level of education has been tagged as very important in ensuring all-rounded citizens capable of functioning effectively in today's world of scientific and technological literacy. Integrated science is taught as a subject with emphasis on the following science subjects: biology, agricultural science, chemistry and physics. According to Leung (2006), one of the rationales for rolling out the integrated science curriculum is to depict how knowledge gained by students across the various science subjects are connected in the scheme of things in the natural world unlike other science disciplines which may involve single- subject's courses that limit the individual's perspective in the educational process. The curriculum of the integrated science has an underlying basic theory as embodied in Gestalt psychology with a main idea that "studying the whole is better than the summation of parts or fragments".

What all integrated curricula have in common is an underlying theoretical foundation emanating from Gestalt psychology. The focus of Gestalt psychology is in two-fold: examining the learner as an organic whole and engaging the individual in focused learning experiences that are purposeful and meaningful (Benjafield, 1996). The implication is that learners over all (mental) experiences as a whole is more meaningful when learning is done holistically than when studied in isolation. According to Gestaltists (proponents of Gestalt theory of learning), insightful learning is the way forward in science education this is due to the instantaneous awareness establishing the relationship among the aspects of a prevailing task to be solved. The attempt to solve the given task actually occurs in the learner's mind which eventually prompts a novel idea to help solve the problem at hand.

A science teacher's role is therefore to organize their lessons in such a way that learners will unravel possible patterns and existing relationships without difficulty. In this regard learners can solve every day basic scientific problems by perceiving the various aspects of issues inherently as a whole. This would allow the learners to recognize and appreciate the major content of the SHS integrated science curriculum such as diversity of matter in the world, the interactions between the matter in it and the energy, the stability of the natural systems and cycle that preserves life on earth. This is due to the fact that our environment in general is naturally interrelated. Hence, students can make a better meaning out of the aforementioned linkages if they seek knowledge and skills through a unified method of teaching and learning. The teaching and learning of integrated science in the case of non-science students can help them to acquire fundamental knowledge in the sciences and to function effectively in this technological world.

Thus, the teacher's main aim in insightful learning is to assist learners to restructure or re-orient their thoughts in other to find solutions to a given puzzle or subject matter. The teacher is supposed to select a subject matter that meets the needs of the learners and order it in a logical sequence to portray any possible association between its components. Therefore, any perceived difficulty experienced by the teacher in this quest will have a huge toll on the presentation of lessons and eventually pose difficulty on the part of students in the study of the subject.

Abbey et al. (2008) reported that knowledge gained in general science is often beneficial in other branches of science. They further opined that in the real world, knowledge and expertise from the different fields of science among others are used to produce a particular material, like chemical for controlling insects. This points to the fact that every student needs to study integrated science during their preparatory stages whether science or non-science students. The basic skills and knowledge acquired in integrated science can help them to be scientifically literate in this era of science and technology. Following the socioeconomic and political importance of integrated science as a subject, it was introduced as teaching subject at the pre-tertiary education in Ghana.

According to Anthony-Krueger (2001) the process of knowledge acquisition in science requires some form of learning skills which students are to be endowed with if they can be effective and proficient in their chosen endeavors. These learning skills are to be imbibed by learners right from their formative stages of education as the teacher adopt and employ the best practices and teaching strategies in this regard. The integrated science syllabus was therefore structured extensively to encompass all aspects of human enterprise. And has henceforth gained much recognition in our educational institutions especially at the pre-tertiary educational level and a perquisite for higher education in Ghana. It is therefore a mandatory subject that students at junior high school ought to study and endeavour to pass well in the BECE before securing admission into the senior high schools in Ghana.

Draghicescu et al. (2014) reported that an integrated science teaching approach is supposed to allow learner's experience to be clearly involved in the education process, by offering more substance and relevance of learning. Topics such as Energy Sources and renewability, Environmental challenges and management, personal Health and nutrition. What Is Good to Eat, have a great potential to become more accessible and interesting for students if they are considered beyond the narrow lens of disciplines, separated from each other, and treated as an inter-, multi- and/or trans-disciplinary.

A study conducted by Azure (2015) reported that students at the SHS level were not taken through stated activities as enshrined in the integrated science curriculum. The implication is that teachers taught integrated science without following the suggested activities in the syllabus, as a result student were made to read text books during classes period and the teacher does the explanation of some of the concepts to students. The performance of SHS students in integrated science has not been very encouraging. Ogunkola and Samuel (2011) reported that the use of new terms, symbols and terminologies in physics and chemistry as compared to biology were some sources of concern with regards to perceived difficulty inherent in the teaching and learning of integrated science. This buttresses the assertion made by Ogunbiyi (2004), that the fundamental problems facing science teaching is the question of how updated are the professional science teachers. According to him the majority of science teachers trained before 1995 are handicapped with modern teaching methodology for effective lesson delivery in this dispensation. He therefore suggested for the retraining of teachers in their respective areas of specialization.

2.3 Concepts of Perception and its Influence on Learning

Perception, from the Latin word 'perceptio', implies gathering or receiving information and making meaning out of it. It is therefore considered as the sensory experience or recognition around one's environment. According to Allport (1996) the way we judge or evaluate something reveals our perception about it in that respect. Perception includes the use of the five senses touch, sight, sound, smell, and taste. Through the perceptual process, a person gains information about the chemical and physical properties of elements within the environment that are very essential for our survival.

Perception is a process that relate to the acceptance of information by human brains. It does not only create the experience of the world around us but also informs us to act accordingly within our environment.

Studies by Anamuah-Mensah (1995) (as cited in Davis, 2010) suggested that students' perceptions of the topics in the Science syllabus strongly reflected their actual performance on those topics as indicated by the grades obtained at the GCE 'O' level examinations. Other Studies by Abdullahi and Aninyie (1983); Akinmade and Adisa (1984) (as cited in Davis 2010), have revealed that certain science topics were perceived to be difficult by students in Nigeria and their perception of the topics depicted a reasonable relationship with their performance in their examinations.

There are several reasons why students at the SHS level, may perceive integrated science as difficult with regards to other subject areas (Cimer, 2012; Estacio & Cornejo, 2021; Etobro & Fabinu, 2017; Ogunkola & Samuel, 2011; Tekkaya, Ozkan & Sungur, 2001). Ogunkola and Samuel (2011) reported that such a situation may be due to how the students perceive the subject as a result of their previous experiences or from what other people have said about the subject. They again proposed that majority of students generally has difficulty in chemistry and physics concepts such as components of the air, energy, physical and chemical changes. Whereas the biology concepts such as healthy lifestyles, light, the eye, sound and the air were considered to be relatively easier. From their point of view, the experimental group they interviewed supported their findings because the students generally thought that biology concepts were more interesting and easier to study than physics and chemistry concepts. According to them students involved in the study further revealed that biology concepts were more practical, realistic and relevant to the immediate environment they find themselves unlike many abstract concepts in physics and chemistry.

A study conducted by Ogunkola and Samuel (2011) about science teachers' and students perceived difficult topics in the integrated science curriculum had the purpose of identifying integrated science concepts or topics that lower secondary school students and teachers perceived to be difficult. They also wanted to find out if there is a significant difference between the teachers and students' perception; significant difference in students' perceptions of difficult topics based on their interest in science, gender, habits of study and the location of the school in a bid to offer some suggestions to improve the teaching and learning of integrated science. The study showed that students' topic difficulty ranged from 6.67% to 38.7%. Subsequently, Physics and chemistry topics were ranked as the areas with the highest levels of difficulty. Topics in Biology and Environmental science had a low measure of difficulty indices. Biology topics like nutrition, the human eye, defects of the eyes and the ear had topic difficulty indices ranging from 6.67 % to 12.5 %. Environmental science topics such as recycling and pollution also registered low difficulty indices. Some chemistry and physics topics had relatively low indices of topic difficulty. Analysis of the experimental group interviewed revealed similar results. The students admitted that although science was an interesting subject, the instructional presentation and strategies of teachers could make it difficult at times.

For example, Krapp (2002) identified a significant decline in interest in physics, chemistry and mathematics as students' progress through secondary school. He also reported that this decline is more pronounced in girls. Comparative analysis studies from a 'Relevance for Science Education Project (ROSE)' held in countries across Europe between 2003 and 2008 revealed that the population of students regarding science subjects (especially physics and chemistry), as difficult has increased (Gedrovics, Mozelka & Cedere, 2010). There has also been a continuous reduction in post-compulsory high school science enrolment throughout the world over the past twenty years (Trumper, 2006).

Adeyemo (2011) also reported that, learning environment and availability of educational infrastructure are factors affecting positive learning outcome. He further explained that students' perception about a physics classroom environment has direct effect on the effectiveness of learning. He concluded that, academic performance of 16 physics students depended on both the teachers' and students' perception of the classroom environment.

2.4 The Role of Science Education in Senior High Education in Ghana

A developing nation like Ghana appreciates the importance of integrated science education as very pivotal, in national development. Integrated Science as a subject has therefore become an integral part of the pre-tertiary educational curriculum programmes in most developing countries.

There are two main science syllabuses for senior high schools in Ghana, namely the teaching syllabus issued by NaCCA on behalf of Ministry of Education and examination syllabus by WAEC. Both syllabuses lay emphasis on students' acquisition of some skills by means of practical work in the science subjects including integrated science. The Ministry of Education teaching syllabus for senior high school integrated science (2010) edition among other things emphasises the development of practical skills to enable students to relate science learnt at school to scientific concepts in modern and traditional industries or real-world situations. The central aspect of this current syllabus is the inherent concept of profile dimensions which dictates the basis for instruction and assessment in science. A dimension here depicts a psychological unit for describing a particular learning behavior. The three profile dimensions and their percentages for teaching, learning and testing in integrated science as enshrined in the syllabus are knowledge and understanding (30%), application of knowledge (40%), and practical/experimental skills (30%). A summation of percentage weights allocated to application of knowledge (30%) and practical/experimental skills (40%) makes (70%), which implies that the bulk of instructional method of lesson delivery in science must be practical-based in order to achieve the above-mentioned aims. Students can then apply knowledge acquired through manipulating equipment, solving experimental or enquiry-based problems, especially in a laboratory environment to realise effective practical skill development.

According to Ampiah (2004), the achievement of the above mentioned aims and objectives means that “students must of necessity use the conventional approach of doing science in the laboratory”. It is therefore very appropriate that WAEC and CRDD unanimously lay emphasis on manipulation of equipment, conduction of experiment, report writing and the acquisition of various laboratory skills which can be imbibed mainly through practical activities. Therefore, science teaching minus laboratory experiences is not really science education (Trowbridge, Bybee & Powell, 2004). This confirms the unanimous resolution approved by both Virginia Academy of Science Council and the Academy Conference (U.S.A) at their 1995 annual general meeting. According to them knowledge gained from science courses with strong laboratory components enable students to understand in more practical and concrete ways their own physical make-up and the functioning of the natural world around them. Thus, laboratory experiences through hands-on activities stand to stimulate the potentials of promising science students hitherto turned off by the lecture method of teaching science (chemistry). Hands-on laboratory experiences further engage students in open-ended investigative processes, which use scientific problem-solving procedures and application of information heard in lectures. This enhances reinforcement and clarification of scientific principles and concepts for effective learning. In spite of the numerous provisions and other efforts by the government of Ghana to lay emphasis on science education as the engine of development in the country, its advancement has not been up to expectation (Anamuah-Mensah, 1995). Batagaraw (2005) however, observes that defective planning, unqualified teachers, examination malpractices, maladministration, poor maintenance practices, inadequate financing and mismanagement are some of the factors militating against quality (science) education. This study therefore hopes to ascertain whether the reality in our science classrooms is also associated with the perception of some topic difficulty in the syllabus on the part of teachers and students.

2.5 Teacher's Role in Achieving Curriculum Objectives in Integrated Science

A number of factors militate against the successful implementation of an integrated science curriculum, including various outputs and inputs related to teacher quality such as professional development, experiences, adequate planning periods, and adequate content preparation of teachers with regard to content knowledge associated with the curriculum taught (Leung, 2006). The quality of every educational enterprise ultimately rests on the expertise of the teacher. This invariably underscores the importance associated with the production of high-quality teachers (Pemida, 2005).

Several studies have revealed that, the effectiveness of science teaching and learning could be influenced by factors such as content knowledge and pedagogical skills of the teacher leading to poor lesson preparation, lack of appropriate instructional materials, lack of monitoring and supervision of activities in the school, low motivation of teachers, and inadequate staffing (qualified teachers), poor learning/teaching attitude, and lack of interest on the part of students among others (Anamuah-Mensah et al., 2017; Fredua-Kwarteng & Ahia, 2005; Ngman-Wara, 2015; Parker, 2004; Quansah et al., 2019). Available reports on the quality of science teachers however indicted some teachers of gross incompetence (Adeyegbe, 1998; Onu, 2005). The reason for the continuous decline in the quality of science education at the SHS level has therefore been attributed to many factors like teacher quality (Onu, 2005), teaching method (Efe, 2005), lack of availability of human and material resources (Ausiobo, 2002; Lawrence & Tanko, 1998) and also neglect of practical work (Bugaje, 2013).

According to Bugaje (2013), the role of a science teacher among others is to change the method of classroom instruction from lecture to innovative learning strategy such as cooperative learning and concepts mapping, and to make use of improvisation in the absence of standard equipment. These innovations coupled with the right perception by teachers may go a long way to enhance students' performance in science. Innovative practices lead to effective teaching processes, a good knowledge of the subject matter, understanding of basic principles of child development, ability to joggle between different but effective teaching strategies, and "adaptive teaching" to local situations (Darling-Hammond, 2006; Danmaigoro, 2005; De Jong, Veal & Van Driel, 2002; Parker et al., 2018). This justifies the observation by Bugaje (2013), that one's method of teaching could be considered as the vehicle through which an instruction is delivered and that the wrong perception by the students presuppose inappropriate methods of instructional delivery.

The issue is, practical instruction is time consuming and costly, especially in the chemistry and physics aspects of integrated science, hence the effectiveness of the instructional delivery medium ought to justify such inputs to sustain the confidence in its propagation and practice. In the traditional method of teaching science other than the practical approach, students do not get the opportunity of an appropriate learning environment to explore the various facets of learning domains to realise the desired and expected goals of science education. Akinbote and Oguranti (2004) noted that the opportunity for a student to maximise his or her potential depends largely on the type of learning environment exposed. This learning environment happens to be controlled and managed by the implementer of the curriculum, the teacher.

According to Lunetta (1998, p. 252) "practical enquiry alone is not sufficient to enable students to construct the complex conceptual understandings of the contemporary scientific community. If students' perception towards science are to be positive, then intervention and negotiation with an authority, usually the teacher is very essential". Millar (2004, p. 3) pointed out that teachers ought to recognize that "ideas and explanations of scientific concepts do not simply emerge from data". If students are to learn science effectively in this regard, then it behoves on the teacher to adopt a hypothetico-deductive approach to the teaching and learning activities (Pardo & Paker, 2010). The implication is that the teacher must bear the onus in designing an appropriate learning environment that will enhance students to scaffold the concepts under consideration to the realisation of the curriculum objectives.

Brown and Ryoo (2008), have reported that the use of "everyday English'' language in the introduction of scientific concepts before teaching scientific terms or phenomenon improves learning outcomes as against the traditional method of teaching science. In a study conducted in Effutu in the Central Region of Ghana by Quansah et al. (2019), students expressed better understanding of integrated science topics when delivered in the fante language (local language). One student was quoted as saying *"I understand the concepts better when the Fante language is used." Again, "since English language is the accepted language in class, Integrated Science lessons are boring, but when the teacher allows us to speak the Fante language we are able to communicate and make the class exciting"*. The findings of their study underscore Ausubel (1968) learning theory and Vygotsky's (1962) advance organisers in the learning of new concepts.

Thus, students' previous knowledge including language plays a vital role in bridging the gap between what are already known and new concepts to be learnt. Science is an empirical subject and for majority of students, the greatest stumbling block in its study is to learn the language, since one of the major characteristics of science (chemistry) as a subject is the richness of words and terms.

Essentially, almost all of what we customarily perceive as knowledge is ‘’language’’. This presupposes that the key to understand or comprehend a subject is to first understand its language. Therefore, science teachers should endeavour to enrich their introductory lessons with simple language devoid of terminologies and ambiguity as a prelude to the actual learning of the scientific terms and phenomenon. Consequently, it has become imperative to seek innovative strategies to enhance the quality of instruction of learning of science (Bugaje, 2013). Some of the innovative strategies are:

a. Cooperative learning: Cooperative learning is a teaching strategy where students work together in small teams and use a number of activities to achieve academic objectives and improve their understanding of the subject matter (Adeyemo, 2010). This kind of learning is activity-based and student-centred with the teacher as a mere facilitator of learning. Following the increasing class sizes in today’s science classrooms, an adoption of cooperative learning as part of the practical instructional approach may be of huge benefits in improving student’s performance in science education. A number of research studies have been carried out on the efficacy of cooperative learning in Nigeria (Adeyemo, 2010; Nbina & Mmaduka, 2014). It was concluded in these studies that cooperative learning is most useful than other instructional strategies.

b. Concept mapping: This is an instructional strategy that involves the use of diagram in which concepts are organised into a hierarchical network depicting the relationship among concepts (Efe, 2005). This instructional innovation reflects a chronological arrangement of a disciplined conceptual learning profile. It is useful in facilitating learning and has been used to evaluate learning as a study skill, yielding meaningful and high achievement in science (James, 2000). Concept mapping instructional strategy when employed by science teachers will make science learning more meaningful by assisting students to organise incoming information and construct mental scaffolds between what is already known and what is to be learnt (Egbebedia, 1999). The apparent difficulty nature of science as perceived by students may be demystified through concept mapping and laboratory instructional strategy. This would result in an improvement in output in science education.

c. Information communication technology (ICT): It is defined as the technology involving creating, processing, storage, retrieval, and transmission of data and information including telecommunication, satellite, technologies, electrical and electronic computing (software/hardware), the internet and global systems of mobile communication (GSM) (Afolabi, Adedayo & Adeyanju, 2005). With the ICT, various concepts theories and principles can be depicted through power point presentation as well as computer and projector simulation in a large class situation. It gives the teacher a meaningful classroom or laboratory instruction and makes presentation exciting enough to sustain students' interests in the subject. According to Musa (2005), computer instruction which may form part of laboratory instructional approach of teaching assists science teaching in the following ways;

(a) Laboratory data analysis/process

(b) Simulating and modelling

(c) Drill and practice

(d) Teacher's ability (word processing keeping)

Industrial science topics like production of alcohol, soap, petroleum and extraction of some metals can be done through simulation (Ojo, 2005). Simulation, therefore, tends to solidify the connection between practical activity or a phenomenon and assumptions. The teacher talks less, while students construct their own conceptual understanding of the subject matter under consideration. It has been observed that student learning rate is faster with computer assisted instruction (CAI) than with other instructional strategy and enhances learning rate to augment retention (Ojo, 2005).

a. Improvisation- the need for improvisation has become very necessary in science education as a result of the following reasons:

i. Increase in class sizes and rising cost of standard science equipment

ii. Shortage of some science equipment on the production market.

iii. The need to promote scientific thinking and the inability to internalise chemistry processes and skills (Bugaje, 2008).

Improvisation which simply means making a substitute for something out of available materials at a time must be adopted seriously by chemistry teachers to improve the quality of education by way of developing manipulative skills and ignite the “can do” spirit in students. Ibrahim, Paulina, Abubakar and Abdulkadir (2010), have therefore offered the following as some of the merits of improvisation in science education.

1. It encourages individuality, self-reliance and self-independence.
2. It allows teachers and student to achieve educational goals and lesson objectives by the three domains of taxonomy of learning namely affective cognitive and psychomotor aspect of life.
3. Practical work in improvisation allows students to have consistency in learning.
4. Improvisation facilitates originality of work.

A teacher is someone who is certified to interact with learners to cause a change in their behaviours. The role of the teacher in realizing the objective of science education is very crucial in this era of scientific and technology advancement. Science teachers ought to orient their pedagogy into an innovative practical instructional approach to fulfil the aims and objectives of science education. Teachers at all levels of the education system are very important in the overall development of any nation (Anho, 2001).

The qualification of a teacher therefore comprises mastery of the subject matter, an in-depth knowledge of child psychology, instructional methodology and some level of educational administration. Certification of teachers may therefore differ from one country to the other due to differences in licensing requirements and some strict parameters. A standard training certification generally implies that the teacher has been prepared according to the laid down teacher education program pertaining to that particular nation. Most countries may use one or more tests of basic skills, subject matter, knowledge and some teaching experience for admission into the teaching profession.

According to Anho (2001) teachers' education is often divided into three stages namely:

a. Initial teacher training.
b. The induction process involving the training and support of the trainees during the first few years of teaching.
c. Teacher development for practicing teachers.

The teacher is thus, a practitioner who joins the teaching profession with a certain level of knowledge and aspires to acquire new knowledge and experiences based on the previous knowledge (Dodds, 2001). Osborne and Simon (2000) have also noted that a teacher's background in both education and science has a bearing on students' achievements in science. This is in agreement with the observation by Barnett and Hodson (2001) that some teachers often fail to carry out in the school laboratory what they have promised students they will do. Thus, creating a discrepancy between teachers' rhetoric and classroom behaviour. This sends mixed messages to students and other observers about the expertise and preparedness of the teacher. What goes on in the classroom, the impact of the teacher and method of teaching has been identified in several studies as crucial variables for improving students' learning outcomes (UNESCO, 2004). Hence, the pedagogy of teachers is of critical concern in any educational reform designed to improve quality.

Consequently, good basic education is considered to be the results of interaction of multiple factors, the most important of which is increasingly recognised to be quality teachers and teaching methods (Lewin & Staurt, 2003 Anderson, 2002). The implication is that there is a huge bearing of a teacher's quality or expertise on students' performance in science education especially at the pre-tertiary level (Onu, 2005). Muhammed (2006) concluded that, one of the cardinal elements of teacher quality has been the provision of adequate opportunities for personal growth and professional development of teachers in general. The rapidly increasing sophistication of this world has rendered some of the knowledge and skills teachers acquire in their pre-service training apparently stale and obsolete in the phase of new challenges and realities.

"There is currently a wide spread agreement that classrooms and schools which provide opportunities for inquiry-based learning, experimentation, reflection and dialogue are powerful contexts for effective students learning" (Borko, 2004). Subsequently, the concept of teaching is going through a global paradigm shift with regards to the role of the teacher and method of instruction in the classroom. These new trends in pedagogy demand an orientation in the roles of teachers in the teaching service. Hence teachers should be 'adaptive experts' in education and their training should not end with the award or receipt of teaching certificate but must constitute life-long learning through continued teacher professional development (Darling-Hammond, 2006).

Furthermore, teachers have been implored to juggle between direct instruction and a more discovery-based form of open-ended teaching and learning activities to improve students' performance (UNESCO, 2004). The case of quality in-service professional development of teachers coupled with supportive school community of practice is essential to ensuring that reforms in teaching and learning reach the classrooms for effective implementation and sustenance (Santiago & Mckenzie, 2006). This underscores the recognition of teachers as envisaged in the Ghana Education Strategic Plan (2003-2015) that no education system can rise above the quality of its teachers. Thus, the government of Ghana among other things will continue to give major support to teacher education in all the educational planning activities of the country. Teachers are pivotal in every quality education. If they exhibit apathy, lack of commitment, inspiration, zeal and motivation, the whole country will literally sink. If teachers have perceived difficulty in their subject areas and deliver wrong knowledge to students, these students will be a burden and a threat to national development (Musa, 2005).

The National Science Teachers Association (NSTA) in the United States has also made some recommendations for science teachers' educational training support. NSTA (2006) therefore recommends the following to guide science teachers in their laboratory instructions. These are:

1. Regular professional development opportunities to ensure that science teachers have practical experiences that familiarise them with the pedagogical techniques needed to facilitate inquiry-based laboratory instruction that resonate with the appropriate science content (NSTA, 2006).

2. Yearly evaluation of the laboratory investigation to determine if they continue to be an integral and effective part of the whole program and delivery of all contents.

3. Periodic training in laboratory logistics including setup, safety management of materials and equipment, and assessment of student's practices. Safety equipment and annual safety training should be provided so that science educators become well informed about yearly changes in safety procedures to ensure that student and educators are protected.

4. Training to work with students with academic or remedial needs, physical needs and gifted and talented students so that teachers can differentiate instructions appropriately. Assistive equipment, additional personnel and facilities modified as needed, should also be provided to ensure equity in instruction of all students during laboratory work.

5. Effective pre-service programs that prepare teachers to carry out science activities in the laboratory as a central part of every science curriculum. Educational training institutions therefore need to incorporate programs that will prepare science teachers well enough for activity-based learning such as laboratory work to enable them improvise instructional materials when the need arises (Taale & Antwi, 2009). Osborne, Simons and Collins (2003), therefore concluded that the single most vital change that could be effected to improve the quality of science education would be the recruitment and retention of able, bright enthusiastic science teachers. An improvement in senior high school students' performance in integrated science however, may be realised among other things, if teachers are supported, trained adequately and well-motivated.

This work hopes to bridge any existing gap especially in the area of perceived science topic difficulty amongst students and science teachers.

2.6 Students' Attitude towards the Study of Science

Attitude is considered as "the sum total of a person's inclinations and feelings, prejudice and bias, preconceived notions, ideas, fears, as well as threats and convictions about a specific topic" (Abdalla, 1991). The expression "attitude towards science lessons" therefore signifies all that an individual feels and thinks about science lessons as a result of interacting directly or indirectly with various aspects of science activities, which exert a direct influence on his/her behavior towards the study of science (Ampiah, 2004). Students' attitude towards science in general has been of interest to many science researchers (Osborne, Simon & Collins, 2003) as it is considered to be a necessity in the teaching and learning of science.

Ampiah (2004) reviewed that the science laboratory environment notwithstanding has both intrinsic and extrinsic factors inherent in student's attitude towards science. A study by Starke and Gray (1999) on the contrary, reported that much of what goes on in science learning environment does not attract students across all ages. Other studies on students' attitude and achievement in science however reported of a positive correlation between these variables (Cheung, 2009; Offei-Koranteng, 2013; Weinburgh, 1995). Consequently, a well-designed science learning environment must have what it takes in terms of human resource and material support to attract and sustain students' interest in science education so as to improve performance. According to Ampiah (2004), attitude has three essential features namely; affective, cognitive and behavioural. He further elaborated their distinct characteristics as follows;

The affective has to do with expressions of likes and dislikes, pleasant and unpleasant feeling towards an object. The knowledge about the nature and identity of the object represents the cognitive aspects while the desiring movement towards or away from the object becomes the behavioural. In a survey of over 1400 students in England, it was reported that 71% chose doing experiment in class as one out of three methods of teaching and learning science they 'found enjoyable' (Cerini, Murray & Reiss, 2003). Most students normally patronise science practical activities when it is well organinsed. Many studies conducted in the past have reported that females (girls) have less positive attitudes towards the study of science compared to males (boys) who have a more positive attitude (Breakwell & Beardsell 1992; Erickson & Erickson; Hendley et al. 1996; 1984; Jovanic & King, 1998; Kahle & Lakes, 1983). Conversely, some previous studies have also reported contrariwise, citing empirical evidence in the past where females (girls) have demonstrated a more positive attitude towards science topics than males (boys) (Colley et al., 1994; Elwood & Combar, 1995; Havard, 1996; Lightbody & Durndell 1996; Whitehead, 1996). From the foregoing discourse, the joy and fun aspects of science activities coupled with a good learning environment may be responsible for the attraction and sustenance of their interest to learn the concepts effectively. This ultimately improves students' positive attitude towards science practical activities. Benette, Rollnick, Green and White (2001) reported that students who had less positive attitude towards science practical activities achieved low scores in examination. Science practical examination is compulsory for all students especially at the SHS level. A student must perform creditable in both theory and practical to secure a good grade in the examination. Science learning environments therefore ought to be designed to elicit positive depositions in students' attitudes to make learning interesting and optimize performance. Various researchers have however expressed the complexity involved in measuring attitude in education yet a person's response to a given statement suggest his actions and inactions. Thus, it may be measured using the Likert scale (Abdalla, 1991).

2.7 Studies on Teachers' Perception

Ghana's development rest partly on the expertise of scientific literate citizens who through the school system has acquired some necessary skills from teachers through the existing educational policies and curriculum reforms. Perception has been found to be the result of a person's attitude. For instance, two individuals having diverse perceptions may look at the same thing and conceive entirely different thoughts to exhibit different attitudes.

According to Adediwura and Tayo (2007), attitude may be defined as a consistent tendency to respond in a particular manner either negatively or positively with regards to a specific situation. Attitude may have both cognitive and emotional dimensions Fazio and Roskes (1994) (as cited in Davis, 2010). Attitudes have been of concern to educational psychologist over the years due to the positive influence it has on how the society perceive things around them.

Eggen and Kauchak (2001) reported that positive attitude portrayed by teachers contribute to effective teaching and learning. The teacher therefore ought to explore possible approaches to woo students and sustain their interest with respect to the lesson to be taught so as to obliterate the elements of distraction during the lesson delivery.

A study conducted by Eggen and Kauchak (2001) listed some attitudes of teachers that could enhance the instructional delivery in the classroom. These attitudes are, the teacher should be full of enthusiasm, caring, firm, exhibiting democratic principles to make students responsible, effective use of instructional period, interacting freely with students and agent of motivation. Several educators, researchers and psychologists, have enumerated some of the variables that influence students' performances academically.

Davis (2010) reported that the academic performance of a student is dependent on the individual's innate traits of intelligence and other sociological factors. These sociological factors may include the attitude and perception of individuals involved in the education system. Ojerinde (1981) as cited in Davis (2010), also identified some personality factors that have profound effect on students' academic performance. He went on to mention factors like motivation, achievement, anxiety the state of interest of students. The implication is that, teacher variables such as knowledge of subject matter, teaching skills, classroom attitude, qualification and professional experience have a toll on student's performance.

According to studies by Mensah and Somuah (2013), teachers' perceptions about the teaching of science with emphasis on the challenges and appropriate prescription revealed that Integrated Science teachers conceded that the subject is broad and diverse in nature. The implication is that integrated science teachers ought to have good content knowledge in chemistry, physics, biology and Agricultural science with some level of technology in other to handle the subject effectively. It was again reported that some integrated science teachers struggled to teach topics like basic electronics, electricity, chemical bonding and that teachers have different perspectives about how students learn. The results of the study indicated that, a number of science teachers revealed some level of difficulty exhibited by students in dealing with scientific concepts and terms.

A study conducted by Warnick, Thompson and Gummer (2004), on perception of science teachers with regards to the integration of science into the agricultural education curriculum has shown that a number of Oregon science teachers support the integration of science in the agricultural education curriculum since agriculture is considered as an applied science. According to the Science teachers there is a huge benefit for student in the event of integrating science into the agricultural education curriculum. Over 50% of science teachers engaged in the study however raised some concerns grappling the integration of science concepts into the agricultural education curriculum. These concerns were teacher's lack of an agricultural background, lack of funding and equipment, lack of an integrated science curriculum, and lack of agricultural science workshops.

Consequently, science teachers and agriculture teachers ought to join forces to solicit for external support that emphasize integration of science curriculum. It was suggested that teacher training programs in agriculture education ought to be reviewed to reflect the amount of pure science offered at the undergraduate level to ascertain if there are appropriate science topics that can be incorporated into the undergraduate program. According to studies conducted by Edu and Edu (2013) on student's attitude and experience as influencing variables of teachers' perception of difficult concepts in primary science reported that significant difference exists between perception of difficult topics in Primary Science curriculum by teachers who are positive and others who are negative in their attitude towards the subject.

2.8 Relationship between Teachers' and Students' Perception

Results of studies on the relationship between students' and teachers' perception in science have been equivocal. Literature has indicated that evaluation of perceived difficulties of participants in a given area of study makes use of test and non- test methods. The test may be 1. Multiple choice test items (objectives) 2. Short answer test items (subjective) 3. Use of internal and external examination outcomes. The non-test methods include 1. Observations 2. Interviews 3. Questionnaires the non-test method was used by Leece (1976) to obtain students' and teachers' perception of the level of difficulty of all the 19 curriculum topics of an "A" level Nuffield chemistry. The respondents had to indicate the difficulty of each of the topics on a 4-point Likert scale. [The responses ranged from "much harder than average" to "much easier than average"]. An approximate facility index was calculated for each topic resulting in high positive rank correlation between teachers' and students' perception of the topics. This was contrary to the general expectation of negative correlation between teachers' and students' perceived chemistry topics. Students' interest in amount of substance was lowest but highest in atomic structure and carbon chemistry. Topics in physical chemistry listed as difficult included equilibrium and free energy, and equilibrium involving redox and acid base systems as well as gaseous and ionic systems, energy changes and bonding. Amount of substance and periodicity were among the easiest. These difficult topics require a wide range of mathematical skills and knowledge of many basic chemical concepts including molarity of solutions, mole concept, and ionic equation and balancing of chemical equations. Furniss (1977) used a combination of tests non-test method to investigate difficulties encountered in chemistry. Two sets of students were involved in the study sixth formers and first year chemistry undergraduates. Both groups took two sets of tests.

The sixth formers had a test before the final examination and another test a month after the final examination. A section of the paper inquired about topics they had found difficult, easy or enjoyable while their teachers' problems and attitudes towards the 'A' level chemistry were also investigated. The undergraduates had one test before and the other after the year ended. Only their perception of organic chemistry was tested. The perceptions of teachers and students in the sixth form group were at variance.

Thus, while students indicated that carbon chemistry, energy changes and bonding were difficult to learn, teachers indicated that these were easy to teach. Two other areas which students had difficulty with were reaction rates, equilibrium and free energy. The teachers also regarded periodicity and atomic structure as easy to teach. In organic chemistry, functional groups, structure, isomerism and nomenclature were found to pose difficulties. This study recommended the necessity to relegate certain topics from the sixth form chemistry with the caution that the harm that may be done by material that is incorrectly learnt and misunderstood is difficult to right and hinder subsequent learning. Besides, some of the teachers involved in the survey admitted their lack of knowledge in certain aspects of chemistry. A much-simplified non-test method, which does not even relate to topics in science was used by Dunne and Rennie (1994) to obtain students' perceived difficulty in science as part of a broader survey on gender, ethnicity and science. The statements; "Science is too difficult for me" "I find science easy to understand" had to be completed with responses ranging from "very difficult" to "very easy". The simplicity of the study on perception gives evidence that when afforded the opportunity, students readily provide their perceptions of a given topic. In Ghana the non-test method has been used by Apafo (1992) (as cited in Wood, 1994) to explore the perceived difficulties of students with the 'O' level chemistry. Anamuah-Mensah and Apafo (1986) used the same method to investigate teachers' reactions to the 'A' level chemistry syllabus. Both studies were necessitated in part by the relatively low achievements by students in the final examinations. In both studies, the instruments used consisted in part, of the topics in the respective syllabuses to which the respondents reacted. The 'O' level group made up of both remedial and lower six form students had to indicate which topics were easy or difficult to grasp, never grasped or not taught. The study revealed that, students had difficulty with almost all the 46 topics. Solubility, electrolysis, redox reactions, energy changes, metals and non-metals were found to be among the most difficult to grasp by students. Organic chemistry was not listed.

Since the respondents were not given the chance to indicate possible sources of some of their difficulties; they were limited in attributing their difficulties to either the nature of the topics or the intellectual developmental level of the students. The teachers had to indicate which topics were taught with ease or difficulty and which were not taught and reasons for any difficulties. The result showed that teachers had difficulty with orbital nature of atoms, benzene and its aromatic systems and they did not teach many topics in the application section as they spent too much time on principles.

The reasons given by less than 20% of the sample for finding a topic difficult included the following; 1. Too many topics in the syllabus 2. Teaching period being too short 3. Being comfortable with certain aspects of the topics 4. The abstract nature of some topics 5. Lack of reference books. In this study, the non-test method based on respondents' reaction to the topics of the syllabus was adopted. Its advantage over the test method is its time and cost effectiveness. Its limitation is that, it cannot unlike the test method, isolate either the causes or the exact problems causing a respondent's difficulty on specific topics.

Shaibu and Olarewaju (2007) for instance in their study which sought to find the perception of difficult biology concepts among senior secondary school students and teachers found that there was no significant relationship between the students' and the teachers' perception of the difficult biology concepts. However earlier study by Shaibu (1988) on the relationship between teachers and student's perception on chemistry found out that there was a statistically significant difference between their perceptions. Shaibu and Olarewaju (2007) therefore suggested that: "The question of whether or not significant differences exist between the perception of students' and their teachers regarding the conceptual difficulty levels of various school subjects need further investigation and clarification in the continued search to improve the quality of teaching and learning of science generally and biology specifically".

According to Adediwura and Tayo (2007), students' perception of teachers' knowledge of subject matter, attitudes to work and teaching skills is absolutely dependent on the fact that they have been taught by the teachers under evaluation and are familiar with them. They therefore, have minds already preoccupied with memories and reactions that inventory for data collection would measure. Perception may be energized by both the present and past experience, individual attitude at a particular moment, the physical state of the sense organ, the interest of the person, the level of attention, and the interpretation given to the perception.

Eggen and Kauchak (2001) highlighted three headings under which a study on teachers' knowledge of subject matter can be done. These are namely: knowledge of content, pedagogical content knowledge and general pedagogical knowledge. It is a statement of fact that nobody can teach what he does not understand. It has been established that there is high correlation between what teachers know and what they teach (Adediwura & Tayo, 2007). Thus, the ability to teach effectively depends on the teachers' knowledge, and knowledge occurs in a variety of forms. Teacher effectiveness is impeded if the teacher is unfamiliar with the body of knowledge taught and when teachers' effectiveness is subject specific. The implication of this for teachers is that they must thoroughly understand the content of what they teach. The teacher whose understanding of topic is thorough use clearer language, their discourse is more connected, and they provide better explanation than those whose background is weaker. The way the students perceive the teachers in terms of their (teachers) knowledge of content of subject matter may significantly affect the students' academic performance (Adediwura & Tayo, 2007). Behar and Polat (2007) alluded that the passive roles of students in the classroom and their perception about the teacher as the repository of knowledge, as contributing to the perceived difficulty of science topics. Pedagogical content knowledge depends on an understanding of a particular topic and how to explain it in a way that it will make sense to the students. Pedagogical content knowledge implies, an understanding of ways of representing the subject matter that make it comprehensive to others and an understanding of what makes the learning of specific topics easy or difficult. Eggen and Kauchak (2001) declared that where pedagogical content knowledge is lacking, teachers commonly paraphrase information in learners' textbooks or provide abstract explanations that are not meaningful to their students. From evidences available in literature, it is clear teachers' knowledge of subject matter is highly essential for effective teaching. Ehindero and Ajibade (2000) confirmed that a teachers' teaching is influenced by the level of his pedagogical knowledge, as different from his subject matter knowledge. It is to be acknowledged that knowledge about instructional method is different from knowledge pertaining to the content of the subject. They are however ultimately yoked, since teachers' content delivery in the classroom also indicate how knowledgeable in the area of subject matter. Lang, Wong and Fraser (2005) carried out some studies about the chemistry laboratory classroom environment, teacher-student interactions and student attitudes towards chemistry among gifted and non-gifted secondary-school students in Singapore. The data collected involved the use of 35-item Chemistry Laboratory Environment Inventory (CLEI), the 48-item Questionnaire on Teacher Interaction (QTI) and the 30-

item Questionnaire on Chemistry Related Attitudes (QOCRA). The outcome proved the validity and reliability of the CLEI and QTI for the sample under consideration. Their study had the purpose of, validating the Chemistry Laboratory Environment Inventory (CLEI) and Questionnaire on Teacher Interaction (QTI) among Grade 10 students in Singapore; investigating stream (gifted versus non-gifted) and gender differences in classroom environment perceptions on (a) the actual and preferred forms of the CLEI, (b) the actual form of the QTI. and investigate associations between student attitudes to chemistry and students' perceptions on (a) the CLEI, (b) the QTI.

Lang et al. (2005) inquired from the teachers' point of view whether the findings could be of assistance to chemistry teachers so as to have some reflection about the various aspects of the chemistry laboratory, their interactions with students and their teaching strategies in the environment. In the case of the students, the findings presented a better understanding of the students' perceptions on the prevailing and expected chemistry laboratory classroom learning environment and the teacher–student interactions that could help the gifted student, the non-gifted, to have some improvement in the future. The findings with the QTI indicated that there should be the need to be more aware of dynamic teacher–student interactions taking place in the classroom with an understanding of the dynamics involved in the process of communication, the learning environment can therefore be managed in a better way. The study again revealed that the interpersonal behaviour of teachers has an effect on the students' attitudes towards chemistry.

2.9 Attitude of Students towards Science Practical Activities

Attitude is considered as "the sum total of a person's inclinations and feelings, prejudice and bias, preconceived notions, ideas, fears, as well as threats and convictions about a specific topic" (Abdalla, 1991). Attitude is therefore a predisposition of an individual towards classification of objects and events in order to have a reaction with consistency in evaluation. An individual who exhibits some kind of attitude towards something is reacting according to the conception of that item other than to its actual state. People normally form attitude based on some kind of learning experience, if the experience is favourable to the person a positive attitude is formed and vice versa (Orunaboka, 2011). The attitude held by an individual could influence the way they act as a person and other circumstances. Human attitude can therefore be developed and changed. Attitude is not all about negativity such as prejudices, biases and dislikes, but also positivity which is sometimes termed as sentiment, which involves our attachment and loyalty to others, objects and ideas (George, 2000). Human attitudes are not innate, they are learnt from the environment. Some attitudes may be due to individual experience, knowledge and skills gained from other sources. However, attitude is not stagnant but rather dynamic over a period of time at a gradual pace (Olasheinde & Olatoye, 2014). Fasakin (2011) reported that attitude is a major determinant in the choice of subject at school.

The term "attitude towards science practical" is therefore used to indicate all that an individual feels and thinks about science practical work as a result of interacting directly or indirectly with various aspects of science practical activities, which exert a direct influence on his/her behavior towards science practical work (Ampiah, 2004). Students' attitude towards science practical has been of interest to many science researchers (Osborne, Simon & Collins, 2003) as it is considered to be a necessity in the teaching and learning of science. Ampiah (2004) reviewed that the laboratory environment notwithstanding has both intrinsic and extrinsic factors inherent in student's attitude towards science. A study by Starke and Gray (1999) on the contrary, reported that much of what goes on in science instructional environment does not attract students across all ages. Other studies on students' attitude and achievement in science however reported of a positive correlation between these variables (Weinburgh, 1995; Cheung, 2009 cited in Offei-Koranteng, 2013). Consequently, a well-designed science laboratory for practical lessons should have what it takes in terms of human resource and material support to attract and sustain students' interest in science practical activities to improve performance. According to Akinmade (1992) cited in Ampiah (2004), student's attitude has three essential dimensions namely; affective, cognitive and behavioral. He further elaborated their distinct characteristics as follows;

The affective has to do with expressions of likes and dislikes, pleasant and unpleasant feeling towards an object. The knowledge about the nature and identity of the object represents the cognitive aspect while the desiring movement towards or away from the object becomes the behavioral. Science learning environments therefore ought to be designed to illicit such depositions in students' attitudes to make learning interesting and optimize academic performance. Various researchers have however expressed the complexity involved in measuring attitude in education yet a person's response to a given statement suggest his actions and inactions. Student's attitudes with respect to interest in science has been found to be dependent on the content of the science curriculum, duration for lessons, method of teaching and availability of a well-resourced laboratory (Freedman, 1997).

2.10 Empirical Framework

There has been a number of empirical studies on concepts and perceptions with regards to topic difficulty in integrated science across the educational lather globally.

Davis (2010), investigated students' and teachers' perceptions of organic chemistry topics in the SSS chemistry syllabus. The study compared the perception of students with that of their teachers with the view of finding out whether perceptions were correlated. The sample was drawn from 10 senior secondary schools in the Central

Region where students had already treated organic chemistry. The survey method was used and questionnaires were administered to 300 chemistry students' and their 35 teachers. The study showed that the SSS chemistry students perceived 14 out of the 31 organic chemistry topics in the syllabus to be relatively difficult to learn. Chemistry teachers on the other hand perceived all the 31 topics to be relatively easy to teach. The results also revealed that significant difference existed between male students' and female students' perception of the difficulty level of organic chemistry topics.

Ogunkola and Samuel (2011) carried out an investigation on the perception of students and teachers of the difficult topics in integrated science of lower secondary school's curriculum in Barbados; to ascertain whether there were statistically significant differences in (a) students' perception and teacher perception of difficult topics and (b) students' perception of difficult topics based on their gender, interest in science, study habits and school location and school category. Teachers and students were presented with separate questionnaires to give response. Students' questionnaire consisted of three sections. a.) An interest scale: students were to complete a five-point Likert scale with 15 items designed to measure the level of students' interest in science. b) A study habits inventory: consisting of 15 items arranged in a two column Likert scale (agree/disagree) constructed to measure students' study habits. c) A topic difficulty scale: consisting of 26 science topics arranged in a rating scale. Students were to give responses about how difficult or easy they perceive each topic. Teachers' questionnaire on the other hand had two sections. a.) Demographic information about teaching experience and qualifications. b.) Topic difficulty scale: same as the 26 science topics on the students' questionnaire designed to measure teachers' perception of the difficulty of teaching the topics. Results from the study indicated that unlike the students, the teachers generally revealed little difficulty in teaching most of the listed topics.

However, few teachers expressed difficulty with the teaching of some topics like; acids and bases, light and the eye, sound and the ear, energy, physical and chemical changes. The findings of this study revealed that some integrated science topics in the syllabus are perceived to be more difficult especially with physics and chemistry than others, and that teaching strategies required to override the status quo may be a suspect to the difficulties experience by students in science education in general.

Kihwele (2014) conducted a study on students' perception of science subjects and their attitudes in Tanzanian Secondary Schools. He found out that most secondary school students (in boarding house) drop science subjects. Some students believe they have low ability to pursue science subjects. According to the research, students are not interested in science because they believe science is difficult and requires high mental acumen to understand the concepts involved. It also involves lots of calculations and uses complex language although students were not doing well in English and Mathematics subjects. They responded that science subjects were difficult and if they had their own way, they would drop biology and mathematics yet they were compulsory per the program they were pursuing in the school.

Ennin (2015) carried out an investigation into topic difficulty in Integrated Science perceived by selected senior high school students and teachers in Gomoa East district in the Central Region of Ghana. Her study involved 300 Integrated Science students and 15 Integrated Science teachers from two public senior high schools in Gomoa East district in the central region of Ghana. Her research revealed that science topic difficulties existed among students and teachers of Integrated Science. Again, there was significant difference between male and female science students' perception of topic difficulties. Both students and teachers gave reasons such as science subject is full of mathematics and diagrams, unavailability of prescribed textbooks, poor teaching methods by teachers among others. She concluded that the topics that both teachers and students perceived to be difficult are the same ones that WAEC's Chief Examiner's Report (2010-2011) indicated as posing difficulties to S.H.S science students. She therefore recommended some strategies to be adopted by teachers to help themselves and their students in making the perceived difficult topics in the S.H.S Integrated Science syllabus, less difficult.

Sakpaku (2016) researched into the perceptions of integrated science topics by teachers and students in the JHS integrated science syllabus. His study compared the perception of students with that of their teachers'. The study adopted the survey method involving 300 Form three (3) Junior High School students and 30 Integrated science teachers within 56 public Junior High Schools in Ketu-North District of Volta Region in Ghana. The study revealed that JHS 3 students perceive 8 (eight) out of 43 integrated science topics as being difficult to learn comparatively. According to the research, Integrated science teachers perceived 8 out of 43 topics to be relatively difficult to teach by about 20%. It was therefore suggested that, in-service training and workshops should be organized for teachers regularly by educational authorities so that teachers can teach concept such as basic electronics, chemical compound, acids, base and salt, electrical energy among others with ease.

Finally, Awere (2018) investigated science (chemistry) topic difficulty as perceived by SHS students and how the available textbooks and teachers can help to address the difficulties. The study employed the descriptive survey design with a population of 280 SHS 3 science (chemistry) students and sixteen teachers in eight schools from five administrative districts in Western Region of Ghana. It was established at the end of the studies that, students perceived nine (9) out of the twenty carefully selected topics in the SHS curriculum to be difficult. The respondents attributed the topic difficulty to;

abstract nature of the topics in the syllabus, lack of practical activities, unavailability of prescribed textbooks, and uninteresting lessons. The study also concluded that, no significant difference existed with regards to the topics perceived to be difficult by both male and female students. Again, it was revealed that science (chemistry) teachers' instructional strategies contributed to students' perceived topic difficulty in the selected schools. From the foregoing discussions it is increasingly evident that science topic difficulty is prevalent and that more studies ought to be carried out to help address the challenges identified.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter deals with the methodology that was followed in carrying out this study.

The following sub headings were considered under this chapter:

- Research Design
- Population
- Sampling Technique/Procedure
- Research Instruments
- Validity of Instruments
- Reliability of Instruments
- Data Collection Procedure
- Data Analysis Procedure

3.1 Research Design

Research design is a detailed "blueprint" or framework for the process of collecting, discussing, analysing and interpreting data/information as well as related literature in order to enhance the drawing of inferences and arriving at final conclusions based on the relationships between and among the variables of interest in the study (Creswell, 2003). This study employed the descriptive survey design to determine SHS 3 students' and teachers' perception of the extent of difficulty of integrated science topics in the syllabus. The design involved both integrated science students' and teachers' groups from two (2) Senior High Schools in the Central Region of Ghana. These two schools were University Practice Senior High and Effutu Senior High Technical. The questionnaire used contained both closed-ended and open-ended questions. This was administered to both SHS Form three students and their integrated science teachers.

The questionnaire sought to gather information from SHS students and their integrated science teachers about their perception on the topics in the integrated science syllabus. The independent variables were gender and the type of respondents, whilst the level of perception for the students and teachers was the dependent variable.

3.2 Population

According to Agyedu, Donkor and Obeng (2011), research population is a complete set of individuals (subjects), events or objects with clear observable features for which a researcher is interested in studying. The target population for this study was S.H.S 3 students offering integrated science and their integrated science teachers in the public Senior High Schools in Ghana. Subsequently, the accessible population was made up of S.H.S 3 students within the public Senior High Schools in the Cape Coast metropolis of Central Region. S.H.S 3 students were the focus because they have covered a greater part of the topics in the integrated science syllabus and were in a better position to give responses about it. There were 76 public S.H.S in the Central region in 2020/2021 academic year. All the 76 SHS offered integrated science as a compulsory core subject. Out of the 76 schools, three were boys' School, three were girls' School and 70 were co-educational. Out of these 76 S.H.S, ten were located within the Cape Coast Metropolis. The schools used for the study were University Practice SHS and Effutu SHTS which were co-educational (boys and girls). Cape Coast Metropolis was chosen for the study due to proximity and researcher's familiarity with the area. There were about 9,615 SHS 3 students and 108 integrated science teachers in all the 10 Senior High Schools in the Cape Coast Metropolis in 2021/2022 academic year.

3.4 Sample and Sampling Technique

Purposive sampling technique was employed in the selection of the schools for the study. According to Makhado (2002), the use of purposive sampling techniques is important because it allows the researcher to select subjects that will furnish him /her with the needed information to help achieve the purpose of the research. Out of the Ten (10) SHS in the metropolis two were selected purposefully for the study. These two schools have treated most of the topics in the integrated science syllabus by the third year and were having mock final examinations. A total of 103 students were sampled from the first school (University Practice SHS) and 104 students from the second school (Effutu SHTS) to make a total of 207 for the study. Eighteen (18) integrated science teachers were purposefully sampled for the study since some teachers teach only an aspect of integrated science and not the entire subject. Nine (9) teachers were chosen from each of the two schools for the study to make a total of 18 integrated science teachers.

3.5 Research Instruments

This study involved the use of questionnaire as the main instrument. Questionnaire was used because it is effective in gathering information and ensures anonymity of respondents (Macmillan, 1996). The questionnaire was in two-fold; ‘‘Questionnaire for Integrated science teachers’’ (QIT) and ‘’Questionnaire for students ‘’ (QS). A 5-point Likert scale type of questionnaire was employed. The structure of the instruments was crafted from previous studies in the area of perceptions (Ampiah, 2001; Davis, 2010; Awere, 2018) and was modified to suit this study. The questionnaire was filled at the respondent’s own convenience within the period allotted. Moreover, it offered assurance of anonymity.

3.5.1 Questionnaire for students (QS)

Questionnaire for students (QS) was used to obtain the necessary information from the SHS 3 students on their perception of the difficulty of integrated science syllabus topics. The topics contained in the students' questionnaire (QS) was based on the integrated science teaching syllabus (2010) provided by G.E.S. The students' questionnaire had two sections; A and B. Section A, contained three items for gathering background information on class, age and gender of student respondents. Section B had 50 items, 1 to 48 to solicit free responses on the topic difficulty in the integrated science syllabus based on a 5-point Likert scale. Items 49 - 50 were open ended questions to seek for some of the reasons for the perceived topic difficulty amongst students (Appendix, B).

3.5.2 Questionnaire for Integrated Science teachers (QIT)

Questionnaire for Integrated science Teachers QIT was used to obtain information from the S.H.S integrated science teachers on their perception on topics in the integrated sciences syllabus. The (QIT) was based on the Ministry of Education (2010) S.H.S teaching syllabus for integrated science. The questionnaire was in two sections A and B. Section A was made up of 4 items for soliciting demographic information including teaching experience, gender, area of specialty and qualification. Section B contained a total of 50 items.

Items 5 - 48 covered all the topics under the S.H.S integrated science syllabus. Items 49 - 50 were open ended questions. To respond to the items, the respondent was required to indicate his or her perception on the teaching of each topic listed on a five (5) point Likert scale. (Appendix, A).

3.6 Validity of the Instrument

The designed questionnaire items were given to my supervisors for their comments and suggestions. The supervisors, integrated science teachers and postgraduate colleagues in the area of science education were allowed to go through the items to determine if the items measure the intended content area (face validity) and whether they covered the whole content area (content validity). The comments and suggestions from them, helped with the modification of items in the questionnaires. Furthermore, factors that may contribute to the low validity of the questionnaires such as unclear directions, reading vocabulary and sentence structures, poor item construction and ambiguities in language construction were eliminated before administering to the target population.

3.7 Reliability of Instrument

The reliability of an instrument is about the consistency of the scores obtained over time on a population of individuals irrespective of time differences and the scorers (Amedahe & Gyimah, 2008). The instruments were therefore pilot-studied in Kwegyir Aggrey Senior High Technical School and Methodist Senior High School all in the Mfantseman district of the Central Region. These selected Senior High Schools had similar characteristics to the target schools. The instrument was trial tested using 40 form three (3) students and six integrated science teachers. Their responses were analysed to test for the reliability of both QS and QIT Cronbach's Alpha Coefficient was used to calculate the reliability of the pilot study. The Cronbach's Alpha coefficient found to be 0.96 for the students and 0.85 for teachers. The results indicated that, the instrument was reliable from the pilot-test and could be administered to the target population.

3.8 Data Collection Procedure

An introductory letter was sent personally by the researcher to seek permission from the various Senior High schools involved in the study. The School Heads of the sampled institutions notified their respective Heads of science departments. The researcher made a follow up by paying a visit to the school after two days to ascertain the acceptance of the permission letter and to meet the authorities, heads of science departments and integrated science teachers to arrange for a convenient time for the administration of the questionnaire. A meeting was scheduled with each of the Heads of science departments with regards to the appropriate day and time for the questionnaire administration. The selection of respondents was done with the help of the Heads of departments a day before the actual day for collection of data. The purpose and relevance of the study was made known to all the respondents involved in the study immediately after their selection. The instruments were hand-delivered to each of the respondents involved in the study on the day of administration in the first school. Integrated science teachers were given their questionnaire in the staff room after the researcher had reminded them to read the instructions carefully before giving their responses. Questionnaire for students were administered after that of the teachers in their classrooms. The researcher moved to the second school the next day and repeated the same exercise. Students' questionnaires were administered a day after that of the teachers. The heads of science departments assisted with the collection of the questionnaire on the same day. In all it took one week to collect the data from respondents in the two schools involved in the study.

3.9 Data Analysis

The data were analysed using the research questions as a guide. This was organized and coded with various numbers assigned to each variable such as age, gender among others for students and also gender, age range, academic qualification, teaching experience, subject specialty among others with respect to teachers. Inputs were made of the coded data using the Statistical Package for the Social Sciences (SPSS) computer software. Data were then analysed using frequency tables, percentages, pie chart, clustered graph, mean, standard deviations and independent t-test. Students' perceived difficulties with integrated science topics at the S.H.S level was analysed by the use of means and standard deviations. The items in section "B" of the questionnaire for the students were assigned values on a five-point Likert scale. It must be noted that in scoring students' responses on the Likert scale items, "Not Difficult to Understand" scored 1 point, which happened to be the minimum on the scale. If the response was "Sightly Difficult to Understand", 2 points was awarded. A response, "Moderately Difficult to Understand" also attracted 3 points, followed by the response; "Difficult to Understand" which also scored 4 points and finally, a response of; "Very Difficult to Understand" scored 5 points, which is the maximum on the scale (i.e 1 – Not difficult to understand, 2- Slightly difficult to understand, 3 - Moderately difficult to understand, 4 - Difficult to understand, and 5 - Very difficult to understand). Since the scale was a 5-point Likert-type scale format, three (3), the mid value was chosen as an average value to which mean scores below it was considered as perceived topics not difficult to be learnt by students. Mean scores above the mean score of three (3) was considered as topics perceived to be difficult to learn by students. The mean and standard deviation scores for each of the topics selected were estimated. Hence, students' perceived difficulties with the topics were determined when a response had a mean of above 3.

The 5-point Likert scale for teacher respondents was also scored as follows, 5 was assigned if the respondent had a high perception of difficulty towards the integrated science topic, that is if the topic is very difficult to teach, 4 corresponds to topics found difficult to teach, 3 is interpreted as moderately difficult to teach, 2 corresponds to slightly difficult to teach and 1 is assigned to topics found to be not difficult to teach. Again, mean score above 3 was perceived as difficult to teach and mean score below 3 is considered not difficult to teach. For the main hypothesis of the study, whether differences exist between male and female perceived topic difficulties in the integrated science syllabus was determined by conducting an independent t-test for samples (male and female students). Thus, an independent t-test for the two independent samples was performed to determine if there was a significant difference in the difficulties as perceived by these two groups with respect to the integrated science subtopics and main topics (sections).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

The purpose of this study was to find out perceived topic difficulty in the integrated science syllabus amongst students as well as (integrated science) teachers in two public senior high schools in the Cape Coast Metropolis. In this chapter, the findings from the study are presented and discussed in the context of available literature and previous studies. The discussion and analysis of the results presented in this chapter are based on the research questions of the study. Frequency tables, pie chart, clustered graph, mean, standard deviations and two tailed independent sample t-test were used to analyse the findings and present the results.

The research questions formulated to guide the study were:

1. What topics in the integrated science syllabus are perceived as difficult to learn by SHS students?
2. (a) What topics in the integrated science syllabus do SHS teachers perceive as difficult to teach,

   (b) and what are the reasons for the difficulty?
3. Is there significant difference in the topics perceived to be difficult by SHS students compared to their teachers?
4. Is there significant difference in SHS students' perceptions of difficult topics based on their gender?

4.1 Demographic Data on Respondents

4.1.1 Demographic data on student respondents

A total of 207 students from two selected schools took part in the study. Table 4 shows the gender of students involved in the study.

Table 4: Students' Demographic Characteristics

Gender	Frequency	Percentage (%)
Male	110	53.10
Female	97	46.90

Source: Field work, 2021/2022 academic year

The age distribution of student respondents is presented in Figure 1.

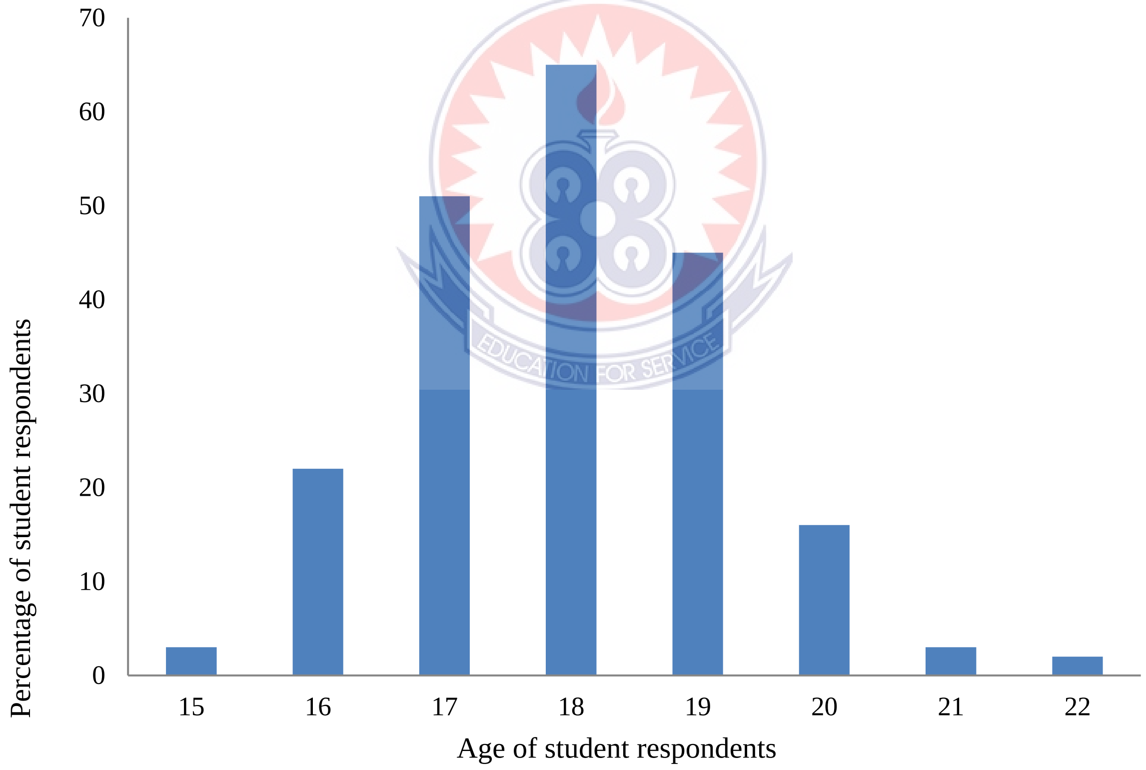

Figure 1: Age distribution of student respondents

Table 4 and Figure 1 presents gender characteristics and age distribution of the student respondents respectively. Out of the 207 respondents, majority (110) were males and the remaining (97) were females. This reveals that male students were more than females in the study. A greater proportion of the students' respondents were below 20 years (89.70%) and only a few (10.30%) were 20 years and above. This agrees with the Ghana Education Service policy on entry age into SHS. The G.E.S policy stipulate at least 15 years as the threshold for SHS students. Student respondents in this study were all in SHS 3 with expected age above 16 years as confirmed by the results above. It was therefore not out of place to have majority of students in the study between the ages of 17 and 19.

4.1.2 Demographic data on the teachers

There were 18 teachers involved in the study. In all 16 teacher-respondents were males (88.80%) and two (11.20%) were females (Table 5). This suggests that there are a greater number of male integrated science teachers in the Senior High Schools where the study took place. Among the teachers who participated in the study, 38.90% were in the age group 20 – 29 years, 33.33% were between 30 - 39 years and the remaining 27.77% were between 40 - 49 years. The age characteristics pre-supposes that majority of the teachers were (20 - 29) and full of energy for hard work to raise the performance of students. A total number of 15 respondents held a Bachelor's Degree and the remaining three held Master's Degree. Out of the 15 First Degree holders, one was a female and the rest (14) were males. For the teacher respondents with Master's Degree, three were males and one was a female. Following the level of qualification of respondents, they were able to comprehend and give appropriate responses to the questionnaire with ease. Majority of respondents had less than six years of teaching experience (38.89%) (Table 5). Out of the 18 respondents, four (22.22%), three (16.67%), three (16.67%) and one had 6-10 years, 11-15 years, 16-20 years and 21+ years of teaching experience respectively. The implication is that majority of respondents may lack enough experience in the teaching of integrated science. Bandura

(1997) cited in Awere (2018) revealed that, teachers with adequate teaching experience often exhibit high level of confidence and efficiency in handling learning challenges of students. Table 5, further shows that subject specialization was fairly and evenly distributed among the teachers with four specialized in Biology, four specialized in chemistry, another four specialized in agricultural science, three specialized in Physics and the remaining three teachers specialized in integrated science. Deduction from the result on subject specialization indicates that few integrated science teachers (16.67%) have specialized in the teaching of the subject and should be able to handle all the topics in the syllabus. Omosewo (2009), asserted that many integrated science teachers handling the subject in most Senior High Schools are experts in an aspect of science, not in the entire integrated science education. Thus, S.H.S management engagement of non-specialized integrated science teachers to teach the subject holistically may be due to inadequate number of experts in the subject. This is contrary to the policy of Ghana Education Service (G.E.S) which states that S.H.S teachers are to handle subjects based on their specialty. All teachers who participated in the study responded yes to being professional teachers. Again, the Ghana Education Service expect all teachers to acquire professional training in education and all the teachers in the study were in conformity. Table 5 presents the demographic data on Teacher-respondents.

Table 5: Demographic Data of Teacher-Respondents

Variable	Frequency	Percentage (%)
Gender		
Male	16	88.80
Female	2	11.20
Age		
22-30	7	38.90
31-39	6	33.33
40-48	5	27.77
49 and above	0	0.0
Educational Level		
Bachelor's Degree (Males)	14	77.80
Bachelor's Degree (Females)	1	5.55
Master's Degree (Males)	2	11.10
Master's Degree (Females)	1	5.55
PhD	0	0
Years of Experience		
1-5 (Males)	6	33.33
(Females)	1	5.56
6-10 (Males)	4	22.22
11-15 (Males)	3	16.67
16-20 (Males)	2	11.10
(Females)	1	5.56
21 and above (Males)	1	5.56
Subject Specialization		
Biology	4	22.22
Chemistry	4	22.22
Physics	3	16.67
Agricultural science	4	22.22
Integrated science	3	16.67
Teacher professionalism		
Yes	18	100
No	0	0

Source: Field work, 2022

4.2 Perceived Difficulty of Integrated Science Topics by SHS Students

In answering research one, Senior High School Students on the average perceive interaction of matter with the sub-topics: biotechnology, endogenous technology, and atmosphere and climate change as the most difficult integrated science topics which recorded the highest mean scores of 4.41, 4.25 and 3.84 respectively (Table 6). Other topics with high mean scores were hydrological cycle under the main topic cycles (3.95) and nuclear energy under the main topic energy (3.74). The least perceived difficult integrated science topics are matter, introduction to integrated science and diversity of living/non-living things which are all under the main topic; diversity of matter with mean scores of 1.6195, 1.6763 and 1.7826 respectively.

The three most difficult integrated science topics as perceived by the SHS students (biotechnology, endogenous technology and atmosphere/climate change) are all located towards the end of the syllabus (Table 6), which indicates that students may probably be in their final year when being taught such topics and that teachers may race them through the topics under the guise of completing the syllabus. Again, noticeable from Table 6 is the fact that all the least perceived difficult topics are located at the beginning of the integrated science syllabus. The implication is that students may get enough time to go over the topics for a better understanding.

The topic 'air movement' under the main topic - cycles, recorded the highest standard deviation (3.89) followed by the topics 'hydrological cycle' (3.18) and 'general principles of farm animals' production' (2.58) also under the main topic – cycles. Students' perceived difficulty of Integrated science topics is shown in Table 6.

Table 6: Perceived Difficulty of Integrated Science Topics by SHS Students

Integrated Science Topic	Mean	Std. Deviation	N
Diversity of Matter:			
1: Introduction to Integrated Science	1.68	0.90	206
2: Measurement	2.23	1.09	205
3: Diversity of Living/ Non-living things	1.78	0.86	206
4: Matter	1.62	0.70	204
5: Cells and Cell Division	2.44	1.13	202
6: Rock	2.24	1.01	204
7: Acids, Bases and Salts	2.88	1.38	206
8: Soil conservation	2.50	1.42	205
9: Water	2.30	1.45	202
10: Metals and Non-metals	2.36	1.26	205
11: Exploitation of minerals	3.67	1.46	205
12: Rusting	3.55	1.54	204
13: Organic and inorganic compounds	3.48	1.29	201
Cycles			
14: Air movement	3.09	3.89	204
15: Nitrogen cycle	3.23	1.45	205
16: Hydrological cycle	3.95	3.18	203
17: General principles of Farm animals production	3.30	2.58	206
18: Life cycle of pest and parasite	3.27	1.60	203
19: Crop production	2.60	1.62	206
Systems:			
20: Skeletal systems	2.43	1.19	205
21: Reproduction and growth in plants	2.35	1.22	204
22: Food and Nutrition	3.00	2.11	206
23: Dentition, feeding and digestion in mammals	2.81	1.55	206
24: Respiratory system	3.04	1.45	205
25: Transport: diffusion, osmosis and plasmolysis	2.65	1.42	205

Table 6 Cont'd

Integrated Science Topic	Mean	Std. Deviation	N
26: Excretory systems	3.34	1.53	205
27: Reproductive system and growth in Mammals	2.76	1.45	205
28: The Circulatory systems	3.53	1.41	206
29: Nervous systems	3.61	1.48	195
Energy:			
30: Forms of energy and energy transformation	2.38	1.83	206
31: Solar energy	3.03	1.68	202
32: Photosynthesis	2.48	1.55	204
33: Electronics	3.36	2.52	200
34: Electrical energy	3.19	1.47	206
35: Sound energy	3.47	1.61	202
36: Nuclear energy	3.74	1.51	204
37: Light energy	3.07	1.63	199
38: Heat energy	2.76	1.58	204
Interaction of Matter:			
39: Ecosystem	2.87	1.60	202
40: Atmosphere and climate change	3.84	1.50	206
41: Infections and diseases	3.74	1.53	203
42: Magnetism	3.72	1.52	203
43: Force motion and pressure	3.00	1.41	205
44: Safety in the community	3.69	2.07	203
45: Endogenous technology	4.25	1.25	204
46: Biotechnology	4.41	1.04	202
47: Work and machines	2.96	1.52	205
48: Variation and inheritance	3.54	1.54	205

Source: Field work, 2022

Scale: mean score 1 – 2.99 (Not Difficult to Understand), 3.0 (Moderate), 3.1 – 5.0 (Difficult to understand).

Atmosphere and climate change, biotechnology and endogenous technology are sub-topics under the main topic "interaction of matter" while topics such as nuclear energy falls under the main topic "energy" and hydrological cycle falls under "cycles. This finding especially with difficulty with interaction of matter topics corroborates with findings from a descriptive study conducted among some Senior High Schools in the Phillipines (Estacio & Cornejo, 2021). In their study, Estacio and Cornejo reported that High School students identified the science topics "Bioenergetics" and "The Environment – ecosystem, atmosphere and etc" as the most difficult topics. Reasons to this finding are multifaceted. In this study, some plausible reasons could be as a result of unavailability of quality instructional materials and resource center, abstract nature of the topics, overloaded topic content leading to teachers racing to complete lessons, use of English language (foreign language) as the medium of instruction and use of too many technical terms. The use of foreign language (English) as the medium of instruction in Ghanaian Schools have been reported elsewhere as a challenge in integrated science education (Appiah & Beccles, 2022; Ferreira, 2011; Ong, 2004; Quansah et al., 2019; Tan & Tan, 2008). Also, many integrated science teachers handling the subject in most Senior High Schools are experts in an aspect of science, not in the entire science education (Omosewo, 2009). Poor English language proficiency by students affect their ability to read, self-learn and grasp topic contents with ease; while poor English proficiency of teachers could impede the quality of lesson preparation and logical delivery of topic contents which then affects the confidence of the teacher (Ferreira, 2011; Parker et al., 2018). In a study conducted in Efutu in the Central Region of Ghana by Quansah et al. (2019), students expressed better understanding of integrated science topics when delivered in the fante language (local language). One student was quoted as saying

> *"I understand the concepts better when the Fante language is used." Again, "since English language is the accepted language in class, Integrated Science lessons are boring, but when the teacher allows us to speak the Fante language we are able to communicate and make the class exciting".*

The problem with unavailability of quality instructional materials and resource centers has been identified as widespread among senior high schools in Ghana (Azure, 2015; Mudulia, 2012; Quansah et al., 2019). Other studies have also highlighted the use of too many technical terms, content knowledge and inadequate pedagogical skills of some science teachers in Ghana due to poor teacher preparation, medium of instruction, lack of effective supervision and monitoring at school, and poor attitude and interest of high school students (Anamuah-Mensah et al., 2017; Fredua-Kwarteng & Ahia, 2005; Ngman-Wara, 2015; Parker, 2004). Among many reasons given by participants in the Philippines study most students identified the use of many technical terminologies in the bioenergetics topic as a major challenge (Estacio & Cornejo, 2021).

4.3 Topics in the Integrated Science Syllabus that SHS Teachers Perceive as Difficult to Teach

To answer research question two (a) teachers were asked to state five most difficult topics to teach. The results of the teachers' responses are presented in the pie chart in Figure 2.

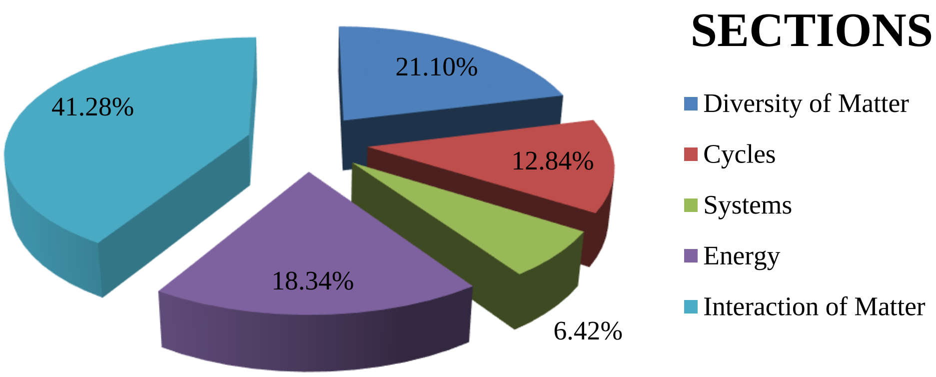

Figure 2: Perceived difficulty of integrated science topics categorized under sections among teachers

Source: Field data (2022)

From Figure 2, 6.42% of the integrated science teachers responded that they had difficulty in teaching topics under the section systems with emphasis on the skeletal system (1.8%) and nervous system (4.58%). A number of teachers (41.28%) found topics under the section interaction in nature such as infections/disease (3.66%), safety in the community (2.75%), endogenous technology (1.8%), biotechnology (12.8%), work and machines (6.4%), variation and inheritance (13.76%) as the most difficult topics to teach. In the case of the section diversity of matter 21.10% of the teachers expressed difficulty in teaching the following topics diversity of living /non-living things (1.8%), exploitation of minerals (3.6%), rusting (1.8%), organic and inorganic compounds (13.76%). With regards to energy as a section, 18.34% of the teachers responded that they have difficulty in teaching the topics such as electronics (16.51%) and solar energy (1.8%). Furthermore, 12.84% of the teachers indicated that they had difficulty in teaching topics under cycles such as nitrogen cycle (5.5%), general principles of farm animals' production (1.8%), life cycle of pests and parasites (3.6%) and crop production (1.8%) (Figure 2).

4.3.1 Teachers' reasons for the most difficult topics to teach in the integrated science syllabus

Following the identification of difficult integrated science topics by S.H.S teachers with regards to research question two (a), the study probed further to explore reasons why teachers find such topics difficult to teach, in order to answer research question two (b). Figure 3 presents the reasons provided by the teachers in a clustered graph.

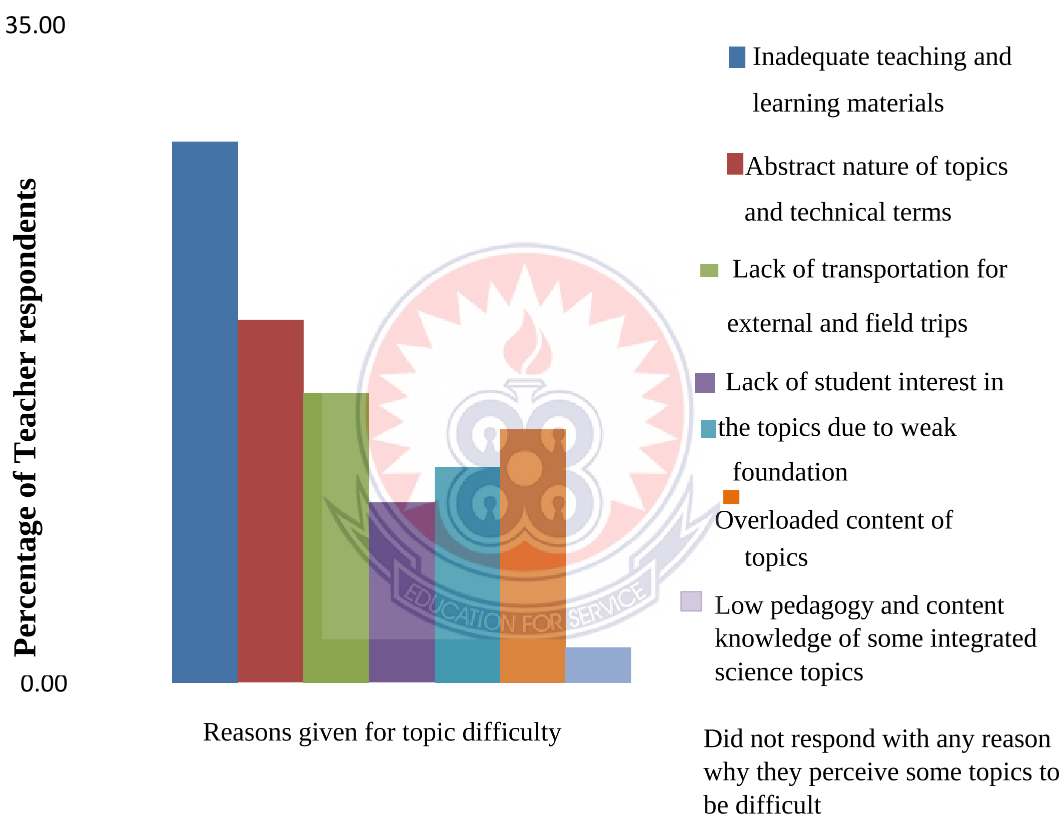

Figure 3: Teachers' reasons for the most difficult topics to teach in the integrated science syllabus

Source: Field data (2022)

From Figure 3, the teachers presented the following reasons for the perceived difficulty in teaching some Integrated science topics such as inadequate teaching/learning materials, abstract nature of some topics, lack of transport and student interest, overloaded content and low teachers' knowledge in pedagogy. About 28.80% of the teachers reported that inadequate teaching and learning materials was the main reason why they find some topics difficult to teach. A significant proportion (19.30%) of the teachers also reported that the abstract nature and too many technical terms of some topics make it difficult for them to teach. Lack of transportation for external field trips was also expressed by about 15.40% of the teachers. Some teachers (13.50%) also iterated that low pedagogy and content knowledge of some integrated science topics inhibits their ability to teach them without difficulty. Teachers (11.50%) also expressed concerns over some topics being overloaded with content. Even though about 1.90% did not respond with any reason why they perceive some topics to be difficult to teach, about 9.60% of the teachers attributed their difficulties to lack of interest by students in the topics due to their weak foundation (Figure 3). Reasons given above with respect to the abstract nature of some topics, weak science foundation of students or low prior knowledge, poor content knowledge of teachers, and topics with too many terminologies are similar to reasons given in previous studies by students and teachers for why some science topics are difficult to study (Appiah & Beccles, 2022; Cimer, 2012; Estacio & Cornejo, 2021; Etobro & Fabinu, 2017; Ogunkola & Samuel in 2011; Tekkaya, Ozkan & Sungur, 2001). The teachers' content knowledge of science topics has a strong capacity to influence all aspects of teaching such as preparation, planning, organization of contents and thoughts and decision making regarding the choice of content to be learnt (De Jong, Veal, & Van Driel, 2002; Parker et al., 2018). Poor topic content knowledge also has the ability to strongly affect the confidence of integrated science teachers for quality lesson delivery (Parker et al., 2018). The management of the sampled schools and other stake holders should take practical steps to address the reasons expressed by teachers in this study to improve the quality of integrated science education in the aforementioned schools.

4.4 Perceived Difficulty of Integrated Science Topics compared between S.H.S Students and Teachers

Research question three sought to know how the perception of difficulty with integrated science topics varied amongst teachers and S.H.S students. This was achieved by comparing the mean scores of students and those of integrated science teachers. The mean scores give vivid description of the average responses expressed by both students and teachers with respect to which of the topics they perceive are more difficult. Table 7 shows the differences in the top 5 most difficult integrated science topics as expressed by students and teachers using average scores.

Table 7: Differences in Integrated Science Topics Perceived to be Difficult by SHS Students and Teachers

Most perceived difficult topic	**Mean score**	**Standard deviation**
Students		
Interaction of matter:		
No 40: Atmosphere and climate change	3.84	1.50
No 45: Endogenous technology	4.25	1.25
No 46: Biotechnology	4.41	1.04
Cycles:		
No 16: Hydrological cycle	3.95	3.18
Energy:		
No 36: Nuclear energy	3.74	1.51
Most perceived difficult topic	Mean score	Standard deviation
Teachers		
Interaction of matter:		
No 46: Biotechnology	2.33	0.77
No 48: Variation and inheritance	2.28	1.02
Systems:		
No 29: Nervous systems	2.24	0.66
No 28: The Circulatory systems	2.06	0.64
Energy:		
No 33: Electronics	2.50	0.79

Source: Field data (2022)

Scale: mean score 1.0 – 2.99 (Not Difficult to Understand), 3.0 (Moderate), 3.1 – 5.0 (Difficult to understand). Comparing the mean scores of topics for both teachers and students, both recorded a relatively high score for the integrated science topic 'biotechnology' under the main topic 'interaction of matter'. The topic 'biotechnology' recorded the highest mean score for students (mean = 4.41, sd = 1.04) and (mean = 2.33, sd = 0.77) also second highest for teachers with regards to the topic biotechnology. This implies that the topic 'biotechnology' is a major challenge for students in the study area but not very difficult for teachers when provided with all the needed teaching resources. Table 7, further shows that though both students and teachers expressed similar difficulty in some common main/major topics or sections such as interaction of matter and energy, but the specific topics have been different except 'biotechnology'. For example, both students and teachers expressed difficulty in interaction of matter as a major topic or section, but teachers highlighted 'variation and inheritance' as the topics many have difficulty with; while students highlighted 'endogenous technology', and 'atmosphere and climate change' as their challenge.

4.5 Gender Difference in Perceived Difficulty of Science Topics among SHS Students

Research question four sought to find out whether there was significant difference in SHS students' perceptions of difficult topics based on their gender?

Table 8 presents the results of students' perceived difficulty with various integrated science main topics or sections among males and females. From Table 8, although there was a slight mean difference (0.231) between male and female students on their perceived difficulty on the main topic (section) "Diversity of Matter," the topic was perceived to be more difficult for the male students (mean = 32.427, sd = 8.583) than the female students (mean = 32.196, sd = 8.602). Thus, the topic was perceived to be easier for the female students than the male students. Table 8 presents, gender difference in perceived difficulty of Integrated science main topics.

Table 8: Gender Difference in Perceived Difficulty of Integrated Science Main Topics

Integrated Science Main Topics (Sections)	**Gender**	**N**	**Mean**	**SD**	**t-test**	**p-values**
Diversity of Matter	Male	110	32.427	8.583	0.193	0.847
	Female	97	32.196	8.602		
Cycles	Male	110	19.109	5.838	0.301	0.764
	Female	97	19.412	8.564		
Systems	Male	110	28.482	8.644	1.039	0.300
	Female	97	29.876	10.642		
Energy	Male	110	27.532	9.472	0.608	0.544
	Female	97	26.711	9.886		
Interaction of matter	Male	110	34.890	10.720	1.182	0.238
	Female	97	36.629	10.338		

*Significance Level = $P<0.05$, Source: Survey, 2022

On the contrary, the female students (mean = 19.412, sd = 8.564) perceived the main topic “Cycles” to be more difficult than the male students (mean = 19.109, sd = 5.838), despite the slight mean difference of 0.303 among their perceptions. Thus, “Cycles” as a main topic was perceived to be easier for the male students than the female students. Similarly, there was a mean difference of 1.394 of students’ perceived difficulty on the main topic “Systems” among the males and the females, where the female students (mean = 29.876, sd = 10.642) perceived the topic to be more difficult than their male (mean = 28.482, sd = 8.644) counterparts. Therefore, the topic “systems” was perceived to be easier for the male students than the female students. For the main topic or section "Energy," it was perceived to be more difficult for the male students (mean = 27.532, sd = 9.472) than their female (mean = 19.412, sd = 8.564) counterparts, with a mean difference of 0.821. Accordingly, “energy” as a topic is perceived to be easier for female students than male students. Similar to the topic “systems," the female students perceived the topic “Interaction of matter” to be more difficult than the male students, with a mean difference of 1.739. This implies that the topic “Interaction of matter” was perceived easier among the male students than the female students.

The results of the independent sample t test at P<0.05, which are also presented in Table 8, show that there was no significant statistical difference in the perceived difficulty of all five (sections) main integrated science topics among the male and female students. Thus, there was no significant statistical difference in perceived difficulty among students based on gender with regards to the various main integrated science topics in the syllabus such as diversity of matter (t = 0.193, sig. = 0.847), cycles (t = 0.301, sig. = 0.764), systems (t = 1.039, sig. = 0.300), energy (t = 0.608, sig. = 0.544), and interaction of matter (t = 1.182, sig. = 0.238). This indicates that both male and female students are perceived to experience similar difficulties in all the indicated integrated science main topics, despite the slight mean differences. Thus, the null hypothesis that there is no significant difference in the integrated science topic difficulty as perceived by SHS male and female students can be upheld. The finding of this study is similar to a study by Haruna (2021), who found that both male and female students perceived difficult biology topics in the same way. On the contrary, the findings of this study contradict the finding of a study by Na’Allah, Maryam, and Abdulrahim (2019), who found a significant difference in the perceived levels of difficulty of integrated science subject concepts between male and female junior secondary school participants.

In this study, out of the 48 integrated science subtopics examined in the syllabus, only six (introduction to integrated science; diversity of living/non-living things; soil conservation; transport, diffusion, osmosis and plasmolysis; Photosynthesis; and Ecosystem), were statistically significant with regards to gender at P<0.05 (Table 9). With a significance level of P<0.040, females (mean = 1.54, sd = 0.81) slightly perceived ‘introduction to integrated science’ topic as less difficult than males (mean = 1.80, sd = 0.97). With regards to the topic on ‘diversity of living/non-living things’, females recorded slightly lower mean score (mean = 1.64, sd = 0.74) compared to males (mean = 1.92, sd = 0.94) at $P<0.019$ significance level. Perceptions on the difficulty of the topic ‘soil conservation’ recorded similar mean scores among both male (mean = 2.48, sd = 1.47) and female (mean = 2.52, sd = 1.38) students at $P<0.005$ significance level. Similar findings also apply to the topic 'transport: diffusion, osmosis and plasmolysis’ where Table 9 shows that at a significance level of $P<0.006$, both males (mean = 2.62, sd = 1.37) and females (mean = 2.69, sd = 1.49) recorded almost the same mean scores. However, with regards to the topic ‘photosynthesis’, males (mean = 2.35, sd = 1.47) expressed slightly less difficulty compared to their female counterpart (mean = 2.65, sd = 1.64) at a significance level of $P<0.024$. From Table 9, another topic that was significant with the gender disaggregation was ‘ecosystem’ under the main topic ‘interaction of matter’. On the average, females (mean = 3.15, sd = 1.63) expressed more difficulty with the topic ‘ecosystem’ than their male counterparts (mean = 2.65, sd = 1.53) at $P<0.011$ significance level. Table 9, shows the gender differences of perceived difficulty of integrated science subtopics among S.H.S students.

Table 9: Gender Differences of Perceived Difficulty of Integrated Science Subtopics among S.H.S Students

Integrated Science Topic	Gender of respondent	N	Mean	Std. Deviation	t-test	Sig. (2-tailed)
Diversity of Matter:						
1. Introduction to Integrated Science	Male	110	1.80	0.97	2.066	*0.040
	Female	96	1.54	0.81		
2. Measurement	Male	110	2.26	1.15	2.092	0.538
	Female	95	2.21	1.02		
3. Diversity of Living/ Non-living things	Male	110	1.92	0.94	2.373	*0.019
	Female	96	1.64	0.74		
4. Matter	Male	109	1.71	0.70	1.840	0.167
	Female	95	1.53	0.70		
5. Cells and Cell Division	Male	107	2.56	1.18	1.539	0.125
	Female	95	2.32	1.07		
6. Rock	Male	109	2.22	1.02	1.985	0.232
	Female	95	2.27	1.00		
7. Acids, Bases and Salts	Male	110	2.84	1.38	2.032	0.073
	Female	96	2.94	1.38		
8. Soil conservation	Male	109	2.48	1.47	2.153	*0.005
	Female	96	2.52	1.38		
9. Water	Male	106	2.30	1.41	2.652	0.355
	Female	96	2.29	1.50		
10. Metals and Non-metals	Male	110	2.40	1.20	1.213	0.756
	Female	95	2.33	1.34		
11. Exploitation of minerals	Male	109	3.56	1.49	0.858	0.671
	Female	96	3.80	1.41		
12. Rusting	Male	110	3.27	1.62	0.982	0.324
	Female	94	3.88	1.38		
13. Organic and Inorganic compounds	Male	108	3.42	1.33	1.435	0.066
	Female	93	3.57	1.26		
Cycles:						
14. Air movement	Male	109	3.00	1.42	2.415	0.092
	Female	96	3.19	5.51		
15. Nitrogen cycle	Male	109	3.37	1.51	2.291	0.067
	Female	96	3.08	1.38		
16. Hydrological cycle	Male	107	3.74	1.54	1.572	0.557
	Female	96	4.20	4.34		
17. General principles of Farm animals' production	Male	110	3.39	3.23	0.649	0.194
	Female	96	3.23	1.54		
18. Life cycle of pest and parasite	Male	108	3.19	1.56	1.995	0.082
	Female	95	3.38	1.64		

Table 9: Cont'd

Integrated Science Topic	Gender of respondent	N	Mean	Std. Deviation	t-test	Sig. (2-tailed)
19. Crop production	Male	109	2.66	1.70	2.232	0.651
	Female	97	2.55	1.53		
Systems:						
20. Skeletal systems	Male	110	2.49	1.14	1.451	0.914
	Female	95	2.38	1.24		
21. Reproduction and growth in plants	Male	110	2.38	1.22	1.648	0.919
	Female	94	2.33	1.23		
22. Food and Nutrition	Male	109	2.82	1.59	2.232	0.613
	Female	97	3.22	2.57		
23. Dentition, feeding and digestion in mammals	Male	109	2.72	1.52	0.432	0.656
	Female	97	2.93	1.58		
24. Respiratory system	Male	108	2.91	1.29	2.212	0.132
	Female	97	3.22	1.59	2.632	*0.006
25. Transport: diffusion, osmosis and plasmolysis	Male	109	2.62	1.37		
	Female	96	2.70	1.49		
26. Excretory systems	Male	109	3.14	1.48	1.914	0.078
	Female	96	3.54	1.56		
27. Reproductive system and growth in mammals	Male	109	2.62	1.30	2.257	0.110
	Female	96	2.94	1.60		
28. The Circulatory systems	Male	109	3.50	1.37	1.282	0.120
	Female	97	3.56	1.46		
29. Nervous systems	Male	103	3.73	1.34	1.491	0.658
	Female	92	3.47	1.62		
Energy:						
30. Forms of energy and energy transformation	Male	109	2.54	2.20	1.870	0.312
	Female	97	2.22	1.30		
31. Solar energy	Male	106	3.02	1.67	1.172	0.843
	Female	96	3.06	1.69		
32. Photosynthesis	Male	108	2.35	1.47	2.342	*0.024
	Female	96	2.65	1.64		
33. Electronics	Male	107	3.47	3.19	2.759	0.526
	Female	93	3.25	1.42		
34. Electrical energy	Male	109	3.30	1.43	2.426	0.624
	Female	97	3.07	1.51		
35. Sound energy	Male	108	3.56	1.57	2.153	0.529
	Female	94	3.39	1.65		

Table 9: Cont'd

Integrated Science Topic	Gender of respondent	N	Mean	Std. Deviation	t-test	Sig. (2-tailed)
35. Sound energy	Male	108	3.56	1.57	2.153	0.529
	Female	94	3.39	1.65		
36. Nuclear energy	Male	107	3.86	1.44	2.793	0.315
	Female	97	3.64	1.57		
37. Light energy	Male	108	3.09	1.63	2.271	0.562
	Female	91	3.07	1.64		
38. Heat energy	Male	109	2.63	1.48	1.948	0.727
	Female	95	2.92	1.69		
Interaction of matter:						
39. Ecosystem	Male	108	2.65	1.53	1.978	0.011*
	Female	94	3.15	1.63		
40. Atmosphere and climate change	Male	109	3.71	1.60	2.437	0.219
	Female	97	4.01	1.33		
41. Infections and diseases	Male	109	3.74	1.55	2.842	0.143
	Female	94	3.71	1.51		
42. Magnetism	Male	107	3.70	1.47	2.251	0.125
	Female	96	3.76	1.56		
43. Force motion and pressure	Male	108	2.87	1.43	1.348	0.098
	Female	97	3.18	1.35		
44. Safety in the community	Male	108	3.51	1.69	1.642	0.063
	Female	95	3.92	2.43		
45. Endogenous technology	Male	107	4.26	1.22	2.052	0.216
	Female	97	4.26	1.27		
46. Biotechnology	Male	108	4.37	1.05	2.167	0.114
	Female	94	4.49	1.01		
47. Work and machines	Male	108	2.81	1.48	2.788	0.094
	Female	97	3.12	1.57		
48. Variation and inheritance	Male	108	3.59	1.49	1.539	0.159
	Female	97	3.51	1.61		

*Significance Level = P<0.05, **Source**: Field work, 2022
Scale: mean score 1 – 2.99 (Not Difficult to Understand),3.0 (Moderate), 3.1 – 5.0 (Difficult)

In this study, there was no statistically significant difference with perceived difficulty of integrated science main topics in the syllabus between male and female students. This finding corroborates with findings from previous studies in Philippines which found no statistical significance between gender and perceptions of students on difficulty of science topics but disagrees with findings from previous studies (Davis 2010; Ennin 2015; Sadera et al., 2020; Tekkaya, Ozkan & Sungur, 2001). Females in this study expressed slightly less difficulty in the subtopic's introduction to integrated science; diversity of living/non-living things; and transport, diffusion, osmosis and plasmolysis compared to males but males also expressed relatively less difficulty in the topics on soil conservation; Photosynthesis; and Ecosystem compared to females. The influence of gender on the attitude of students towards science topics has been a subject of debate and investigation for many decades in the past. Many studies conducted in the past have reported that females (girls) have less positive attitudes towards the study of science compared to males (boys) who have a more positive attitude (Breakwell & Beardsell, 1992; Erickson & Erickson 1984; Hendley et al., 1996; Jovanic & King, 1998; Kahle & Lakes, 1983). However, some previous studies have also reported otherwise, citing empirical evidence in the past where females (girls) have demonstrated a more positive attitude towards science topics than males (boys) (Colley et al., 1994; Elwood & Combar, 1995; Havard, 1996; Lightbody & Durndell 1996; Whitehead, 1996).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This study sought to examine topic difficulty in the integrated science syllabus amongst students as well as (integrated science) teachers in two public senior high schools in the Cape Coast Metropolis of Ghana. In this chapter, the summary, conclusions and recommendations for the study as well as some suggestions for future studies are presented.

5.1 Summary

This study investigated the difficulty of integrated science topics experienced among students and integrated science teachers in two public senior high schools. Specifically, the study investigated: (1) perceived difficulty of integrated science topics by SHS students, (2a) topics in the integrated science syllabus that SHS teachers perceived as difficult to teach, (2b) teachers' reasons for the most perceived difficult topics to teach in the integrated science syllabus, (3) a comparism of the perceived difficulty of integrated science topics between SHS students and teachers, and (4) gender differences in perceived difficulty of integrated science topics among SHS students. To address the study's objective, 207 students and 18 teachers were sampled from two senior high schools in the Cape Coast Metropolis. Frequency tables, mean scores, standard deviation, percentages and two tailed independent sample t-test were employed for both main integrated science topics (sections) and individual topics to conduct a robust analysis of the data to answer the research objectives.

The frequency tables were mainly used to present results of the demographic characteristics of both the teachers and students. The mean and standard deviation was used to assess perceived difficulty of integrated science topics by SHS students and to compare perceived difficulty of integrated science topics between SHS students and teachers. Group statistics and independent t-test were employed to investigate whether there is a statistical significance in terms of gender differences in the responses of study participants with regards to the main topics (section) in order to answer the null hypothesis and the two tailed independent sample t-test was also used to investigate the gender differences in perceived difficulty of integrated science subtopics among students. Teachers' reasons for the most difficult topics to teach in the integrated science syllabus were presented using a bar graph and a pie chart was also employed to present a pictorial description of perceived difficulty of science topics among teachers.

5.2 Summary of the Major Findings

1. The demographic characteristics of the teachers who participated suggest that 16(88.8%) were males and only two (11.2%) were females. Majority (83%) had bachelor's degree as their highest educational level and about 38.9% of the teachers had less than 6 years of teaching experience. Also 6.67% of the teachers specialized in the teaching of integrated science as a subject. With regards to the students, majority (52.7%) were males and majority (77.8%) were also within the age bracket 15-19 years. Further deductions from the results on subject specialization of teachers indicated that few integrated science teachers (16.67%) have specialized in the teaching of the subject and should be able to handle all the topics in the syllabus.

2. The study found that students perceived integrated science topics such as biotechnology, endogenous technology, atmosphere and climate change,

hydrological cycle and nuclear energy as difficult to understand compared to the other topics.

3. The findings of this study further affirm that no significant difference exists in the SHS integrated science topics perceived to be difficult by male and female students in general. However, females in this study expressed slightly less difficulty in understanding the topics introduction to integrated science; diversity of living/non-living things; and transport, diffusion, osmosis and plasmolysis compared to males but males also expressed relatively less difficulty in the topics on soil conservation; photosynthesis; and ecosystem compared to females.
4. Furthermore, the study reports that some sub-topics under sections or major integrated science topics such as diversity of matter, cycles, systems, energy and interaction of matter are difficult integrated science topics for teachers to teach without the needed support. Some reasons given by teachers for the difficulty were inadequate teaching and learning materials, abstract nature of some topics, lack of transport for external field trips, low student interest due to weak foundation in science, overloaded topic content and low teachers' knowledge or expertise on some topics.
5. The study also found that the sub-topic 'biotechnology' is a challenge for both teachers and students. Though both students and teachers expressed varied levels of difficulty in some common main/major topics such as energy, interaction of matter and energy; the specific sub-topics have been different except 'biotechnology'.

5.3 Conclusion

This study is very unique in assessing the difficulty of integrated science topics among both students and teachers in selected senior high schools in the Cape Coast Metropolis. Findings from this study address pertinent gaps in the Ghanaian literature that has not been adequately investigated. Findings from this study may be useful to the Ghana Education Service, management of schools studied and all stakeholders. The study revealed that 88.33% of the teachers teaching integrated science in the sampled schools were not specialist in the subject. Also, students from the two participating senior high schools reported that biotechnology, endogenous technology, atmosphere and climate change, hydrological cycle and nuclear energy were the most difficult to understand integrated science topics. From their responses, the study also found no significant statistical difference in perceived difficulty among the male and female students on the various integrated science main topics (sections). Furthermore, 12.5% (6 out of 48) of integrated science subtopics (introduction to integrated science; diversity of living/non-living things; soil conservation; transport, diffusion, osmosis and plasmolysis; Photosynthesis; and Ecosystem) were found to be statistically significant by male and female students with regards to perceived topic difficulty. Teachers also expressed difficulty in teaching some topics with reasons. These topics were diversity of matter, cycles, systems, energy and interaction of matter. However, both students and teachers expressed difficulty in the topic “biotechnology”. Some reasons expressed by teachers for the difficulty in teaching some topics include; inadequate teaching and learning materials available, abstract nature of some topics, lack of transport for external field trips, low student interest due to weak foundation in science, overloaded topic content and too much use of jargons and scientific terms/words that makes it difficult to logically make meaning out of the topic. These findings and reasons expressed by teachers, when paid attention to may provide critical solutions to the perceived difficulty in the teaching and learning of integrated science lessons among senior high schools in Ghana.

5.4 Recommendation

Both students and teachers have some difficulty with some integrated science topics in the senior high school syllabus. Various reasons have been given by teachers for the difficulties expressed and gender has also been statistically found to be slightly significant in identifying topics of difficulty among senior high school students. In this study, further investigation is recommended or needed to help advance knowledge on the role gender plays in the uptake of integrated science topics and lessons in Senior High Schools.

Based on the profound findings of this study, some recommendations have been made. These recommendations are;

1. From the study, it is clear that there are perceived difficulties in the learning and teaching of SHS Integrated science topics in the syllabus. Management and Integrated science teachers in the sampled schools should review and simplify topics such as biotechnology, endogenous technology, atmosphere, climate change, hydrological cycle, nuclear energy, diversity of matter, cycles, systems, energy and interaction of matter; in the integrated science syllabus for easy teaching and understanding by both teachers and students.

2. School management and heads of science department should organize periodic in-service training for integrated science teachers to allow those with some level of difficulty in some topics to be supported. Also, Integrated science teachers concerned should try and teach the identified perceived difficult topics by students earlier (in form two) so that students could have enough time for a backup plan.

3. Integrated science teachers should be encouraged to organise more practical lessons in the instructional delivery to improve students understanding of the topics in the syllabus.

4. Field trips, excursions and field practical periods should be made mandatory and supported with budget in the participating senior high schools to help in the teaching and learning of perceived difficult integrated science topics.

5. Heads of Senior High Schools, Parent-Teacher Associations, Old students Associations, Non-Governmental Organizations and all stakeholders should help to provide adequate teaching and learning materials for integrated science to help in the teaching and learning process. This could be in the form of provision of textbooks, adequate funds and other items for practical demonstrations either in the laboratory or classroom.

5.5 Suggestions for Further Research

Owing to the findings and limitations of this study, some few suggestions for further research have been outlined below;

1. A future study could replicate this study in all senior high schools in Ghana to provide a clearer picture of the problem in Ghana. This is particularly important as this present study only sampled students from two schools and as a result, inhibits the generalizability of the study findings to even the political regional boundaries of the selected schools.

2. A future study could also investigate what integrated science teachers do when they have difficulty with some integrated science topics. This would help to provide some tailored assistance to integrated science teachers who have difficulty with some topics.

3. Another future study could investigate how the type of language used for teaching and learning of integrated science topics can affect the uptake of integrated science lessons in Senior High Schools.
4. A study be devoted to integrated science difficulties perceived by SHS students and how they are addressed by their teachers and authorized textual materials.
5. Furthermore, a future study could explore further the gender dynamics in the uptake of integrated science topics in senior high schools in Ghana.

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APPENDICES

APPENDIX A

Questionnaire for Senior High School Integrated Science TEACHERS (QIT)

UNIVERSITY OF EDUCATION-WINNEBA

FACULTY OF SCIENCE EDUCATION DEPARTMENT OF INTEGRATED SCIENCE EDUCATION

TEACHERS' PERCEPTION ABOUT TOPICS IN THE INTEGRATED SCIENCE SYLLABUS

This questionnaire is aimed at gathering information on the perception of senior High School students on the topics in the integrated science syllabus. We will be very grateful if you could respond to the items on the questionnaire as candidly as possible. This research is for academic purposes only and you are assured of confidentiality and anonymity in all responses given.

SECTION A

BACKGROUND INFORMATION Please fill in the required information in the space provide or Tick (√) the appropriate response given

1. BIO DATA

: GENDER: MALE [ ]

FEMALE [ ]

AGE: 20-30 [ ]

31-39 [ ]

40-48 [ ]

49 and above [ ]

2. ACADEMIC QUALIFICATION

Bachelor's degree [ ]

Master's degree [ ]

PhD [ ]

Others (please specify) ……………………… ……………………………………...

3. AREA OF SPECIALIZATION /MAJOR SUBJECTS (Write your

response) ……………………………………………………………………………

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TEACHING EXPERIENCE (Years):

How long have you been teaching Integrated Science?

1-5 Years [ ]

6-10 Years [ ]

11- 15 Years [ ]

16-20 Years [ ]

21Years and above [ ]

YOU ARE A PROFESSIONAL TEACHER?

Yes [ ]

No [ ]

SECTION B

Please respond to each of the following items in the table by ticking [√] using the key provided below

KEY:

NDT-Not Difficult to Teach

SDT- Slightly Difficult to Teach

MDT-Moderately Difficult to Teach

DT- Difficult to Teach

VDT- Very Difficult to Teach

SECTIONS	No.	TOPICS	Not Difficult to Teach (NDT)	Slightly Difficult to Teach (SDT)	Moderately Difficult to Teach (MDT)	Difficulty to Teach (DT)	Very Difficult to Teach (VDT)
DIVERSITY OF MATTER	1	Introduction to Integrated science					
	2	Measurement					
	3	Diversity of Living /Non-Living Things					
	4	Matter					
	5	Cells and Cell divisions					
	6	Rocks					
	7	Acids, Bases and Salts					
	8	Soil conservation					
	9	Water					
	10	Metals and Non-metals					
	11	Exploitations of minerals					
	12	Rusting					

	13	Organic and Inorganic Compounds					
CYCLES	14	Air movement					
	15	Nitrogen cycle					
	16	Hydrological cycle					
	17	General principles of Farm animals' production					
	18	Life cycle of pests and parasites					
	19	Crop production					
SYSTEMS	20	Skeletal system					
	21	Reproduction and growth in plants					
	22	Food and Nutrition					
	23	Dentition, Feeding & digestion in Mammals					

	No.	TOPICS	Not Difficult to Teach (NDT)	Slightly Difficult to Teach (SDT)	Moderately Difficult to Teach (MDT)	Difficult to Teach (DT)	Very Difficult to Teach (VDT)
	24	Respiratory system					
	25	Transport: diffusion, Osmosis and Plasmolysis					
SYSTEMS	26	Excretory system					
	27	Reproductive system and growth in mammals					
	28	The Circulatory System					
	29	Nervous system					
ENERGY	30	Forms of energy and energy transformation					
	31	Solar energy					
	32	Photosynthesis					
	33	Electronics					
	34	Electrical energy					
	35	Sound energy					

	No.	TOPICS	Not Difficult to Teach (NDT)	Slightly Difficult to Teach (SDT)	Moderately Difficult to Teach (MDT)	Difficult to Teach (DT)	Very Difficult to Teach (VDT)
	36	Nuclear energy					
	37	Light energy					
	38	Heat energy					
INTERACTION OF MATTER	39	Ecosystems					
	40	Atmosphere and climate change					
	41	Infections and diseases					
	42	Magnetism					
	43	Force motion and pressure					
	44	Safety in the community					
	45	Endogenous Technology					
	46	Biotechnology					
	47	Work and machines					
	48	Variation and Inheritance					

State any five (5) topics in the integrated science syllabus you find very difficult to teach

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Give your reasons for the difficulty in teaching each of the topics stated above

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APPENDIX B

Questionnaire for Senior High School Students (QS)

UNIVERSITY OF EDUCATION-WINNEBA

FACULTY OF SCIENCE EDUCATION DEPARTMENT OF INTEGRATED SCIENCE EDUCATION

PERCEPTION ABOUT TOPICS IN THE INTEGRATED SCIENCE SYLLABUS

SECTION A

BACKGROUND INFORMATION

Please fill in the required information in the space provide or Tick (√) the appropriate response given BIO DATA:

GENDER: MALE [ ]

FEMALE [ ]

AGE………… FORM……….

SECTION B

Please respond to each of the following items in the table by ticking [√] using the key provided below:

<u>KEY:</u>

NDU - Not Difficult to Understand

SDU - Slightly Difficult to Understand

MDU - Moderately Difficult to Understand

DU - Difficult to Understand

VDU - Very Difficult to Understand

SECTIONS	No.	TOPICS	Not Difficult to Understand (NDU)	Slightly Difficult to Understand (SDU)	Moderately Difficult to Understand (MDU)	Difficult to Understand (DU)	Very Difficult to Understand (VDU)
DIVERSITY OF MATTER	1	Introduction to Integrated science					
	2	Measurement					
	3	Diversity of Living/ Non Living Things					
	4	Matter					
	5	Cells and Cell divisions					
	6	Rocks					
	7	Acids, Bases and Salts					
	8	Soil conservation					
	9	Water					
SECTIONS	No	TOPICS	Not Difficult to Understand (NDU)	Slightly Difficult to Understand (SDU)	Moderately Difficult to Understand (MDU)	Difficult to Understand (DU)	Very Difficult to Understand (VDU)
	10	Metals and Non-Metals					
	11	Exploitation of minerals					
	12	Rusting					

	13	Organic and Inorganic Compounds					
CYCLES	14	Air movement					
	15	Nitrogen cycle					
	16	Hydrological cycle					
	17	General principles of Farm animals production					
	18	Life cycle of pests and parasites					
	19	Crop production					
SYSTEMS	20	Skeletal system					
	21	Reproduction and growth in plants					
	22	Food and Nutrition					

SECTIONS	No.	TOPICS	Not Difficult to Understand (NDU)	Slightly Difficult to Understand (SDU)	Moderately Difficult to Understand (MDU)	Difficult to Understand (DU)	Very Difficult to Understand (VDU)
SYSTEMS	23	Dentition, Feeding & digestion in Mammals					
	24	Respiratory system					
	25	Transport: diffusion, Osmosis and Plasmolysis					
	26	Excretory system					
	27	Reproductive e system and growth in mammals					
	28	The Circulatory System					
	29	Nervous system					
ENERGY	30	Forms of energy and energy transformation					
	31	Solar energy					
	32	Photosynthesis					
	33	Electronics					
	34	Electrical energy					
	35	Sound energy					
	36	Nuclear energy					

SECTIONS	No.	TOPICS	Not Difficult to Understand (NDU)	Slightly Difficult to Understand (SDU)	Moderately Difficult to Understand (MDU)	Difficult to Understand (DU)	Very Difficult to Understand (VDU)
	37	Light energy					
	38	Heat energy					
INTERACTION OF MATTER	39	Ecosystems					
	40	Atmosphere and climate change					
	41	Infections and diseases					
	42	Magnetism					
	43	Force motion and pressure					
	44	Safety in the community					
	45	Endogenous Technology					
	46	Biotechnology					
	47	Work and machines					
	48	Variation and Inheritance					

Indicate any 5 topic(s) you find most difficult to understand in integrated science.

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