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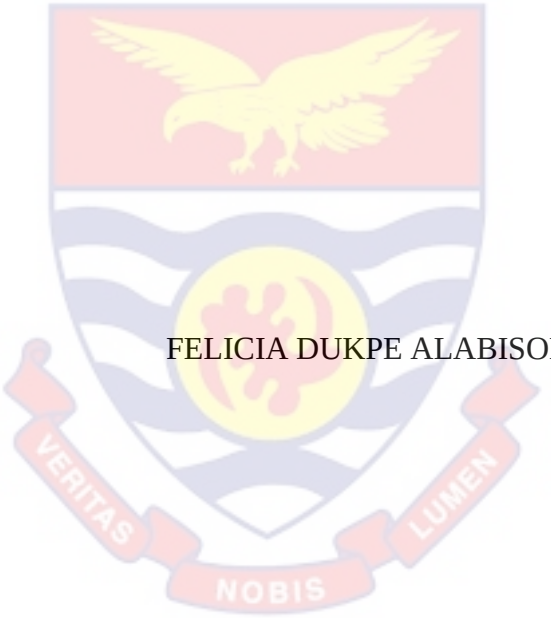
INVESTIGATING THE FIDELITY OF IMPLEMENTATION OF SENIOR HIGH SCHOOL INTEGRATED SCIENCE CURRICULUM IN GHANA



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UNIVERSITY OF CAPE COAST

INVESTIGATING THE FIDELITY OF IMPLEMENTATION OF SENIOR HIGH SCHOOL INTEGRATED SCIENCE CURRICULUM IN GHANA

BY

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Thesis submitted to the Department of Science Education of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Science Education.

JANUARY 2024

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: .....Date: .....

Name: Felicia Dukpe Alabison

Supervisors' Declaration

I hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature: ..... Date: .....

Name: Dr. Kofi Acheaw Owusu

ABSTRACT

Science teachers hold a pivotal role in the educational system, serving as the bridge through which science curriculum is brought to life within the classroom. Among the myriad of responsibilities, they bear, one critical component is ensuring the faithful implementation of the science curriculum. This research, therefore, investigated Senior High School (SHS) science teachers' fidelity of the science curriculum in Ghana. A total of 189 teachers from the Takoradi Metropolis in Ghana's Western Region participated in the study. Data collection methods included the use of questionnaires, observational checklists, and semi-structured interviews, allowing for a comprehensive blend of qualitative and quantitative data. Data analysis involved calculating frequency and percentages, employing Chi-Square tests, and conducting thematic analyses. The results showed that Ghanaian SHS Integrated Science teachers do not implement the Integrated Science curriculum with fidelity. Key factors contributing to this deviation include a scarcity of teaching and learning resources, overcrowded classrooms, and time constraints. Consequently, the research recommends that the Ministry of Education, the Ghana Education Service (GES), and educational stakeholders allocate adequate funding to schools for the provision of necessary teaching materials and the construction of additional classroom facilities.

KEY WORDS

Fidelity

Curriculum

Curriculum Fidelity

Adherence

Implementation

Ideal Teaching Methods

Actual Teaching Methods

Prescribed Teaching Methods

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DEDICATION

To my family and loved ones

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CHAPTER ONE

INTRODUCTION

This chapter serves as the general introduction of the entire research. The chapter includes the background to the study, which explains and gives the general overview of fidelity of implementation, the statement of the problem, which justifies the need for this research in Ghana, the research questions, and the relevance/significance of the entire research to important stakeholders in education. The chapter also covered the delimitation which gives the scope of the research and limitation of the study as well as the organisation of the entire study.

Background to the Study

Curriculum plays an important role in the field of education (Gatawa, 1990). According to Lewy (1991), indicated that education in general can only be understood and described by looking at the curriculum components. This is because the curriculum of subjects, such as science, at any level of education, covers all the concepts and activities or methods that relate to how the concepts or topics in a subject should be taught to students as planned by the developers (Tyler, 1949). Thus, the curriculum is a pivotal document in the educational process. Litjens and Taguma (2010) view curriculum as "a composite whole including the student, the teacher, teaching and learning methods/activities, anticipated and unanticipated experiences, outputs and possible outcomes within an educational institution" (p. 49). Curriculum, therefore, encompasses the whole educational machinery covering teachers, content, methods, materials and students.

A well-developed curriculum document will need to be implemented for it to have the intended effect on society. Thus, the best-designed curriculum will fail or might not have the proposed outcomes if the components of the curriculum are not implemented properly in school. This means that the degree of implementation or actualization of a curriculum in the manner in which it was proposed will determine its success (Ruiz-Primo, 2006). Teachers, as implementers of the curriculum, are expected to put the various components of the curriculum into practice as planned by curriculum developers with the aim of supporting students learning in the classroom (Lochner, Conrad & Graham, 2015). Dusenbury, Brannigan, Falco and Hansen (2003) argue that the actualisation or implementation of curricula in the way it was proposed to be executed by the planners constitutes the fidelity of the curriculum. Some scholars conceive curriculum fidelity as the same a`s curriculum implementation or curriculum integrity (Bumen, Cakar & Yildiz, 2014).

Mihalic (2002) explained curriculum fidelity as a confirmation of how well a curriculum is being implemented in relation to the core mandate of the curriculum. In other words, curriculum fidelity is the degree by which teachers who are implementers put the curriculum into practice without altering the original design. Guo et al. (2020) further add that curriculum fidelity is the extent to which an intended program is put into practice by teachers. Curriculum fidelity looks at key areas of the curriculum, such as whether the aims of the curriculum are being conveyed or whether teachers are utilising the proposed teaching methods and materials in the right manner and arrangement (Davis, 2014). Cobbold (1999) summarises curriculum fidelity as how faithful teachers put the curriculum into practice.

O'Donnell (2008) indicated that adherence, dose/duration, quality of curriculum delivery, student responsiveness, and curriculum differentiation are the ways through which curriculum fidelity can be measured. O, Donnel accentuated that since the syllabus brings out the broad goal of the curriculum by outlining the various contents and how these contents should be taught in the classroom, adherence to the curriculum is whether the prescribed activities, materials and techniques in the syllabus are being delivered as it was designed or written. Dose/duration looks at how much of the written curriculum is delivered or the quantity of the curriculum delivered (Sanetti & Kratochwill, 2009). Dose of the curriculum is measured by asking how much the teacher implemented the entire scope of the written curriculum. In an attempt to measure dose, researchers find out the quantum of information given to students within the period of schooling by documenting what was covered on a regular basis and at the end of the school year (Mihalic, 2002). The quality of curriculum delivery is the manner in which teachers deliver the curriculum as proposed by the designers (Bumen, Cakar & Yildiz, 2014). Student responsiveness focuses on students' participation in the teaching and learning process while curriculum differentiation deals with implementing the new curriculum fully without mixing it with the previous curriculum (O'Donnell, 2008).

It has been argued that adherence to the curriculum is the most important element of curriculum fidelity (Gonzalez, 2020; Azano et al., 2011). The aim of measuring adherence to the curriculum is to examine for instance the activities and methods prescribed in the curriculum and how it is being implemented in the classroom (Gonzalez, 2020). According to Biesta, Priestley, and Robinson

(2015), Smith (2020), and Johnson and Taylor (2019), there are three forms of teaching methods. This includes ideal teaching methods, prescribed teaching methods and actual teaching methods. The ideal teaching methods are the theoretical teaching methods teachers prefer to use to teach in the classroom based on their own beliefs and philosophies about teaching (Biesta et al., 2015). The prescribed teaching methods are the recommended teaching methods teachers are expected to use in the classroom (Johnson & Taylor, 2019), and the actual teaching methods are the methods that teachers actually employ in their day-to-day teaching (Smith, 2020). Measuring adherence allows curriculum developers to compare prescribed methods and activities to the ideal and actual teaching methods in reality to determine the synergy in these methods. Adherence being the focal point in curriculum implementation, teachers can examine their own level of faithfulness, which will provide the opportunity to make necessary adjustments. Hattie (2005) opines that to measure teachers' adherence to the curriculum in a country, it is essential that the country has a specific written and documented description of the curriculum that highlight and details the essential elements for its implementation. Components of the curriculum including the scope and sequence, activities and pacing guide are helpful features that can elucidate the essential elements or steps of the curriculum. This means that if a teacher follows the curriculum and teaches what the curriculum describes during the academic year, then one may say that they are adhering to it.

The importance of curriculum fidelity in education has been well documented in literature. For instance, Bumen, Cakar and Yildiz (2014) noted in their study that the success of the education system is contingent on teachers'

fidelity to the curriculum. They further explain that teachers' ability to translate the intended goals of the curriculum in the classroom defines the outcome of the students. Dusenbury et al., (2003) added that an assessment of curriculum fidelity allows researchers to identify what has been changed in a curriculum and how changes impact student outcomes. Again, Skolits and Richards (2010) pointed out that, curriculum fidelity provides evidence of whether teachers can implement the curriculum with a high level of consistency leading to the unravelling of failures and challenges associated with the implementation of the curriculum. Gonzalez (2020) also argued that the importance of curriculum fidelity is that it often helps to explain why curricula succeed and fail.

Thus, even as Ghana has been implementing its Integrated Science curriculum over the years, there is the need for the country to assess how the curriculum is being presented and implemented. This assessment can provide valuable insights into the effectiveness of the curriculum and inform necessary adjustments to improve educational outcomes in Ghana.

Statement of the Problem

In Ghana, there are syllabi for the various levels of the educational system which emanate from the broader curriculum. The syllabus serves as a guide outlining the specific content and how this content should be taught in the classroom. The Ghanaian Senior High School (SHS) Integrated Science syllabus, for instance, seeks to guide and direct the teaching and learning process with the aim of increasing students' conceptual understanding and interest in science (Ministry of Education, [MoE], 2010). In order to achieve the aim of increasing students' conceptual understanding and interest in science, the Ghanaian SHS science curriculum outlines the various objectives to be achieved

for each topic and indicates how the stipulated objectives can be achieved by prescribing teaching and learning activities/methods.

Science teachers are expected to translate the theoretical information in the syllabus into real classroom practices by utilising the prescribed teaching methods/activities in the syllabus. The developers of the SHS science syllabus believe that effective utilisation of these prescribed teaching methods/activities in any given situation at any given time will increase students' understanding and interest as well as their academic performance in science as in the case of all other syllabus (Erden, 2010). Although the current Integrated Science syllabus has been in existence for about a decade, students' performance in the subject has not been encouraging (West African Examinations Council (WAEC), 2011-2020).

The WAEC Chief examiners' reports on the performance of senior high school students in integrated science indicate that generally, achievements in the subject are very low (WAEC, 2011, 2012, 2013, 2014, 2015, 2017, 2018, 2019, 2020). Table 1 presents the statistics of students' performance in science from 2015 to 2020, reflecting trends in academic performance.

Table 1: Students performance in Integrated Science

Year	Number of candidates	Number of candidates with grades A-C6	Number of candidates with grades D7-F9
2015	268,765	62,355 (23.38%)	206,410 (76.80%)
2016	274,209	131,733 (48.39%)	142,476 (51.96%)
2017	289,169	121,972 (42.52%)	161544 (56.3%)
2018	316,952	158,255 (49.93%)	158,697 (50.07%)
2019	346,041	212,579 (62.14%)	133,462 (38.57%)
2020	370267	194,891 (52.64%)	175376 (47.4%)

(WAEC, 2015-2020)

From Table 1, out of 268,765 candidates who sat for the science paper in 2015, only 62,355 (23.38%) passed with grades A1-C6. In 2016 out of 274,209 candidates presented, only 131,733 (48.39%) obtained grades A1-C6. In 2017, out of 289,169 who sat for the science paper, 161544 (56.3%) failed to obtain the pass credit of A1-C6. Again, in 2019, out of 346,041 who wrote the science paper, 133,462 (38.57%) failed to obtain the pass credit of A1-C6. In 2020, out of 370267 students who sat for the science paper, 175376 (47.4%) could not obtain A1-C6 grades.

Stakeholders have tried to investigate the reasons for students' poor performance in Integrated Science by looking at the factors that affect academic performance (Abreh, Owusu & Amedahe, 2018; Appiah & Beccles, 2022. For instance, Abreh et al. (2018) found that lack of full completion of the syllabus due to insufficient duration, lack of teaching and learning materials, low interest of students in learning science, poor teaching approach and laziness on the part of teachers were the major reasons that militated against students' performance. Appiah and Beccles (2022) found that teacher attitude, school environment and student attitudes toward Integrated Science were the major factors that affected SHS students' performance in Integrated Science.

Most of the research investigating poor performance of students in Integrated Science have neglected how teachers translate what has been documented in the science syllabus into reality in Ghanaian senior high schools. Whether teachers are aware of the prescribed teaching methods in the syllabus and how factors such as experience and gender are associated with their awareness of the prescribed teaching methods have not been documented. Thus, teachers' fidelity of implementation of the SHS Integrated Science curriculum

has not been explored. This creates a situation where it is difficult for stakeholders in education to determine whether SHS Integrated Science teachers are implementing the curriculum faithfully as intended by the designers.

A review of literature revealed that curriculum fidelity studies conducted in Ghana focused on SHS teachers' fidelity in French, accounting, economics and geography (Kwarteng et al., 2018; Zar, 2015; Owusu, 2012). Since reasons have been sought for students' poor performance in Integrated Science over the years and the problem still persists, it is prudent that unexplored areas such as teachers' fidelity of the curriculum is investigated. Hence, the need for research on SHS teachers' fidelity of implementation of the SHS Integrated Science curriculum.

Purpose of the Study

The purpose of this study was to investigate SHS science teachers' fidelity of the science curriculum in Ghana. Specifically, the research sought to:

1. identify teachers' awareness of the stipulated teaching methods in the Integrated Science syllabus.
2. delineate methods teachers use to teach Integrated Science and their alignment with the prescribed teaching methods in the syllabus.
3. identify, if any, differences existing between teachers' ideal teaching methods, actual teaching methods in the classroom and those prescribed in the syllabus.
4. gouge reasons accounting for teachers' usage or non-usage of prescribed teaching methods in the SHS Integrated Science syllabus.

Research Questions

1. What are teachers' awareness of the stipulated teaching methods in the Integrated Science syllabus?
2. Which methods do teachers use to teach content in the SHS Integrated Science syllabus and how does it conform to the prescribed teaching methods?
3. How do teachers' ideal teaching methods and actual teaching methods in the classroom conform to prescribed teaching methods in the SHS Integrated Science syllabus?
4. What reasons account for teachers' usage or non-usage of prescribed teaching methods in the SHS Integrated Science syllabus?

Significance of the Study

In an effort to improve the teaching of Integrated Science in Ghanaian Senior High Schools to increase students' performance, this study would make the following important contributions. The findings of this study such as the teachers' awareness of the stipulated teaching methods of Integrated Science in the curriculum are expected to be a valuable source of information for policy formulation and implementation in Ghana, especially for Ghana Education Service. This will help them in organising in-service training for teachers to enlighten them on the prescribed teaching methods if there is a discrepancy. The findings of this study will highlight the teaching methods/activities used by teachers in teaching Integrated Science and how the teaching methods employed by teachers in teaching Integrated Science in the classroom conform to the prescribed teaching methods in the SHS Integrated Science curriculum. The findings of this study will unearth the reasons which account for teachers' usage

of teaching methods other than the stipulated teaching methods in the syllabus and the challenges they encounter in utilizing the prescribed teaching methods. This will help Ghana Education Service to address the stated problems to maximise teachers' continuous usage of the prescribed teaching methods.

Delimitations

There are different modes of measuring curriculum fidelity according to literature. This includes adherence, dose/duration, quality of program delivery, participant responsiveness, and program differentiation. However, this study was delimited to SHS teachers' adherence to the various teaching methods prescribed in the SHS science curriculum. This was because a number of studies posit that, adherence to the curriculum is the most important element of curriculum fidelity that should be focused on in research (Gonzalez, 2020; Azano et al., 2011). The study was also delimited to the SHS science teachers in the Sekondi-Takoradi metropolis. The metropolitan nature of Secondi-Takoradi informed its choice, given that the metropolis possesses the variables of interest for the study.

Limitation

Generalisation of the result may be limited as the result pertains to only the locality, which is Sekondi-Takoradi Metropolis, within which the study was carried out.

Definition of Key Terms

Fidelity: The faithfulness to a cause, event, or programme

Curriculum Fidelity: it is defined as the determination of how well an intervention is implemented in comparison with the original program design during an efficacy and/or effectiveness study.

Adherence: Attachment or commitment to an event, programme, or activities.

Ideal teaching methods: These are theoretical teaching methods teachers prefer to use to teach in the classroom based on their own beliefs and philosophies about teaching.

Prescribed teaching methods: These are recommended teaching methods teachers are expected to use in the classroom.

Actual teaching methods: These are the methods that teachers actually employ in their day-to-day teaching.

Organisation of the Study

The whole research was organised into five different chapters. Chapter one looked at the introduction of the research. This included the background to the study which gave the general overview of the study, statement of the problem which pointed out the motivating factors of the study, research objectives and research questions which gave the direction of the research, significance of the study, delimitations which gave the boundary of the research, limitation, and definition of key terms and how the who research was organised. Chapter two reviewed the literature on teachers' awareness and utilisation of teaching methods. This looked at teaching methods, science teachers' utilization of teaching methods and challenges of teachers in utilising teaching methods. Chapter three concentrated on the methods employed by the researcher in obtaining and analysing data. This included, research design, population, sample and sampling technique, data collection instrument, data collection procedure and data analysis. The fourth chapter was devoted to the presentation and discussion of results obtained from respondents. The last chapter focused on the summary, conclusion, and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

Overview

The aim of the study was to investigate SHS science teachers' fidelity of the implementation of the SHS Integrated Science curriculum in Ghana. This chapter, therefore, highlights the literature review on the concepts of curriculum and fidelity of implementation. The chapter also presents and discusses the theoretical framework of fidelity of implementation and empirical review of teachers' awareness of prescribed teaching methods, association between teachers' awareness and their gender and experience, teachers' fidelity of implementation of the prescribed teaching methods and the reasons for teachers' usage or non-usage of prescribed teaching methods.

The Concept of Curriculum

The word curriculum is derived from the Latin word "currere" which means "run" and it signifies a "run-away" or "racecourse" in which one runs to reach a goal (Connelly & Lantz, 1991). Currently, it serves as a metaphor to describe certain idea of an unfolding sequence of events. Since the school does not follow a single sequence of events, the term "curriculum" has several meanings (Jackson, 1992). It can be used to refer to a specific subject of study and at another time it is broadly described to include every aspect of an educational setup (Tamakloe, 1992). However, the word "curriculum" is frequently employed anytime education is brought up. Lewy (1991) acknowledges that no educational process can be adequately explained without including the elements of the curriculum. Lewy's description of the educational process implied interacting with certain course materials. According to him,

these curriculum components comprise information and knowledge, emotions, beliefs, and abilities that support people in carrying out socially sanctioned roles and tasks. The curriculum is the core of the study of education since it contains the elements that always make up the educational process (Kwarteng et al., 2018).

Tanner and Tanner (1995) indicated that a curriculum is a "plan or program of all experiences which the learner encounters under the leadership of a school" (p. 158). The school is, therefore, accountable for the entirety of the experiences of children. This conforms to the explanation of Sergiovanni and Starrat (1983) who opined that curriculum includes what students in a school are to encounter, practice and master. Marsh and Willis (2003) define curriculum as "the interrelated set of plans and experiences that a student undertakes under the guidance of the school (p.13)". As a result, the curriculum includes all formative activities and experiences that goes on in the classroom and outside the classroom, as well as planned and unplanned as well as purposefully directed interactions with the aim of forming adults who will contribute to society.

Kelly (2009) explained curriculum as any learning that is organised and guided in groups and individually in and outside the school. Thus, curriculum refers to the knowledge, abilities, and attitudes that students are supposed to learn throughout a course or program of study (p. 10). The curriculum outlines the content, teaching methods and assessment practices and indicates the resources that are required by teachers to put the curriculum into practice. Tyler (1949) stated that the curriculum refers to the set of experiences that include all activities associated with teaching a course or a subject that is intended to be

taught to students either in or out of the classroom. All of the instructional activities pertaining to subjects that are taught in different education levels' classes and courses, are included in the curriculum (McBrien and Brandt, 1997). Morris (2003) identified four different ways of defining curriculum. The first definition entails a disciplined study of permanent subjects such as integrated science. The second definition entails the knowledge and information emanating from disciplines already established and the third definition involves learning outcomes that are planned in which the institution is responsible. Lastly, Morris defined curriculum as different experiences students gather under the auspices of the school. Litjens and Taguma (2010) view curriculum as "a composite whole including the student, the teacher, teaching and learning methods/activities, anticipated and unanticipated experiences, outputs and possible outcomes within an educational institution" (p. 49). According to Eisner (2002), the curriculum is planned instruction and has intended outcomes to be achieved. Based on the aforementioned definitions, it can be outlined that curriculum is planned and made up of content, series of courses that students are expected to take under the supervision of the school. Again, the curriculum considers the students and their interaction with each other, the teacher and the materials. In summary, the curriculum encompasses the learner, the teacher, teaching and learning methods/activities, anticipated and unanticipated experiences, outputs and outcomes possible within a learning institution.

Many educators perceive curriculum as a syllabus; however, the curriculum is more than a syllabus (Burton & McDonald, 2001; Hoesny, 2013; Rocha, 2020). A syllabus can be described as a component of a curriculum because it outlines the subject matter of a program. The word "syllabus" comes

from Greek and originally meant a brief summary or table of contents of a discourse related to courses leading up to examinations.

It can be seen from the explanations given by different scholars that education of a country cannot be described and understood without looking at the components of the curriculum. This is because the curriculum of any subject, such as science, at any level of education covers all the concepts and activities/methods that relate to the teaching of that subject that is planned to be taught to students (Tyler, 1949). Thus, the curriculum is a pivotal document in the educational process. However, it must be pointed out that it does not really matter how we define and explain curriculum; what matters is how we implement it.

Curriculum Implementation

Fullan (1991) describes curriculum implementation as the act of bringing an educational program or policy to life through its practical application. This concept involves educators actively engaging in delivering instruction and assessments based on the guidelines and materials provided within a curriculum framework. Such frameworks often include detailed instructional recommendations, scripted dialogues, lesson plans, and evaluative measures aimed at achieving specific educational goals. Wiles and Bondi (2014) emphasise the importance of this structured approach, noting that it aims to ensure consistency across educational settings, thereby aiding teachers in the effective application and sustained operation of the curriculum to fulfil diverse objectives. From the perspective of those directly involved in teaching, Lochner, Conrad, and Graham (2015) highlight the expectation for teachers to execute the curriculum as meticulously designed by its developers, thereby facilitating

the advancement and development of student capabilities. Furthermore, Dusenbury et al. (2003) introduce the concept of curriculum fidelity as a metric for evaluating the extent to which the implemented curriculum mirrors the original intentions of its designers, serving as an indicator of the curriculum's true effectiveness in practice. This integrated view underscores the multifaceted nature of curriculum implementation, emphasising the critical roles of structure, teacher agency, and fidelity in achieving educational success.

Curriculum Fidelity

A well-developed curriculum document will need to be implemented for it to have the intended effect on society. Thus, the best-designed curriculum will fail to have the intended impact and results if it is not properly implemented. This means that the degree of implementation or actualisation of a curriculum in the manner in which it was proposed will determine its success (Ruiz-Primo, 2006). Teachers, as implementers of the curriculum, are expected to translate the curriculum as planned by curriculum developers to enable the support of student progress and growth, thereby linking the notions of effective curriculum implementation and its impact on educational outcomes as highlighted by Lochner et al. (2015). As argued by Dusenbury et al. (2003), a useful way of explaining whether curricula are actualised or implemented in the way it was proposed to be executed by the planners constitutes the fidelity of the curriculum, integrating the concept of curriculum fidelity with the actualisation of curricular goals. Some scholars conceive curriculum fidelity as the same as curriculum implementation or curriculum integrity (Bumen, Cakar & Yildiz, 2014), thus underscoring the synonymous relationship between fidelity, implementation, and integrity in the educational discourse.

The concept of curriculum fidelity is how well a curriculum is being implemented in comparison with the original curriculum design. In other words, is the curriculum being implemented or put into practice effectively and does it achieve the intended goals? (Mihalic, 2002). Cobbold (1999) sees curriculum fidelity as how "faithfully" teachers put the curriculum into practical use in accordance with what the curriculum dictates, thereby emphasising the importance of adherence to the original curriculum design. Guo et al., (2020) further add that curriculum fidelity is the extent to which an intended program is put into practice by teachers, connecting the practice of implementation with the concept of fidelity. Curriculum fidelity examines key components of the curriculum such as whether all pieces of the curriculum are being delivered, or whether teachers are utilising the proposed teaching methods and materials in the right manner and arrangement (Dane & Schneider, 1998; Davis, 2014; O'Donnell, 2008), thereby focusing on the comprehensive delivery and adherence to proposed methods as crucial elements of fidelity. Curriculum fidelity is an important element in the education system for a variety of reasons. These reasons are premised on obtaining a deeper understanding of improving the implementation stage of curriculum. Bumen et al. (2014) noted in a study that the success of the education system is contingent on teachers' fidelity to the curriculum, suggesting a direct link between fidelity and educational success. Bumen et al. further explain that teachers' ability to translate the intended goals of the curriculum in the classroom defines the outcome of the students, thus connecting the fidelity of implementation with student outcomes. Skolits and Richards (2010) opine that curriculum fidelity is the clear evidence showing teachers consistency in putting the curriculum into classroom practices,

highlighting the role of fidelity in evaluating implementation consistency. This helps to unravel the success and challenges of teachers in their implementations. Dusenbury et al. (2003) assert that curriculum fidelity unearths the emerging good, bad (challenges) and the ugly side of implementation of the curriculum as planned, thereby linking fidelity assessment with the identification of implementation challenges. Again, Dusenbury et al. argue that studying curriculum fidelity unravel the reason for the success and failure of innovation and help scholars and researchers determine the impact of the change, thus establishing curriculum fidelity as a tool for understanding educational innovation success and failure. Fullan and Pomfret (1977) added that the concept of curriculum fidelity unravels significant and reasonable information about the feasibility of implementation, further connecting the concept of fidelity with the practical aspects of curriculum implementation.

Measurement of Curriculum Fidelity

Since the inception of formal education, scholars and educators have tried several methods to measure curriculum fidelity. Five different dimensions have been determined for measuring curriculum fidelity (Dusenbury et al., 2003; O'Donnell, 2008). These include adherence, dose/duration, quality of curriculum delivery, student responsiveness, and curriculum differentiation.

Adherence: Adherence refers to the degree of fidelity with which the components of the curriculum are delivered, specifically according to the curriculum's standards (Dusenbury et al., 2003). However, researchers must first completely comprehend the curriculum's standard as well as the essential elements of the curriculum in order to measure adherence in an efficient manner (Dusenbury et al., 2003). O'Donnell (2008) added that adherence to the

curriculum is whether the prescribed activities, materials and techniques in the curriculum are being delivered as it was designed or written.

Dose/Duration: Dose/Duration examines whether the curriculum is implemented consistently with the recommended schedule (Dusenbury et al., 2003). Sanetti and Kratochwill (2009) accentuated that dose/duration looks at how much of the written curriculum is delivered, or the quantity of the curriculum delivered. Dose of the curriculum is measured by asking how much the teacher implemented the entire scope of the written curriculum. In an attempt to measure dose, researchers find out the quantum of information given to students within the period of schooling by documenting what was covered on a regular basis and at the end of the school year (Mihalic, 2002). O'Donnell (2008) summarised that, dosage is measured by looking at the session length, length and number of sessions and the level of cognitive demand delivered to the students.

Quality of Curriculum Delivery: The quality of the curriculum delivery is the manner in which teachers deliver the curriculum as proposed by the designers (Bumen et al., 2014). Mihalic (2002) explains that the quality of curriculum delivery is the extent to which teachers who are implementers of the curriculum do so with enthusiasm and preparedness. The quality of curriculum delivery can be measured by observing in classrooms, obtaining information through teacher reports, and examining documentation such as lesson plans.

Student Responsiveness: Student responsiveness focuses on how responsive the students are to the curriculum (O'Donnell, 2008). In other words, students' participation and involvement in the activities of the teaching and learning process. This is significant because measuring students' responsiveness could

show either a positive or negative reaction to the way the curriculum is implemented (Dusenbury et al., 2003; O'Donnell, 2008).

Curriculum Differentiation: Curriculum Differentiation focuses on determining how modifications influence the components of the curriculum. This aspect looks at whether the modification done has negatively affected the original design. That is, implementing the new curriculum fully without mixing it with the previous curriculum (O'Donnell, 2008). It is therefore important to consistently check the curriculum implementation to determine if any modified aspect of the curriculum does not alter the original design or yield unintended (O'Donnell, 2008).

It has been argued that adherence to the curriculum is the most important element of curriculum fidelity (Gonzalez, 2020; Azano et al., 2011). The aim of measuring adherence to the curriculum is to effectively examine and explore teachers' capabilities of the methods through which the program is implemented (Gonzalez, 2020). Measuring adherence allows curriculum developers to compare what is expected from the program with what is taking place in reality. Being the focal point in the curriculum implementation, teachers can examine their own level of adherence which will provide the opportunity to make necessary adjustments. Hattie (2005) opines that to measure teachers' adherence to the curriculum in a country, it is essential that the country has a specific written and documented description of the curriculum that highlight and details the essential elements for its implementation. Components of the curriculum including the scope and sequence, activities and pacing guide are helpful features that can elucidate the essential elements or steps of the curriculum. This means that if a teacher follows the curriculum and teaches what the curriculum

describes during the academic year, then one may say that they are adhering to it.

Different curricula such as the 2010 Ghanaian SHS Integrated Science curriculum prescribes certain classroom activities that should be followed in the classroom to achieve the general goals of the study. It is believed by the developers of the curriculum that teachers' adherence to the prescribed activities will have a significant impact on the student's responsiveness, interest, understanding and academic performance in the science subject.

Theoretical Framework

The theory that underpinned this whole research was the Diffusion of Innovation (DoI) theory. Everett Rogers in 2014 propounded the theory and indicated that, the DoI theory gives important information of the process involved in putting proposed innovations (curriculum) into practice and highlights when and why these ideas are implemented or rejected. Everett Rogers (2014) defines diffusion as the "process by which an innovation is communicated to members of the social system over time" (p.5). and innovation is explained as an idea, practice, or project that is perceived as new by an individual. Members of the social system are expected to implement the proposed ideas disseminated to them as designed to achieve the intended goals.

Rogers (1996) asserts that the process of diffusing an innovative program involves four stages: dissemination, adoption, implementation, and maintenance. The dissemination stage involves the process by which innovations are spread or distributed to members of the social system. This is where the aims of the innovation are explained to members. The adoption stage refers to the decision processes by which organisations and members of the

social system employ to use an innovation. The maintenance stage refers to how a program is institutionalised over time. The implementation stage refers to the degree to which the program is delivered with fidelity to its original design.

Based on the overriding aim of the present study, the study focused on the implementation stage of the diffusion process, where curriculum, as an innovative program, is translated and implemented in the classroom to achieve the intended goals. In other words, where the curriculum as an innovative program is delivered with fidelity to its original design. (Binnie, N., 2002). explained that teachers' awareness or knowledge of the goals, contents and activities in the curriculum could determine how they implement curriculum.

Previous empirical studies utilising DoI as a theoretical lens have unravelled how educators implement innovations in schools. For instance, Jwaifell and Gasaymeh (2013) used DoI to study the degree to which teachers utilise prescribed teaching methods in Modern System schools in Europe. In this study, teachers who demonstrated a high awareness and understanding of the principles of the teaching methods implemented them in the classroom, and teachers who demonstrated low awareness and understanding failed to implement them with fidelity. The study highlighted that several factors stifle the effective implementation of innovations. In a different study in the United States, Brahier (2006) examined a model of teachers' technology adoption decision-making. The study reported that teachers' adoption and implementation of the innovation were significantly correlated with their perception and understanding of the innovation's compatibility, availability of resources and time constraints.

Prescribed teaching methods in the 2010 SHS Integrated Science Syllabus

One of the important areas of the educational system that affect knowledge creation and students' academic performance is teaching methods used by teachers (Whittle, Telford & Benson, 2018). Considering the importance of teaching methods on students' understanding and academic performance, many countries prescribe certain teaching methods in their curriculum to be employed by teachers in the classrooms. In Ghana, the 2012 SHS Integrated Science Curriculum prescribes student-centered teaching methods that are premised on constructivism as what teachers should employ to teach Integrated Science. This method gives students in the classroom enough opportunity and capability to construct, develop and nurture their own knowledge and understanding through active interactions and engagement with the environment. The teachers only serve as facilitators.

The designers of the curriculum believe that utilization of these teaching methods has the ability to increase the conceptual understanding of students as well as their interest (MoE, 2010. Kumar and Teotia (2017) further add that student-cantered methods premised on constructivism goes a long way to help students develop their scientific skills which is one of the aims of the SHS Integrated Science curriculum. The student-centered teaching methods prescribed by the Ghanaian SHS Integrated Science Syllabus includes discussion, demonstration, group work, project work, discovery method, field trip, audio-visuals, visual charts and experimenting/practical.

Discussion: Discussion method involves engaging students in the classroom in a meaningful discourse (Yusu, Guga & Ibrahim, 2016). This type of teaching method requires students to demonstrate understanding through their

contributions to a teacher or their peers. Again, it gives students the chance to effectively express their ideas and understanding in their own convenient way. This helps students to give deeper explanation of concept without replicating scientific facts without proper understanding According to Seweje (2010), the teacher serves as a facilitator whose major role is to assist learners in their own learning and so generating meaningful connections between past information, new information and knowledge. Akinleye (2010) affirmed that giving children the chance to be heard in class is an important way of helping students solve problems and make decisions with ease. Ying (2020) posits that the discussion method produces positive student learning outcomes. This includes reconciling opposing arguments, formulating cohesive arguments to reach conclusion, preventing the fear of sharing one's opinions, and motivating students to learn better by preparing enough for a lesson. It enables the effective participation of students and embraces nuances.

Demonstration: Smith, Wenderot and Tyler, (2013) define a demonstration as "teaching students how something should be done in a step-by-step process" (p. 432). A demonstration is a very visual method of teaching in which both the teacher and the students participate actively. According to Smith et al.(2013), the ultimate goal of demonstration in school is for students to be able to do or apply whatever they have been taught. Daluba (2013) explains demonstration as the exhibition or display done by teachers while students watch with keen interest. According to Dorgu (2015), teachers' major role in demonstration is to show and illustrate how something is done verbally and through actions. This is followed by students repeating the actions based on outlined procedures. Students are expected to watch keenly the demonstration and act or perform

similarly. Demonstrations are a multi-sensory way of helping students understand scientific concepts that are difficult to grasp with only verbal description (Cabibihan, 2013). Scientific concepts for example are mostly abstract in nature and are full of practical activities therefore, teachers' application of demonstration methods in the classroom will bring the abstract concepts to life. Dorgu (2015) argues that demonstration method is mostly used to develop the psychomotor skills of students in the classroom and practical lessons are mostly done using demonstration. Although demonstration is effective especially in teaching practical lessons, it, however, seems to have drawbacks such as time consuming and lack of equipment for the demonstration. But the benefits accrued far outweighs their drawbacks.

Group work: Group work as a teaching method is a constructivist teaching method where students are put into groups and presented with an activity to perform in the classroom (Cabibihan, 2013). This ensures the effective participation of every student in the classroom. Students then present their answers in the group to sometimes be critiqued by their fellow students and teacher (Gelmez-Burakgaz, 2020). The teacher serves as a facilitator who ensures students perform the assigned task in their respective groups (Smith et al., 2013).

Project work: Project is an idea, plan, or activity directed to change the form of something, to develop it, to complete it (Binnie, 2002). Project work is one of the student-centered teaching methods or activities that systematically engage students to obtain information through an extended inquiry process. In project work, teachers present questions in the form of assignments for students to search for appropriate information or use the information obtained in the

classroom to solve the question. Students are mostly given enough time to present their work. Mostly project is practically oriented to help students develop their practical skills. According to Binnie (2002), the usage of projects is particularly beneficial in supporting students' learning since it forces them to think and improves their learning. Again, project work increases students' problem-solving skills which is an important 21st century skills students are expected to develop. Borich (1988) demonstrates in his study that, project work as a teaching method creates an enabling opportunity for learners to study themselves and demonstrate their knowledge and understanding in solving problems. This stands to reason that, through project work, students are able to obtain adequate knowledge that will guide students to solve scientific problems.

Field trip: According to Obanya (2002), a field trip is any activity or movement that mostly takes place outside of the classroom with the intention of giving students first-hand experience with things or people that are unique to that location. Field trip destinations may include zoos, museums, business establishments, farms, neighbouring colleges, theatres, historical structures or monuments, woods, marshes, natural parks, or the school's premises. Tekbıyık and Akdeniz (2008) assert that field visits enhance learning. This is because trips give students hands-on experience of the concepts learned in the classroom. Field visits provide students a deeper comprehension of a subject and give the subject matter more realism. It has been found that field trips have favourable cognitive and affective effects, such as heightened learning motivation and a more optimistic outlook on science and environmental topics (Bitgood, 1989). Knowledge and skills are acquired as a result. Additionally, field tours can improve visitors' attitudes about the visited location and spark

interest in jobs related to natural resources (Tekbıyık & Akdeniz, 2008). Teachers as implementers of the curriculum are expected to employ these teaching methods in the classroom to increase students' participation, interest, understanding and performance in the subject.

Teachers' awareness of prescribed teaching methods

To determine teachers' awareness of the prescribed teaching methods, Gelmez-Burakgazi (2020) assessed the fidelity of implementation of science teachers in Turkey. The study found that science teachers were unaware of the prescribed teaching methods in the curriculum. The majority of the Turkish teachers used in the research pointed out that, they needed an extensive information of the effect of the prescribed teaching methods and how the methods can be used in the classroom. A similar result was obtained by Tekbıyık and Akdeniz (2008) when they investigated teachers' awareness of prescribed teaching methods in the science curriculum. The study showed that many science teachers are not familiar with the prescribed teaching methods in the curriculum.

Paulo (2014) investigated teachers at the secondary school awareness of the prescribed teaching methods in the Tanzania's syllabus in Tanzania. Teachers were asked to state and describe the teaching methods that would be used in teaching selected topics in the Tanzania secondary school syllabus. It was observed that teachers at secondary schools in Tanzania were aware of the prescribed teaching methods in the syllabus. However, when the teachers were observed in their classrooms, they employed teaching methods different from what they stated. The implication of this result is that awareness of student-

centred methods/activities did not translate to adoption of the teaching methods in the classroom.

Another empirical research by Kafyulilo, Rugambuka and Moses (2012) highlighted similar results that indicated that teachers were aware of recommended teaching approaches in the secondary school curriculum when given questionnaires to indicate prescribed teaching methods. It was found in the study that, despite teachers' awareness of the prescribed teaching methods in the syllabus, they used different teaching methods during the teaching and learning process in the classroom. Kafyulilo et al., therefore, concluded that teachers have a theoretical and superficial knowledge of the prescribed teaching methods. Gbadamosi (2013) assessed science teachers' awareness and utilisation of recommended effective teaching methods by the science curriculum. The study targeted all biology teachers in Nigeria. The innovative Teaching Strategies Questionnaire (ITSQ) was used for the study. It was found that 88% of the teachers used for the study were highly aware of the recommended effective teaching methods. This finding was similar to the finding of Fatokun, Jimoh, and Enefure (2019) who observed that most science teachers are aware of several teaching methods prescribed in various science syllabi but they fail to utilise them in the classroom.

Furthermore, Musa, Mamuda and Kamba (2020) assessed science teachers' utilisation of the prescribed innovative teaching and learning methods in Kebbi State, Nigeria. The study employed a stratified sampling technique to sample 252 science teachers in public secondary schools in Kebbi State. The study revealed that out of 252 teachers who responded to the questionnaires, most of the teachers were not aware of the prescribed innovative teaching

methods in the secondary school syllabus. The few teachers who were aware of the prescribed teaching methods failed to utilise them in their classrooms.

Otami (2019) assessed how the teaching methods used by JHS Integrated Science teachers conform to the prescribed teaching methods in the JHS science syllabus in Ghana, similar results were obtained. The study revealed that JHS science teachers have little knowledge of the prescribed teaching methods and their teaching methods did not conform to the prescribed teaching methods. There is little empirical evidence of SHS science teachers' awareness of the prescribed teaching methods and how their teaching methods conform to the stipulated teaching methods. Therefore, this study seeks to explore SHS science teachers' awareness of the prescribed teaching methods in the Ghanaian SHS science syllabus.

Teachers' awareness of prescribed teaching methods and Gender

In the review of teachers' gender and awareness of prescribed teaching methods, it must be noted that not many research have not been done in this area. The few studies (Gbadamosi, 2013; Khurshid & Zahur, 2013; Olagunju & Abiona, 2008) conducted report that gender has an association with teachers' awareness of prescribed teaching methods however some studies report that female teachers are more aware of the prescribed teaching methods than male teachers whilst other studies report otherwise.

Gbadamosi (2013) conducted a survey on teachers' awareness of the prescribed teaching methods of science syllabus in Nigeria. The study employed questionnaire to collect quantitative data from 300 biology teachers. It was reported that teachers' gender has an association with their awareness of prescribed teaching methods with female biology teachers demonstrating higher

awareness of the prescribed innovative teaching methods than the male biology teachers. Similar results were obtained by Khurshid and Zahur (2013) in a study on science teachers' awareness and utilisation of prescribed teaching methods in the science syllabus. Khurshid and Zahur, discovered that female science teachers show more awareness of prescribed teaching methods than the male teachers. It was explained that male teachers are less concerned about their students' academic performance than female teachers. Therefore, female teachers tend to employ prescribed activities in order achieve intended goals of the syllabus.

Olagunju and Abiona (2008) investigated teachers' awareness of prescribed innovative teaching methods used to teach science in Senior High Schools in Nigeria. The study found that SHS science teachers' awareness is dependent on their gender. Male science teachers demonstrated higher awareness than female teachers. Similarly, Davis, D. L. (2014) found that science teachers' awareness of prescribed teaching methods is associated with their gender with male teachers demonstrating higher awareness than female teachers.

Teachers' experience and awareness of the prescribed teaching methods

Teachers' experience has been documented by several empirical studies (Akinleye, 2001; Commeyras, 2003; Ogundare, 2001) as significant for the effectiveness of schools. Experience of teachers have been found to improve teaching skills of teachers and students tend to learn better from experienced teachers. Again, with experience, teachers acquire myriad of teaching methods that they draw on throughout their teaching (Cossentino, 2003; Gbadamosi, 2013).

In terms of teachers' awareness of prescribed teaching methods and years of experience, Achor and Ogbeba (2010) found in their study on teachers' utilisation of prescribed teaching methods that teachers' awareness of prescribed teaching methods is associated with their years of experience. Teachers who are more experienced with about 10 years of experience show high knowledge of the prescribed teaching methods. This was because they have utilised the teaching methods for quite a number of years. Khursid and Zahur (2013) also found that teachers with more years of experience have high knowledge of the prescribed teaching methods than their counterparts who have less experience in teaching.

Consequently, Darling-Hammond (1999) investigated science teachers' knowledge and awareness of prescribed teaching methods among secondary school teachers. The study found that there is an association between teachers' years of experience and their awareness and knowledge of prescribed teaching methods in the secondary school syllabus. Highly experienced teachers demonstrated higher awareness than less experienced teachers. It was added that despite the fact that teachers who have less years of service tend to utilise new and innovative student-cantered methods, those with more years of service tend to focus on managing classroom and organising lessons according to the prescription of the syllabus. Ehrenberg, Goldhaber and Brewer, (1995) also found that teachers' awareness of innovative teaching methods is dependent on their years of experience with less experienced teachers demonstrating low awareness and highly experienced teachers demonstrating high awareness.

Again, studies conducted by Adeyemi (2008), Akinsolu (2010) and Khurshid and Zahur (2013) supported the assertion that experience of teachers

are associated with their awareness of prescribed teaching methods in the syllabus. More experienced teachers use prescribed teaching methods than less experienced teachers. On the contrary, the finding of Gbadamosi (2013) showed that teachers' experiences have no association with their awareness of prescribed innovative teaching methods. Experienced and less experienced teachers demonstrated similar awareness of prescribed innovative teaching methods.

Teachers' Fidelity to the prescribed teaching methods in the curriculum

Lochner, Conrad and Graham (2015) opine that teachers, as implementers of curriculum, are expected to implement the prescribed activities/methods in the curriculum effectively as planned by developers in the classroom to achieve the intended purpose. This means that there should be a synergy between what is prescribed, what is practiced and consequently what is achieved. This section of the review focused on empirical studies on teachers' fidelity to the prescribed activities.

Pence, Justice and Wiggins (2008) examined preschool teachers' fidelity to the Language-Focused Curriculum (LFC). The study specifically examined teachers' adherence to the prescribed instructional methods in the curriculum. Fourteen (14) teachers were randomly assigned to implement the LFC curriculum. Fidelity was measured 3 times over an academic year using a curriculum fidelity checklist. Teachers exhibited fidelity to the activities prescribed in the curriculum. Lesson observation revealed that teachers were using the prescribed teaching methods/activities in their respective classrooms.

Allo (2020) conducted a study in Indonesia on teachers' fidelity toward the implementation of their 2013 curriculum. The study employed a qualitative

method through the use of semi-structured interview. Twenty (20) teachers who taught at the secondary level were sampled for the research. It was outlined in the research that teachers do not follow the recommended activities and methods in the 2013 curriculum. The teachers continued to utilise the traditional method of teaching, thus the lecture method in the classroom in teaching science. This prevented most of the students from participating in the lesson.

Gelmez-Burakgazi (2020) looked at how faithful science teachers in Turkish primary schools were to the recommended teaching methods. Twenty 1st through 4th grade primary education teachers were interviewed during 2016/2017 spring term in relation to the fidelity measures of adherence. The findings showed that variations in context-based aspects and teacher characteristics affected how faithfully primary educators adhered to instructional techniques and approaches. The majority of the teachers reported using other methods of teaching than those outlined in the curriculum, such as direct instruction, drama/role-play, questioning, and play.

Gbadamosi (2013) assessed teachers' awareness and utilisation of prescribed innovative teaching methods in the secondary science syllabus in Nigeria. The study employed 300 science teachers from Oyo State. Questionnaires and observational checklists were used to collect both quantitative and qualitative information. The results of Gbadamosi showed that teachers employed teaching methods in the classroom which did not conform to the prescribed innovative methods although they demonstrated high awareness of the teaching methods. This demonstrated that science teachers did not implement the science curriculum with fidelity. Similar results were obtained by Annafo et al. (2018) who pointed out that it is one thing having the

knowledge of the prescribed teaching methods as a science teacher and another, is the ability to effectively implement that knowledge in your teaching activities. This means that teachers may have knowledge of the prescribed teaching methods but may find difficulties in implementing them in the classroom.

In Ghana, Zar (2015) investigated SHS teachers' fidelity to the English Language curriculum in Bompeh SHS in Western Region. The study employed a purposive sampling technique to select 8 English teachers. It was reported that English teachers employed the lecture method in teaching the English language which was different from the prescribed teaching methods in the English language curriculum. This showed that English language teachers in Bompeh Senior High Technical School did not implement the English curriculum with fidelity. A similar result was observed by Okra (2002) who assessed teachers' fidelity to the English Language curriculum in the Senior High Schools in the Sunyani district in the Bono Region of Ghana. The study found that SHS teachers employed teaching methods that were different from the prescribed teaching methods in the syllabus indicating that the teachers did not implement the curriculum with fidelity.

Otami (2019) assessed Junior High School (JHS) teachers teaching methods and how they conform to the prescribed teaching methods in the Ghanaian 2010 JHS Integrated Science syllabus. The study employed interviews and an observational checklist to collect qualitative information from the teachers. Lesson observation revealed that JHS Integrated Science teachers employed the expository method, thus, lecture and chalk and talk method in teaching Integrated Science. These teaching methods that were utilised in the

classroom in teaching did not align with the teaching methods and activities recommended or prescribed by the 2010 JHS Integrated Science syllabus.

Generally, it appears from the literature that, little is known on SHS Integrated Science teachers' fidelity to the 2010 SHS Integrated Science curriculum. This study, therefore, sought to investigate SHS science teachers' fidelity to the implementation of the 2010 SHS Integrated Science curriculum in Ghana.

Reasons for teachers' usage or non-usage of prescribed teaching methods

Teaching methods have been documented as one of the important aspects of an educational process that affect students' interest, understanding and academic performance (Whittle, Telford & Benson, 2018). Many curricula worldwide including Ghana's SHS integrated science curriculum prescribe effective constructivist and student-centered teaching methods teachers should employ in their classrooms. However, several studies (Anderman, Sinatra & Gray, 2012; Annafo, Amoah, Baah & Assem, 2018; Bumen et al., 20214 Caughey, 2018; Dusenbury et al., 2003) have documented that some teachers employ these prescribed teaching methods whilst others fail to utilize the prescribed methods in the classroom. Although all curricula are developed based on "theories of learning, teaching, and assessment, and teachers are generally given only one curriculum design, teachers implement the curriculum in different ways" (Songer & Gotwals, 2005). This section, therefore, reviews the literature on some of the reasons for teachers' usage or non-usage of prescribed teaching methods.

Dagnew (2017) explored the reasons for teachers' utilization of prescribed constructivist teaching methods. Teachers were asked to indicate the

reasons for their utilization of these prescribed teaching methods in their classrooms. The teachers indicated that constructivist teaching methods increase students' participation, understanding and performance. This finding was supported by Whittle, Telford and Benson (2018) who posited that constructivist teaching methods improve the conceptual understanding of students in the classroom.

Gelmez-Burakgazi (2020) assessed the reasons elementary science teachers in Turkey failed to employ the prescribed teaching methods in the curriculum. Twenty teachers were interviewed on the reasons for their non-utilisation of the prescribed teaching methods. The teachers teaching science claimed that although they made an effort to implement student-centred teaching methods in their classes, there was a disconnect between their implementation and the curriculum's required activities. Teachers perceived several obstacles to implementation, such as inadequate school facilities, insufficient time, large class sizes, discrepancies between their beliefs about curriculum and promoting learning, and disapproval of certain assigned activities. Sometimes teachers' responses stemmed from disagreements with the curriculum rather than from misunderstandings. According to Fatokun et al. (2019), there are different innovative teaching methods that can be used to teach science. However, many science teachers fail to use them due to the fact that some of them are not familiar with how to integrate them in teaching and others are not willing to implement them in the classroom. Again, their study highlighted that teachers who have knowledge and aware of innovative teaching methods are resistant to change and do not want to abandon their old methods of teaching.

Anderman, Sinatra and Gray (2012) assessed the reasons why teachers fail to use prescribed teaching methods in the classroom. The study outlined that teachers' lack of appropriate skills in using the prescribed teaching methods and the unavailability of teaching and learning materials were the paramount reasons teachers fail to employ the prescribed teaching methods in the classroom and utilisation of these teaching methods are time consuming. Similar results were obtained by Ertmer and Simons (2006) on some of the motives behind teachers' non-usage of prescribed constructivist teaching methods in the classroom. The outcome of the study indicated that low knowledge level of teachers affected how they utilised certain teaching methods/activities in the science classroom. Again, inadequate appropriate teaching and learning materials influenced teachers' non-usage of prescribed teaching methods in the classroom.

In Ghana, Annafo et al. (2018) assessed the reasons why JHS science teachers fail to employ the prescribed constructivist teaching methods in the JHS science syllabus. Their project collected quantitative data from 200 JHS teachers teaching science in Kumasi in the Ashanti Region of Ghana. Close-ended questionnaires were employed in the study. The study showed that several reasons account for teachers' non-usage of the prescribed teaching methods in the JHS science syllabus. These reasons included large size of classes, lack of teaching and learning materials, time and how national examination questions are structured. Unfortunately, the study failed to obtain in-depth information through extensive interviews to get a deeper understanding of why science teachers fail to use these prescribed teaching methods. Similar results were obtained by Abreh et al. (2018) who found that SHS Integrated

Science teachers are unable to complete the science curricula due to insufficient time. Therefore, teachers are forced to employ teacher-centred teaching methods like the lecture method in order to cover many content areas before their final examination.

Otami (2019) assessed reasons JHS Integrated Science teachers fail to utilise the prescribed teaching methods/activities in the Integrated Science syllabus. The study employed interviews to collect qualitative information on the reasons teachers fail to use the prescribed teaching methods in the syllabus. The teachers indicated that an overloaded curriculum, large class size, and inadequate laboratory apparatus and equipment were the major reasons that prevented teachers from utilising the prescribed teaching methods in teaching Integrated Science. Annafo *et al.* (2018) also assessed the reasons for JHS science teachers' non-usage of the activity-based prescribed teaching methods in the JHS science syllabus, and similar results were obtained in the study. Unfortunately, the studies conducted in Ghana fail to look at the reasons for the utilisation or non-utilisation of the prescribed teaching methods in the SHS Integrated Science Syllabus. According to Frimpong (2012), there are some critical factors and issues that prevent Ghanaians teachers from using recommended teaching methods/activities effectively. These include large class sizes and an inadequate supply of teaching and learning materials (Lund & Stains, 2015; Stains & Vickrey, 2017; Zvoch, 2009).

Summary of Key Findings of the Literature Review

Tyler (1949. p. 23) defined the curriculum as "a system of experiences that includes all activities associated with the teaching of a course that is intended to be taught to persons either in or out of the classroom". The

curriculum includes all the teaching activities related to topics to be covered in various classes and courses at an education level (McBrien et al, 1997). Teachers as implementers of the curriculum, are expected to put the various activities in the curriculum into practice to accomplish the intended goals. Therefore, teachers are expected to be assessed from time to time to explore how they implement the curriculum. Dusenbury *et al.* (2003) argued that a useful way of explaining whether curricula are actualised or implemented in the way it was proposed to be executed by the planners constitutes the fidelity of the curriculum.

Cobbold (1999) explains curriculum fidelity as how "faithfully" teachers put the curriculum into practical use in accordance with what the curriculum dictates. This reveals important information about the feasibility of implementation. O'Donnell (2008) indicated that adherence, dose/duration, quality of curriculum delivery, student responsiveness, and curriculum differentiation are the ways through which curriculum fidelity can be measured. However, adherence to the curriculum is the most important element of curriculum fidelity (Gonzalez, 2020; Azano et al., 2011).

Everett Rogers' 1962 diffusion of innovation theory served as the study's theoretical foundation. A framework for comprehending the process by which suggested concepts or innovations are implemented is provided by the theory of diffusion of innovation (Rogers, Singhal, & Quinlan, 2014). Several studies (Gelmez-Burakgazi, 2020; Kafyulilo *et al.* 2012; Musa, Mamuda & Kamba, 2020; Paulo (2014) have been conducted to unravel teachers' awareness of prescribed teaching methods in the syllabus. Some of the studies (Kafyulilo et al., 2012; Paulo, 2014) reveal that teachers are aware of the prescribed teaching

methods whilst some studies (Gelmez-Burakgazi, 2020; Musa et al., 2020) demonstrate that teachers are not aware of the prescribed teaching methods. With regards to the teachers' fidelity, most of the studies conducted on teachers' fidelity to the prescribed teaching methods show that teachers fail to utilise the prescribed teaching methods based on reasons such as class size, time and inadequate teaching and learning materials.

CHAPTER THREE

RESEARCH METHODS

The purpose of this study was to determine SHS teachers' fidelity of the Integrated Science curriculum in Ghana. This chapter deals with the techniques that were employed to conduct the research. It covers the research design, population and sampling technique, data collection instrument, the procedure for data collection, and data processing and analysis technique.

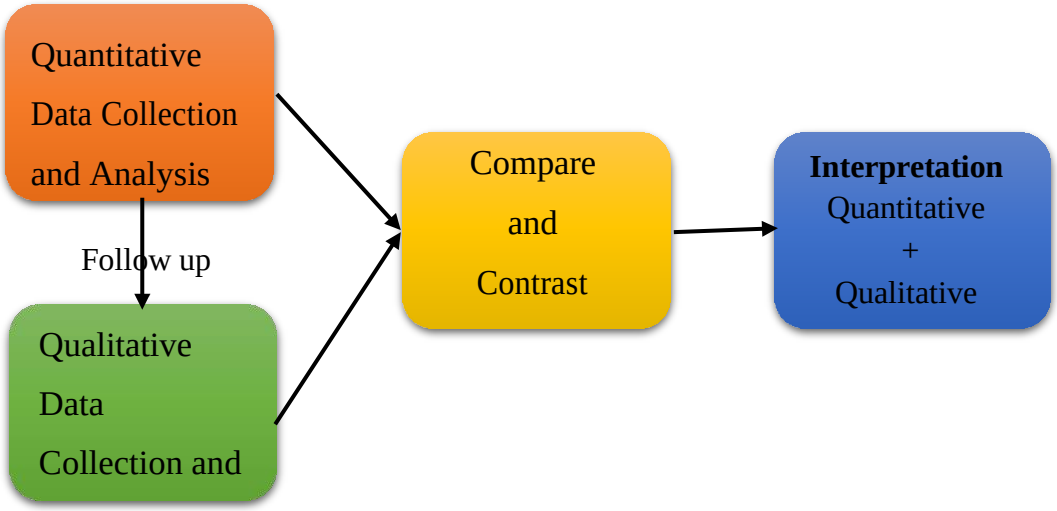
Research Design

A mixed-method approach was employed for the study. According to Creswell *et al*. (2011) the mixed-method collects both quantitative and qualitative information from respondents and has the advantage of combining the strength of both qualitative and quantitative designs. The use of the mixed-methods facilitated the collection of quantitative and qualitative data on science teachers' fidelity to the science curriculum in Ghana. Specifically, the triangulation mixed method design (Ary, Jacobs & Sorensen, 2010) was employed for the study. This design helped to collect quantitative information on teachers' awareness of the prescribed teaching methods in the SHS Integrated Science curriculum and their ideal teaching methods for teaching Integrated Science concepts. This was followed by qualitative information on teachers' actual teaching methods used in the classroom through observation and the reasons for their usage or non-usage of the prescribed teaching methods.

The design helped to obtain different but complementary data on the teaching methods used in teaching science concepts and how they conform to the prescribed teaching methods in the syllabus to best understand the teachers' fidelity to the SHS science syllabus. Since the research sought to directly

compare and contrast prescribed teaching methods in the syllabus with teachers' ideal teaching methods and the actual teaching methods used in the classroom, the triangulation mixed-method was deemed appropriate for the study (Creswell & Clark, 2011; Creswell, 2006).

A diagram of the triangulation mixed-methods design used in this study is presented in Figure 1.



Fig*ure 1:* The triangulation mixed-method design (Alabison,2024)

The quantitative aspect of the mixed-methods for this study was the survey design. The use of a survey design gave the opportunity to collect information with a questionnaire from teachers on the ideal methods for teaching integrated science concepts and their awareness of the prescribed teaching methods in the syllabus. Again, the use of survey design provided consistent information on teachers' awareness of the prescribed teaching methods in the syllabus (Sarantakos, 2013).

After the survey, observations and interviews were conducted to identify teaching methods science teachers use in their respective classrooms as well as identify reasons for their use or non-use of the prescribed teaching methods in

the syllabus. The observations and interviews constituted the qualitative part of the triangulation mixed-method design used for the research.

Although triangulation mixed-method design has the advantage of combining the strength of both qualitative and quantitative designs, its usage came with some challenges. Its usage in research required some level of expertise on the part of the researcher and required a longer timeframe for the study (Doyle, Brady, & Byrne, 2016). The researcher, therefore, read extensively to obtain extensive information on the use of the triangulation method. Again, the benefit obtained from using the design outweighed the shortfalls.

Population

The study targeted all SHS Integrated Science teachers in Ghana. However, the accessible population consisted of all SHS science teachers in the Sekondi-Takoradi Metropolis in the Western Region of Ghana. There are 11 public Senior High Schools in the Secondi-Takoradi Metropolis in the Western Region of Ghana. At the time of data collection, there were 200 Integrated Science teachers in the 11 schools in the Sekondi-Takoradi Metropolis.

Sampling Procedure

Out of the 200 Integrated Science teachers in the 11 Senior High Schools in the Sekondi-Takoradi Metropolis, 189 teachers from the 11 schools were used for the study. The remaining teachers failed to take part in the study because of personal reasons and busy schedule at the time of data collection. One hundred and eighty-nine Integrated Science teachers in the metropolis were used for the quantitative phase of the study. The use of Integrated Science teachers in all 11 schools in the metropolis provided a much more complete

picture of Integrated Science teachers' awareness of the teaching methods prescribed in the syllabus and the teaching methods used in teaching Integrated Science (Lavrakas, 2008). For the qualitative phase of the study, one teacher was randomly selected from each of the 11 schools through computer-generated random numbers to take part in the observation and interview. This was done to obtain a representative sample size for all the teachers in the various schools in Secondi-Takoradi (Saunders *et al.*, 2019). In all, 11 teachers were selected to take part in the observation and interview.

The teachers teaching Integrated Science had varied characteristics. Table 1 shows the demographic descriptions of the respondents.

Table 2: Demographic characteristics of the Respondents

Variable	Sub-Scale	Freq.	%
Gender	Male	122	64.6
	Female	67	35.4
Age Range	20-29	11	5.8
	30-39	81	42.8
	40-49	69	36.5
	50 and above	19	10.1
Highest Academic Qualification	Bachelor's Degree	136	72.0
	Master's Degree	53	28.0
Highest professional Qualification (Education related qualifications)	PGDE/PGCE	30	15.9
	B. Ed.	106	56.1
	M.Ed.	39	20.6
	MPhil	15	7.9
Years of Service	1-5	19	10.1
	6-10	49	25.9
	11-15	57	30.1
	16-20	34	17.9
	Above 20	30	15.9
Forms	SHS 1	65	34.4
	SHS 2	69	36.5
	SHS 3	55	29.1

Source: Field survey, 2024

From Table 1, majority of the teachers were males (n=122, 64.6%) whilst only 67 representing 35.4% were females. With respect to the age range, teachers at the 30-39 were the majority (n=81, 42.8%) and teachers at the 20-29 were the minority (n=11, 5.8%). On the basis of academic qualification, most of the teachers had Bachelor's degrees, (n=136, 72.0%). Only 54 (28.6%) teachers had a Master's degree. Concerning the professional qualification of the teachers, most of the teachers had a B.Ed. qualification (n=106, 56.1%). This was followed by teachers with M.Ed. qualifications (n=39, 20.6%). With respect to the years of service, the majority of the teachers had taught for more than 10 years (n=121, 64.0%). Lastly, out of the 189 teachers used for the study, 65 (34.4%) of them were teaching SHS 1 students, 69 (36.5%) were teaching SHS 2 students and 55 (29.1%) were teaching SHS 3 students.

Data Collection Instruments

Three instruments were used for this study. These were questionnaires, observational checklists and semi-structured interview guides. The questionnaire was used to collect information on teachers' awareness of prescribed teaching methods and the teaching methods used by teachers to teach Integrated Science. The questionnaire asked the teachers to self-report the type of teaching methods they use in the classroom. These teaching methods were classified as "Ideal methods". According to Biesta, Priestley, and Robinson (2015), teachers often have their own beliefs and philosophies about teaching and may prefer certain teaching methods based on their perceptions of what works best for their students. These methods are called teachers' ideal teaching methods. These teaching methods are different from the prescribed teaching methods (Korthagen, 2004).

The questionnaire had both closed and open-ended items with two sections. Section A contained items on the background information of the respondents such as gender, qualification, professional qualification, years of service, and availability of the SHS Integrated Science syllabus. Section B required teachers to provide information on their awareness of the prescribed teaching methods and how they teach selected topics in Integrated Science by indicating the type of teaching methods used in teaching science concepts.

The second instrument was an observational checklist. This was used to collect data on the type of teaching methods used by SHS science teachers in the classroom when teaching selected topics in Integrated Science. Thus, to determine the "Actual" teaching methods in the classroom, the observational checklist was used. The observational checklist was in two sections. The first section (Section A) collected data on the background information of the respondents. This included the topic being taught, class level, class size, and gender of the teacher. The second section (Section B) collected data on the classroom practices of the teacher. This included the type of teaching methods/activities employed by teachers, students' participation in the classroom and teachers' assessment strategies used in the classroom.

The third instrument was a semi-structured interview guide developed to collect qualitative data on the reasons for teachers' usage or non-usage of prescribed teaching methods in the SHS Integrated Science syllabus. The instrument was made up of three items, the first item determined if teachers were aware of the prescribed teaching methods in the Syllabus, the second item determined if teachers use the prescribed teaching methods and the last section determined the reasons for teachers' usage or non-usage of the prescribed

teaching methods. This helped the researcher to delve deeper and obtain an in-depth understanding of the reasons for teachers' usage and non-usage of the prescribed teaching methods in the Integrated Science syllabus.

Validity and Reliability of the Instrument

To ensure the instrument was valid in collecting information from the science teachers, the instrument was presented to my supervisor and two Integrated Science teachers to review. The feedback from these people was incorporated to enrich the instrument. The instruments were pilot-tested with twenty (20) SHS integrated science teachers in four SHS in the Cape Coast Metropolis. These teachers did not form part of the study but had similar characteristics to the sampled teachers. The instruments were pilot-tested to determine if the instrument collected information on the various aspects of methods teachers use in enacting the SHS Integrated Science curriculum. The information obtained from the pilot test was used to modify the instrument to be able to collect consistent information from the respondents.

For the interview and observational checklist, the trustworthiness of the instruments was ensured by recording the responses so that they could be transcribed to produce information as indicated by the respondents. Cronbach Alpha was used to determine the reliability of the questionnaire. A reliability of 0.73 was obtained which indicated that the instrument was reliable (Pallant, 2010). After the main study, the reliability of the questionnaire was again determined using Cronbach Alpha. A reliability of 0.79 was obtained indicating that the instrument was reliable (Pallant, 2010).

Data Collection Procedure

The study sought ethical clearance from the University of Cape Coast Institutional Review Board (UCCIRB). An introductory letter was taken from the Department of Science Education, University of Cape Coast and was presented to the Heads of each school to seek approval for their Integrated Science teachers to be used for the study. The teachers were orientated on the significance and the procedures of the research work by the researcher. This helped to establish rapport with the teachers. A day was agreed to commence the data collection. On the agreed date of data collection, the questionnaires were given to the teachers to complete in order to obtain information on teachers' awareness of the prescribed teaching methods and the teaching methods they employ in teaching selected topics in Integrated Science. The questionnaire administration was done by the researcher and to ensure high completion and response rate of the questionnaire, teachers were allowed appreciable time to complete and submit them over the same day.

The qualitative information was obtained using classroom observation and interviews. Selected teachers were observed three times in an Integrated Science lesson using an observational checklist. The topics taught and their accompanying teaching methods were recorded. After the observation, the teachers were interviewed to elicit the reasons for the usage or non-usage of teaching methods. The interview sections with the teachers were audiotaped after which they were transcribed.

Data Processing and Analysis

Data were analysed based on the research questions raised for the study. Specifically, research question one, which sought to identify teachers'

awareness of the stipulated teaching methods in the Integrated Science curriculum, was analysed with frequency, percentage and chi-square. Chi-square was used to analyse research question one because the independent variable (gender and years of experience, respectively) and the dependent variable (awareness of prescribed teaching methods) are categorical in nature and chi-Square test of independence is commonly used to assesses whether there is a significant association between two categorical variables and helps determine if they are dependent or independent of each other.

The second research question which delineates methods teachers use to teach Integrated Science was analysed with percentages and frequency. Research question three which identified the difference between teachers' ideal teaching methods, actual teaching methods and the prescribed teaching methods in the SHS Integrated Science syllabus was analysed with constant comparison. This was done by comparing the ideal teaching methods, actual teaching methods used in the classroom by direct observation to the prescribed teaching methods in the syllabus and the last research question, which sought to gouge the reasons accounting for teachers' use or non-usage of prescribed teaching methods in the SHS Integrated Science syllabus was analysed with thematic analysis. Thematic content analysis (Brahier, B. R., 2006) was employed because grouping the teachers' reasons for the usage or non-usage of prescribed teaching methods helped in easier understanding and interpretations of the teachers' thoughts.

Ethical Consideration

Given the nature of the study, the researcher and the participants needed to respect one another, build fruitful connections, and create a cooperative

environment. Firstly, the selected schools' heads and Integrated Science teachers were contacted with letters explaining the aim of the research to establish mutual consent to be part of the study. Initial interviews were conducted to explain how the presence of the researcher could impact the science lesson. Furthermore, pseudonyms were used to refer to the participating teachers to ensure the anonymity of teachers (Kearney & Shuck, 2006).

Summary of the Chapter

The study investigated Integrated Science teachers' fidelity to the SHS Integrated science curriculum. The study therefore employed a triangulation mixed-method design to collect both quantitative and qualitative information from SHS Integrated Science teachers in the Sekondi-Takoradi Metropolis in the Western Region of Ghana. A questionnaire, observational checklist and interview guide were the main instruments for data collection. Frequency, percentage direct comparison and thematic analysis were employed to analyse the data.

CHAPTER FOUR

RESULTS AND DISCUSSION

This research investigated SHS science teachers' fidelity to the implementation of the SHS Integrated Science curriculum in Ghana. This chapter presents the results obtained from analyses of data on SHS science teachers' fidelity to the implementation of the SHS Integrated Science curriculum with respect to the research questions raised for the study. The respondents used for the study were Integrated Science teachers at the Senior High Schools in the Secondi-Takoradi in the Western Region of Ghana. Frequency, percentages, Chi-Square, and thematic analysis were used to analyse the results obtained for the study. The results have been presented according to the research questions.

Research Question 1

What is teachers' awareness of the stipulated teaching methods in the Integrated Science syllabus?

Research question one sought to explore teachers' awareness of the prescribed teaching methods in the SHS Integrated Science syllabus. This research question was in three parts. The first part focused on teachers' general awareness of the prescribed teaching methods in the SHS Integrated Science syllabus. The second part focused on the relationship between gender and awareness of the prescribed teaching methods in the syllabus and the last part determined the relationship between SHS Integrated Science teachers' years of service and their awareness of the prescribed teaching methods in the syllabus. To achieve this, 189 teachers were presented with a questionnaire to indicate whether they were aware of the prescribed teaching methods in the Integrated

Science syllabus. The summary of teachers' responses has been presented in Tables 3, 4 and 5.

The results in Table 2 show that out of the 189 teachers, majority (n=149, 79.0%) indicated that they were aware of the prescribed teaching methods in the SHS Integrated Science syllabus. Thus, Integrated Science teachers in senior high schools in Sekondi-Takoradi Metropolis were conversant with the prescribed teaching methods by the science syllabus.

Table 3: Teachers' awareness of the prescribed teaching methods in the syllabus

Variable	Responses	Frequency	Percentage
Teachers' awareness	Yes	149	79.0
	No	40	21.0
	Total	189	100.0

Source: Field data (Alabison, 2024).

The second part of research question one sought to determine the relationship between gender and awareness of the prescribed teaching methods in the syllabus. Data obtained from teachers were analysed with a Chi-Square test of independence where teachers' gender was the categorical independent variable and teachers' awareness was the categorical dependent variable. Preliminary assumptions of 'minimum expected cell frequency', which should be 5 or greater were tested. It was found that 0 cells (.0%) have an expected count of less than 5. This indicated no violation of the assumption as all expected cell sizes were greater than 5. A chi-square test for independence at an alpha of 0.05 indicated no statistically significant association between gender and teachers' awareness of the prescribed teaching methods in the SHS Integrated Science syllabus, $\chi 2$ (1, n = 189) = .004, p = .947, phi = –.01. This

suggests that teachers' awareness of the prescribed teaching methods in the SHS Integrated Science syllabus is not dependent on the gender of the teacher.

Table 4: Chi-Square Test for teachers' awareness of prescribed teaching methods and gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.004	1	.947
N of Valid Cases	189		

Source: Field survey (Alabison, 2024).

The third part of research question one sought to determine the relationship between SHS Integrated Science teachers' years of service and their awareness of the prescribed teaching methods in the syllabus. Data obtained from teachers were analysed with the Chi-Square test of independence, where teachers' years of service was the categorical independent variable and teachers' awareness was the categorical dependent variable. Preliminary assumptions were tested, with no serious violations noted. The analysis showed that there is a statistically significant association between teachers' awareness of prescribed teaching methods and their years of experience $\chi 2$ (4, n = 189) = 32.085 $p<$ 0.001, phi = –.01. This indicates that SHS teachers' awareness of the prescribed teaching methods in the Integrated Science syllabus depends on their years of service.

Table 5: Chi-Square Test for teachers' awareness of prescribed teaching methods and their gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.085	4	0.000
N of Valid Cases	189		

Source: Field survey (Alabison, 2024).

The significant association between teachers' years of service and their awareness of the prescribed teaching methods in the Integrated Science syllabus required that further analysis was conducted to highlight where the significant difference in awareness lay. Pallant (2010) suggests that conducting cross-tabulation is a robust post hoc analysis necessary for identifying the specific source of differences in Chi-Square results. Therefore, cross-tabulation was conducted. According to Tabachnick and Fidell (2019), adjusted residuals with absolute values greater than 2.0 is considered statistically significant, indicating significant deviations from what would be expected by chance alone.

There was a positive adjusted residual of 2.4 for teachers with 1-5 years' experience who were aware of the prescribed teaching methods. This suggests that the observed count of teachers with 1-5 years of experience who are aware of prescribed teaching methods is significantly larger than expected, emphasizing a strong association within this group. This shows that teachers in this experience range are more likely to be aware of the prescribed methods. A negative adjusted residual of -1.1 was recorded for teachers with 6-10 years of experience who were aware of prescribed methods. This result suggests that awareness among teachers in this experience range is significantly lower than anticipated.

A negative adjusted residual of -4.6 was noted for teachers with 11-15 years of experience who were aware of the prescribed teaching methods. A negative adjusted residual emphasises a substantial shortfall in the number of teachers with 11-15 years of experience who are aware of prescribed methods compared to the expected count, revealing a significant difference within this group with a significantly lower awareness level than expected. A positive

adjusted residual of 1.9 for teachers with 16-20 years of experience who were aware of prescribed methods was recorded. This suggests that the observed count of teachers with 16-20 years of experience who were aware of prescribed methods is significantly higher than what was expected. For teachers with over 20 years of experience, there was a positive adjusted residual of 3.1 for teachers who were aware of the prescribed teaching methods. This indicates a substantially higher number of experienced teachers who are aware of prescribed methods compared to what would be expected by chance alone. It suggests that teachers with extensive experience are particularly well-informed about the prescribed teaching methods.

The results illustrate a distinct pattern of awareness of prescribed teaching methods among SHS Integrated Science teachers based on their years of experience. While teachers with 1-5 years and over 20 years of experience exhibit significantly higher awareness levels, those with 6-10, 11-15, and 16-20 years of experience have lower awareness levels.

Table 6: Cross-tabulation of Teachers' Awareness and their Years of Experience

			Awareness		Total
			Yes	No	
Years of Experience	1-5	Count	19	0	19
		% Within Experience	100.0%	0.0%	100.0%
		Adjusted Residual	2.4	-2.4	
	6-10	Count	36	13	49
		% Within Experience	73.5%	26.5%	100.0%
		Adjusted Residual	-1.1	1.1	
	11-15	Count	33	24	57
		% Within Experience	57.9%	42.1%	100.0%
		Adjusted Residual	-4.6	4.6	
	16-20	Count	31	3	34
		% Within Experience	91.2%	8.8%	100.0%
		Adjusted Residual	1.9	-1.9	
	>20	Count	30	0	30
		% Within Experience	100.0%	0.0%	100.0%
		Adjusted Residual	3.1	-3.1	
Total		Count	149	40	189
		% Within Experience	78.8%	21.2%	100.0%

Source: Field survey (Alabison, 2024).

The finding that SHS Integrated Science teachers are aware of the prescribed teaching methods of the science syllabus is in consonant with the findings of Paulo (2014), who investigated secondary school teachers' awareness of the prescribed teaching methods in Tanzania. Paulo observed that

teachers at secondary schools in Tanzania were able to state the teaching methods stipulated in their science syllabus. Thus, they had knowledge of the

stipulated teaching methods in their syllabus. Similarly, the finding of this study is supported by the findings of Kafyulilo *et al.* (2012), who also assessed teachers' awareness of the prescribed teaching methods of science syllabus in Tanzania. Kafyulilo et al. revealed that science teachers knew the stipulated teaching methods in the syllabus.

However, the finding of this study was not in consonant with the findings of Musa et al. (2020), Fatokun et al. (2019) and Otami (2019). For instance, Musa et al. (2020) demonstrated that most science teachers in Kebbi State, Nigeria were not aware of the prescribed innovative teaching methods in the secondary school syllabus. Fatokun et al. (2019) also found that most science teachers are not aware of stipulated teaching methods in the science syllabus because the teachers employed different teaching methods in the classroom which were different from the stipulated teaching methods in the SHS Integrated Science syllabus. Otami (2019) observed that teachers were not aware of the prescribed teaching methods for Integrated Science at the junior high school level.

The results of this study suggest that the sampled teachers are conscious of the methods expected from them to enact various science concepts in the syllabus. Such realisation is critical for the implementation of the curriculum**.** The ambitions and expectations from which stakeholders developed the curriculum could be realised if teachers are aware of the learning experiences they are to provide to learners for them to attain the learning and developmental outcomes stipulated in the curriculum.

With respect to the relationship between teachers' awareness and their gender, despite the fact that not many studies have been conducted to determine

the association between teachers' awareness of prescribed teaching methods and their gender, the few studies (Gbadamosi, 2013; Khurshid & Zahur, 2013; Olagunju & Abiona, 2008) conducted contradict the findings of the current study. For instance, Gbadamosi (2013) found that the gender of teachers has an association with their awareness, manner and level of utilisation of prescribed teaching methods. Furthermore, Khurshid and Zahur (2013) concluded in their study that female teachers are more aware and utilise prescribed teaching methods than male teachers. They proffered that female teachers are more concerned about the academic performance of their students than their male counterparts therefore, they tend to familiarise themselves with the prescribed innovative teaching methods with the aim of improving students' performance. Again, the finding of this study contradicts the finding of Olagunju and Abiona (2008) who opined that senior high school teachers' awareness and utilisation is dependent on their gender. Male teachers demonstrated higher awareness than female teachers in their study.

The finding that there is no association between the gender of SHS Integrated Science teachers and their awareness of the prescribed teaching methods could be due to the fact that both male and female teachers in the study had equal access to teacher training programs, workshops, and educational resources related to the prescribed teaching methods. If training opportunities and resources are distributed fairly regardless of gender, it can lead to similar levels of awareness among male and female teachers.

Lastly the finding that there is an association between teachers' years of experience and their awareness of the prescribed teaching methods is in consonant with the finding of Achor and Ogbeba (2010) and Khursid and Zahur

(2013) who found that teachers' years of experience has an association with their awareness of the prescribed teaching methods. Teachers who are experienced with about 10 years of practice demonstrated a high level of awareness than their counterparts with less than 10 years of experience.

Again, the finding of an association between teachers' awareness of prescribed teaching methods and years of experience is similar to the finding of Davis, D. L. (2014), who pointed out that experience is one variable in education that has an association with teachers' awareness of prescribed methods of teaching. Ehrenberg et al. (1995) also found that teachers' awareness of innovative teaching methods is dependent on their years of experience. The differential patterns of awareness among SHS Integrated Science teachers, as revealed in the studDy, underscore the complex interplay between experience and curriculum engagement (Cossentino, 2003; Gbadamosi, 2013).

Teachers in the early stages of their careers (1-5 years) and those with extensive experience (over 20 years) demonstrate notably higher levels of awareness regarding the prescribed teaching methods. This observation suggests a strong engagement with the curriculum and its recommended teaching methods at these points in a teaching career (Gbadamosi, 2013). The high awareness among teachers with 1-5 years could be attributed to recent education, where prescribed teaching methods and curriculum details are fresh and emphasised. Their recent education likely equips them with high knowledge of prescribed teaching methods in the syllabus. For teachers with over 20 years of experience, their high awareness can be seen as a testament to their dedication to continuous learning and adaptation over time. It is possible that this group has actively sought out opportunities for professional development or has

accumulated a wealth of practical experience that aligns with or even anticipates changes in teaching methods and curriculum expectations. On the other hand, the low awareness observed among teachers with 6-10, 11-15, and 16-20 years reflect a period in a teacher's career where the initial enthusiasm has stagnated, and the opportunity for or engagement in professional growth may be less frequent or impactful (Davis, B. R., 2014),

Research Question 2

Which methods do teachers use to teach content prescribed in the SHS Integrated Science syllabus, and how do these methods align with the prescribed teaching methods?

Research question two sought to identify methods SHS teachers use to teach content prescribed in the Integrated Science syllabus in their classrooms and their alignment with the prescribed teaching methods. In other words, to identify teachers' ideal teaching methods and their alignment with the prescribed methods in the syllabus. Firstly, 189 teachers were presented with a questionnaire with Integrated Science concepts to indicate how they normally teach the science concepts based on the form they teach. Their ideal teaching methods were recorded.

Based on the teachers' responses, five teaching methods emerged. Thus, Integrated Science teachers used either lecture method, discussion method, demonstration, group work and practical method in teaching Integrated Science concepts. Frequency and percentage scores of teachers' responses on each Integrated Science topic were calculated to ascertain how teachers teach individual topics in the Integrated Science syllabus. The summary of teachers' responses has been presented in Table 6.

Table 7: Teaching methods used by Integrated Science teachers in teaching Integrated Science concepts

Level	Topics	N	Teaching Methods	Prescribed Methods				
			Lecture N (%)	Discussion N (%)	Demonstration N (%)	Group work N (%)	Practical N (%)	
SHS 1	Introduction to Integrated Science.	65	44 (67.7)	21 (32.3)	0 (0.0)	0 (0.0)	0 (0.0)	Discussion, group work and project
	Measurement	65	24 (36.9)	5 (7.6)	6 (9.2)	12 (18.5)	18 (27.7)	Discussion and practical
	Diversity of living and non-living things.	65	46 (70.8)	10 (15.4)	4 (6.2)	5 (7.6)	0 (0.0)	Discussion
	Matter	65	16 (24.6)	35 (53.8)	4 (6.1)	4 (6.1)	6 (9.2)	Discussion and practical work
	Cells and cell division	65	46 (70.8)	11 (16.9)	8 (12.3)	0 (0.0)	0 (0.0)	Discussion
	Rocks	65	34 (52.3)	24 (36.9)	2 (3.1)	3 (4.6)	2 (3.1)	Discussion
	Air movement	65	49 (75.4)	12 (18.5)	2 (3.1)	1 (1.5)	0 (0.0)	Discussion
	Nitrogen cycle	65	58 (89.2)	7 (10.8)	0 (0.0)	0 (0.0)	0 (0.0)	Discussion
	Skeletal System	65	22 (33.8)	37 (56.9)	4 (6.2)	2 (3.1)	0 (0.00)	Discussion
	Reproduction and Growth in Plants	65	38 (58.5)	15 (23.1)	0 (0.0)	12 (18.5)	0 (0.0)	Discussion and project work
	Respiratory System	65	49 (75.4)	10 (15.4)	0 (0.0)	6 (9.22)	0 (0.0)	Discussion
	Food and Nutrition	65	15 (23.1)	37 (56.9)	5 (7.7)	8 (12.3)	0 (0.0)	Discussion
	Dentition, Feeding and Digestion in mammals	65	34 (52.3)	24 (36.9)	2 (3.1)	2 (3.1)	3 (4.6)	Discussion
	Transport-Diffusion, Osmosis and Plasmolysis	65	23 (35.4)	17 (26.2)	5 (7.7)	10 (15.4)	10 (15.4)	Project work, practical and discussion

Table 7:Cont'D

	Forms of Energy and Energy Transformation	65	26 (40.0)	34 (52.3)	2 (3.1)	2 (3.1)	1 (1.5)	Discussion
	Solar Energy Photosynthesis	65	34 (52.3)	24 (36.9)	2 (3.1)	2 (3.1)	3 (4.6)	Discussion
	Electronics	65	50 (76.9)	10 (15.4)	0 (0.0)	2 (3.1)	3 (4.6)	Discussion and project work
	Ecosystem	65	40 (61.5)	10 (15.4)	3 (4.6)	10 (15.3)	2 (3.1)	Discussion and field trip
	Atmosphere and Climate Change	65	49 (75.4)	10 (15.4)	0 (0.0)	6 (9.2)	0 (0.0)	Discussion and project work
	Infections and diseases	65	26 (40.0)	25 (38.5)	4 (6.2)	10 (15.3)	0 (0.0)	Discussion
SHS 2	Acids, Bases and Salts	69	25 (36.2)	26 (40.0)	10 (14.4)	4 (5.8)	4 (14.5)	Practical work, demonstration, and discussion
	Soil conservation	69	53 (76.8)	14 (20.3)	0 (0.0)	2 (2.9)	0 (0.0)	Project work and discussion
	Water	69	23 (33.3)	36 (55.4)	1 (1.5)	0 (0.0)	5 (7.7)	Discussion and project work
	Hydrological Cycle	69	64 (92.8)	4 (5.8)	0 (0.0)	1 (1.4)	0 (0.0)	Discussion and project work
	General principles of farm animal production	69	36 (52.2)	26 (37.7)	2 (2.9)	2 (2.9)	2 (2.9)	Discussion
	Excretory system	69	34 (49.3)	28 (40.6)	0 (0.0)	7 (10.1)	0 (0.0)	Discussion
	Reproductive Systems and growth in mammals	69	14 (20.2)	51 (73.9)	0 (0.0)	4 (5.8)	0 (0.0)	Discussion
	Circulatory System	69	34 (49.3)	28 (40.6)	0 (0.0)	7 (10.1)	0 (0.0)	Discussion
	Electrical Energy	69	28 (40.6)	14 (20.3)	12 (17.4)	5 (7.2)	10 (14.5)	Field trip and discussion
	Electronics	69	51 (73.9)	4 (5.8)	4 (5.8)	0 (0.0)	10 (14.5)	Discussion
	Sound Energy	69	28 (40.6)	14 (20.3)	12 (17.4)	5 (7.2)	10 (14.5)	Discussion
	Nuclear Energy	69	44 (64.8)	12 (17.4)	4 (5.8)	10 (14.5)	0 (0.0)	Discussion
	Magnetism	69	28 (40.6)	19 (27.5)	12 (17.4)	5 (7.2)	5 (7.2)	Discussion

Table 7:Cont'D

	Forces, Motion and pressure	69	25 (36.2)	35 (54.8)	4 (5.8)	0 (0.0)	5 (7.2)	Group work and discussion
	Safety in the Community	69	34 (49.3)	28 (40.6)	0 (0.0)	7 (10.1)	0 (0.0)	Discussion and project
	Endogenous Technology	69	44 (63.8)	20 (40.6)	0 (0.0)	5 (7.2)	0 (0.0)	Discussion
	Biotechnology	69	44 (63.8)	17 (24.6)	4 (5.8)	5 (7.2)	0 (0.0)	Discussion
	Work and Machines	69	42 (60.9)	20 (29.0)	0 (0.0)	7 (10.1)	0 (0.0)	Discussion
SHS 3	Metals and Non-Metals	55	33 (60.0)	14 (25.5)	0 (0.0)	5 (7.2)	3 (5.5)	Practical and discussion
	Exploitation of minerals	55	29 (52.7)	18 (32.7)	0 (0.0)	8 (14.5)	0 (0.0)	Discussion
	Organic and Inorganic	55	50 (90.1)	0 (0.0)	0 (0.0)	5 (9.1)	0 (0.0)	Discussion
	Life Cycles of Pests and Parasites	55	29 (52.7)	12 (21.8)	1 (1.8)	8 (14.5)	5 (9.1)	Discussion
	Crop Production	55	29 (40.0)	20 (36.4)	0 (0.0)	6 (10.9)	0 (0.0)	Project and discussion
	The Nervous System	55	25 (45.5)	20 (36.4)	0 (0.0)	10 (18.2)	0 (0.0)	Discussion
	Light Energy	55	29 (52.7)	12 (21.8)	1 (1.8)	8 (14.5)	5 (9.1)	Discussion
	Heat Energy	55	29 (52.7)	12 (21.8)	1 (1.8)	8 (14.5)	3 (5.5)	Demonstration and discussion
	Electronics	55	42 (76.4)	10 (18.2)	0 (0.0)	0 (0.0)	3 (5.5)	Discussion and project
	Variation and inheritance	55	38 (69.1)	8 (14.5)	1 (1.8)	8 (14.5)	0 (0.0)	Discussion

Source: Field survey (Alabison, 2024).

From Table 7, there was greater use of the lecture method in teaching Integrated Science by teachers as compared to the discussion, demonstration, group work, and practical approaches. Most of the SHS 1 Integrated Science teachers employed the lecture method in teaching science concepts such as introduction to Integrated Science (n=44, 67.7%), Cells and cell division (n=46, 70.8%), air movement (n=49, 75.4%), nitrogen cycle (n=58, 89.2%), rocks (n=34, 52.3%), respiratory system (n=49, 75.4%), Reproduction and growth in plants (n=38, 58.5%), Dentition, Feeding and Digestion in mammals (n=34, 52.3%), Electronics (n=50, 76.9%), Ecosystem (n=40, 61.5%) and Atmosphere and Climate Change (n=49, 75.4%) which did not align with discussion, project work and practical outlined in the syllabus for teaching these concepts. Only topics such as matter (n=35, 53.8%), food and nutrition (n=37, 56.9%), skeletal system (n=37, 56.9%), forms of energy and energy transformation (n=34, 52.3%) were taught by the majority of the teachers using discussion method which conformed with the prescribed teaching methods. Surprisingly, topics such as measurement (n=18, 27.7%) and Transport-Diffusion, Osmosis and Plasmolysis (n=10, 15.4%) that involved practical work according to the SHS syllabus were taught by a small number of teachers using practical work.

Similar results were seen for SHS 2 science concepts. There was greater use of the lecture method in teaching concepts such as Soil conservation (n=53, 76.8%), Hydrological Cycle (n=64, 92.85%), General principles of farm animal production (n=36, 52.2%), excretory system (n=34, 49.3%), Electronics (n=51, 73.9%), Nuclear Energy (n=44, 64.8%) and Biotechnology (n=44, 64.8%) which did not conform to the prescribed method (discussion). On the other hand, majority of the teachers utilised discussion method on topics such as water

(n=36, 55.4%), forces, motion and pressure (n=35, 54.8%) and Reproductive systems and growth in mammals. Only a few of the teachers employed group work, demonstration and practical in teaching all the SHS 1 Integrated Science concepts. Topics such as Acids, Bases and Salts and Metals and Non-Metals that demanded practical work were taught by only few teachers using practical.

In SHS 3, majority of the teachers taught all the Integrated science concepts using the lecture method with a section of the teachers using the discussion method as demonstrated in Table 7. Very few teachers employed demonstration, group work, and practical in teaching Integrated Science as shown in Table 7 which aligned with the prescribed methods in the syllabus. This means that the activity-oriented teaching methods such as group work, project work and practical work prescribed by the SHS Integrated Science syllabus are not being utilized in the classroom by the majority of Integrated Science teachers.

The findings showed that teachers, on average, used the lecture method, which is a teacher-centred approach to teach Integrated Science concepts. This is similar to the assertions of Allo (2020), who pointed out that many science teachers continue to employ traditional teaching methods such as the lecture method in teaching science. This makes it difficult for students to develop an understanding of science concepts.

The majority of the proposed instructional approaches for integrated science, including group projects, field trips, practical work, and project work, were not used, according to the research's findings. In order to comply with the Integrated Science syllabus's proposed methods/activities, teachers must allow students to participate actively in their courses and avoid teacher-centred

methods of instruction like the lecture method (MoE, 2010). The finding of this study also showed the unpopularity of some of the prescribed teaching methods in the Integrated Science syllabus like field trip, project work, group work and practical work among teachers. This is not encouraging because of the numerous advantages associated with these methods in teaching science which involve many abstract concepts (Anderson, et al., 2001).

Research Question 3

How do teachers' ideal teaching methods and the teaching methods/activities used in the classroom conform to prescribed methods in the SHS integrated science teaching syllabus?

Research question three sought to determine how teachers' ideal teaching methods and their actual teaching methods used in the classroom conform to the prescribed teaching methods in the SHS Integrated Science teaching syllabus. To answer this research question, 11 Integrated Science teachers from the 11 schools in the Sekondi-Takoradi metropolis were observed in their classrooms to determine how they teach content prescribed in the syllabus. The idea was to determine if there is alignment between the teachers' ideal teaching methods, the teaching methods employed in the classroom during Integrated Science lessons and those prescribed in the syllabus. The 11 selected teachers were given a questionnaire to collect data on their ideal teaching methods of Integrated Science concepts. This was followed by observation to determine what they actually do or practice in the classroom. Each teacher in the schools was observed three times and the teaching methods used to teach were recorded. After the classroom observations, teachers' ideal teaching methods, actual teaching methods and the prescribed teaching methods were

compared. In order to ensure the confidentiality and anonymity of the participating teachers, pseudonyms were assigned to each teacher. These pseudonyms were used throughout the study to replace the actual names of the teachers, thereby safeguarding their privacy and identity. The presentation of the results has been done according to the 11 teachers observed.

John Integrated Science Lesson

John taught Integrated Science in the SHS 3 class, made up of 44 students. He was aged above 50 years at the time of data collection and had taught Integrated Science for 20 years. He holds a Master's degree in Education (M. Ed). He indicated that he had a personal copy of the integrated science syllabus and used it frequently in preparing for his lessons. John's teaching was observed three times in his SHS 3 class and the various teaching methods used in his delivery were documented using the observational checklist. John taught Metals and Non-metals.

Teaching Methods/Activities

In the first lesson observed, John started the lesson by writing the topic "Metals and Non-metals" on the board. After writing the topic, he started explaining what metals and non-metals are with examples to students. After the explanations and examples, he then dictated notes for students to write. The teacher continued the lesson with an explanation of the concepts orally to students without using any appropriate teaching and learning materials in the classroom. This shows that the teacher employed the lecture method, which was purely teacher-centred. On the second and third days of observation, the teacher started the lesson with the same process that was previously done. The teacher introduced the lesson by writing the topic on the board which was followed by

an explanation of the various concepts taught. It can be concluded from the observation that, John used the lecture methods throughout the teaching and learning process. After the lesson observation, John's ideal teaching methods, actual teaching methods and the prescribed teaching methods were compared. The result has been summarised in Table 8.

Table 8: Results of ideal, actual and prescribed teaching methods of John

Lesson	Topic	Sub-topic taught	Ideal teaching method	Actual teaching method	Prescribed teaching method
1	Metals and Non-metals	Classification of elements into metals, semi-metals and non-metals and their properties	Discussion	Lecture	Discussion
2		Uses of metals, semi-metals and non-metals.	Discussion	Lecture	Discussion
3		Alloys, properties and uses.	Lecture	Lecture	Discussion

Source: Field Survey (Alabison, 2024).

It can be seen from Table 8 that John's ideal teaching method for teaching metals and non-metals was the discussion method which differed from the teaching method (lecture method) employed in the classroom when observed. Thus, there was a difference between John's ideal teaching method and the actual teaching method employed in the classroom. However, John's

ideal teaching method conformed to the prescribed teaching methods in the classroom. This shows that John had knowledge of the prescribed teaching methods in the SHS science syllabus although the method he used was different from the prescribed teaching method for the topic that was taught.

Judith Integrated Science Lesson

Judith taught integrated science in the SHS 2 class made up of 49 students. She was aged between 40-49 years at the time of data collection and had taught integrated science for about 11-15 years. She holds a Bachelor's degree in Education (Science Education). She stated that she had a personal copy of the integrated science syllabus and frequently use the syllabus in her lesson preparation. Judith's teaching was observed three times in his SHS 2 class and the various teaching methods used in her delivery were documented using the observational checklist. Judith taught Acids and Bases.

Teaching methods/Activities

In the first lesson observed, Judith concentrated on the definition and properties of acids and bases. She taught the students the various types of definitions of acids and bases and the various physical and chemical properties of acids and bases. The lesson was teacher-centred with Judith presenting and explaining information to students from their Integrated Science textbooks. Although the teacher gave several examples of acids and bases in the environment, there were no discussions or chemical tests to show the chemical properties of acids and bases.

In the second lesson observed, Judith taught the SHS 2students' classification and preparation of salt whereby she presented content information without any practical activity. She also explained the concept to students

through a chalkboard demonstration. The teacher wrote the reaction between Hydrochloric acid and sodium hydroxide and explained how salt is formed from this reaction. On the last day of observation, Judith taught acid-base indicators to students. Again, the lesson was teacher directed with Judith explaining the various acid-base indicators and their uses. The teacher came to the class without any acid-base indicators such as litmus paper, methyl orange, phenolphthalein and methyl red. Although Judith intermittently asked questions at different times, the students were very passive recipients and did not take any active role in the lesson.

The summary of the results of Judith's ideal teaching methods, actual teaching methods and prescribed teaching methods has been presented in Table 9.

Table 9: Results of ideal, actual and prescribed teaching methods of Judith

Lesson	Topic	Sub-topic taught	Ideal teaching method	Actual teaching method used	Prescribed teaching method
1	Acid and Bases	Definitions and properties of acids and Bases	Discussion	Lecture	Discussion
2		Classification of acids and bases.	Discussion	Lecture	Discussion
		Preparation of Salt	Practical	Lecture	Practical
3		Acid-Base Indicator	Lecture	Lecture	Discussion

Source: Field survey (Alabison, 2024).

As shown in Table 9, when Judith was asked to indicate her ideal teaching method (s) in teaching acid, base and salt before the lesson observation, she indicated the discussion method but when she was observed in the classroom, she employed the lecture method. This means that there was a difference between Judith's ideal teaching method and the actual teaching method used in the classroom. However, Judith's ideal teaching method (discussion) conformed to the prescribed teaching methods (discussion) in the syllabus. Thus, there was no difference between Judith's ideal teaching method and the prescribed teaching method in the SHS science syllabus. It can, therefore, be seen from the results that, although Judith knew the prescribed teaching methods in the Ghanaian SHS science syllabus for the concepts she was teaching, she employed the lecture teaching method in the classroom which did not conform to the prescribed teaching methods.

Joshua's Integrated Science Lesson

Joshua was teaching Integrated Science in the SHS 2 class which comprised 48 students. Joshua had taught Integrated Science in the school for 2 years. Joshua possessed Master of Education (M. Ed) with science as his area of specialisation. He had a personal copy of the 2010 science syllabus but never uses it in his lesson preparation. Joshua taught Excretory system.

In all three lessons observed, Joshua used lecture methods in the lesson. He first mentioned the topic to be taught in the classroom and explained the concept of excretion and wrote it on the chalkboard for students' consideration. Joshua showed a picture of the excretory system on a chart to students. Students then drew the excretory system in their books. A similar situation occurred on the second and third day of observation. The teacher explained the various

organs of the excretory system and their products and disorders of the urinary system in humans by using a picture of the excretory system on a chart. Students' participation in the lesson was characterised by the writing of points from the chalkboard into their notebooks. Although some of the students asked questions during the lesson, there was no evidence of student-student interaction throughout the lesson. Joshua's ideal teaching methods, actual teaching methods and the stipulated teaching methods in the SHS science syllabus have been presented in Table 10.

Table 10*: Results of ideal, actual*, and prescribed teaching methods of Joshua

Lesson	Topic	Sub-topic taught	Ideal teaching methods	Actual Teaching methods	Prescribed teaching method
1	Excretory System	Definitions of excretory system and excretory organs	Lecture	Lecture	Discussion
2		Excretory organs and their functions	Lecture	Lecture	Discussion and demonstration
3		Problems of the excretory system	Lecture	Lecture	Discussion Demonstration

Source: Field Survey, 2024.

From Table 10, it can be observed that Joshua's ideal teaching method for teaching the excretory system was the lecture method which was similar to

his actual teaching method in the classroom. This means that there was a similarity between Joshua's ideal teaching method and his actual teaching method in the classroom. However, Joshua's ideal method of teaching the excretory system was different from the prescribed teaching method in the science syllabus. With regard to the difference in teaching methods between the actual teaching method and the prescribed teaching method, discussion methods were prescribed in the syllabus to be used in the teaching excretory system but Joshua employed lecture methods in the classroom.

Maxwell's Integrated Science Lesson

Maxwell was a teacher in SHS 2 class with 49 students. Maxwell was aged 30-39 years and holds a Bachelor's Degree with 8 years of teaching experience. Maxwell had a personal copy of the 2010 SHS integrated science syllabus and frequently used it in his lesson preparation. Maxwell's lesson was observed three times and the teaching methods used during the lesson were documented with an observational checklist. Maxwell was teaching a topic called Magnetism

Teaching methods/Activities

Maxwell reviewed students' previous knowledge that was pertinent to the course at the beginning. Maxwell delivered the lesson via a lecture. For students to follow, Maxwell first wrote an explanation of magnetism, magnetic materials, and magnetic fields on the chalkboard. The purposes and types of magnets were described, with additional information written on the whiteboard. For the benefit of the students, a supplementary illustration of the magnetic field surrounding a magnet was posted on the chalkboard. Similar practices were done in the second and third day of observation with Maxwell using lecture

method where the students were passive recipients of information. After the observation Maxwell's ideal teaching methods, actual teaching methods and the prescribed teaching methods were compared and presented in Table 11;

Table 11: Results of ideal, actual and prescribed teaching methods of Maxwell

Lesson	Topic	Sub-Topic	Ideal teaching methods	Actual teaching methods	Prescribed teaching methods
1	Magnetism	Magnet and magnetic materials	Lecture and Demonstration	Lecture	Discussion
2		Types of magnets and their uses	Lecture and demonstration	Lecture	Discussion
3		Magnetic field	Lecture and demonstration	Lecture	Discussion

Source: Field Survey, 2024.

From Table 11, it can be observed that the syllabus recommends discussion and brainstorming as the methods of teaching magnetism but Maxwell employed lecture method in all his lessons. This showed that Maxwell's actual teaching methods in the classroom was inconsistent with the methods prescribed by the Integrated Science syllabus. Again, the ideal teaching method of Maxwell was inconsistent with the prescribed teaching methods. This showed that Maxwell was not aware of the prescribed teaching methods in the syllabus.

Stephen's Integrated Science Lesson

Stephen's lesson was at SHS 2 class which comprised 52 students. Stephen had Bachelor's degree in Chemistry and was in his 10th year of teaching integrated science in the school. The highest professional qualification was Post Graduate Diploma in Education (PGDE). Stephen had a personal copy of the SHS integrated science syllabus but rarely use it in his lesson preparation. Stephen was also teaching Acid, Base and Salt.

Teaching Methods/Activities

Stephen used lecture method in his lesson delivery in all the three observed lessons. On the first day of observation, Stephen started the lesson by writing the topic on the board. He continued to explain acid and bases as well as properties of acid and bases to students and wrote it on the chalkboard for the students to write in their note books. An experimental procedure to test for the physical properties of acid and bases was explained after which he wrote the procedure on the board for students to copy. On the second and third days of observation, Stephen continued the lesson with lecture method in teaching common chemical substances that are acidic and basic as well as preparation of salts. Teacher started the lesson with explanation of the various concepts to the students and later wrote them on the board for students to copy. Since most of the explanations were done by the teacher, the lesson became teacher centred and the students were passive during the entire lesson. The students only answered questions posed by the teacher during the lesson. Summary of teacher's teaching method during the lesson and the teaching method they said they will use in the classroom before observation and the prescribed teaching methods by the SHS science syllabus has been presented in the Table 12.

Table 12: Results of Ideal, Actual and Prescribed teaching methods of Stephen

Lesson	Topic	Sub-topic taught	Ideal teaching method	Actual teaching methods	Prescribed teaching method
1	Acid and Bases	Definitions and properties of acids and Bases	Discussion	Lecture	Discussion
2		Chemical substances that are acidic and basic	Discussion	Lecture method	Discussion
3		Preparation of Salts	Lecture	Lecture method	Discussion and Practical work

Source: Field survey (Alabison, 2024)

From Table 12, it can be seen that the science teacher indicated that he employs discussion method however, when he was observed in the classroom, he used lecture method in the entire lesson delivery. This showed that there is disparity in the ideal teaching methods of the teacher and the real teaching method employed in the classroom. Again, although some of the teaching methods such as discussion method stated by Stephen before observation conformed to the prescribed teaching methods by the SHS Integrated Science syllabus, the teaching methods used by the teacher during observation were different from the prescribed teaching methods by the syllabus. This demonstrates that there were differences among the teacher's ideal teaching method, what he actually did and what the syllabus prescribes.

Ebenezer's Integrated Science Lesson

Ebenezer was a teacher aged between 20-29. Ebenezer holds Bachelor of Education in science and had taught for 4 years. Ebenezer was teaching Forces, Motion and pressure in SHS 2. Ebenezer said he had personal copy of the Integrated Science syllabus and frequently used it in his lesson preparation. Ebenezer's class was observed three times and the teaching methods employed in the class was recorded with observational checklist.

Teaching methods/Activities

In all the three lessons observed, Ebenezer started the lesson by reviewing students' previous knowledge. This was followed by explanation of the various concepts under force, motion and pressure. Ebenezer gave several practical examples to explain the various concepts under the concepts but the students only spoke when asked questions and when they want to ask questions. Teacher demonstrated high content knowledge. However, lecture method was employed in the entire lessons observed. After the lesson observation, Ebenezer's ideal teaching methods, actual and the prescribed teaching methods were compared to determine the difference between them. Summary of the results is presented in Table 13.

Table 13: Results of Ideal, Actual and Prescribed teaching methods of Ebenezer

Lesson	Topic	Sub-topic taught	Ideal teaching method	Actual teaching methods	Prescribed teaching method
1	Force, motion and pressure	Centre of gravity	Lecture	Lecture	Demonstration and Discussion
2		Pressure and effects of pressure	Lecture	Lecture	Discussion
3		Application of pressure in solids, liquids and gases.	Lecture	Lecture	Project work and Discussion

Source: Field survey (Alabison, 2024).

From Table 13, Ebenezer indicated that his ideal teaching method for teaching the topics under discussion is lecture method. In the classroom, it was observed that Ebenezer used lecture method to teach. However, the prescribed teaching methods for teaching force motion and pressure are demonstration, discussion and project work. This indicates that there is no synergy between Ebenezer's ideal teaching methods, the prescribed teaching methods and actual teaching methods he used to deliver the content. On the other hand, the ideal teaching methods and the actual teaching methods were the same.

Daniel's Integrated Science Lesson

Daniel was a teacher with Bachelor's degree in Human Biology. He was aged 30-39 years and had 4 years teaching experience in the school. Daniel pointed out that she had a personal copy of the SHS Integrated Science Syllabus but rarely use it in her lesson preparation. Daniel was observed three times in her SHS 2 class of 65 students and the observations were conducted with the

help of an observational checklist. In Daniel's class, he was teaching the concept of ecosystem.

Teaching methods/Activities

In all the three lessons observed, Daniel employed lecture method in teaching the concepts in Ecosystem. In the first lesson observed, Daniel started the lesson by indicating to the students the relevance of the topic. He then explained the Components of ecosystem to the students. After the explanation, Daniel wrote some key points on the board for the students to copy into their notebooks. Out of the 65 students in class, only 3 students asked questions during the lesson. In the second and third lessons observed, similar situations were demonstrated in the classroom. The teacher started the class by explaining the concepts of food chain and food web to students. This was followed by giving examples and the students were given different living organisms to construct food chain and food web at the end of the lesson delivery. Although the teacher demonstrated mastery of the subject matter, the students were passive recipients of information in the three lessons observed. The results of the observations have been summarised in Table 14.

Table 14: Results of ideal, actual and prescribed teaching methods of Daniel

Lesson	Topic	Sub-Topic	Ideal teaching methods	Actual teaching methods	Prescribed teaching methods
1	Ecosystem	Components of Ecosystem	Brainstorm	Lecture method	Discussion method
		Food Chain	Activity method	Lecture	Discussion and Field trip
		Food web	Activity method	Lecture	Discussion and field trip

Source: Field survey (Alabison, 2024).

Table 14 shows that Daniel's ideal teaching methods were Brainstorm and activity method which were different from the lecture method employed in the classroom. Again, the syllabus prescribes discussion and field trip method in teaching Ecosystem however, there was a dissonance between the prescribed teaching methods, the ideal teaching methods and the actual teaching methods of Daniel as shown in Table 14.

George's Integrated Science Lesson

George was a teacher in School H who taught Integrated Science in SHS 1 class made up of 41 students. He was aged between 40-49 years at the time of data collection. He was in his sixteenth year of teaching. George holds a Bachelor's degree in Education (Science Education). He stated that he had a personal copy of the Integrated Science syllabus and frequently used it in his lesson preparation. George 's teaching was observed three times in his SHS 1 class and the various teaching methods used in his delivery was documented

using the observational checklist. George taught diversity of living and non-living things.

Teaching methods/activities

In the course of the observation, George taught three different sub-topics under diversity of living things. In all the three lessons observed, George started the lesson by orally telling the students the topic of the day. This was followed by oral explanation of the various concepts under diversity of living things. Some of the students asked questions during the lesson but most students were passive in the whole period. George exhibited high level of content knowledge and confidence in his teaching. Teacher concluded his class by giving the students reading assignment. It can be concluded that George employed lecture method in all the three lessons observed. After the lesson observation, George ’s ideal teaching methods, actual teaching methods and the prescribed teaching methods were compared and summarised in Table 15.

Table 15: Results of ideal, actual and prescribed teaching methods of George

Lesson	Topic	Sub-topic taught	Ideal teaching methods	Actual teaching methods	Prescribed teaching method
1	Diversity of living and non-living things	Classification schemes of Non-living things	Lecture	Lecture	Discussion
2		Classification of living things	Lecture	Lecture	Discussion
3		Classification of living things	Lecture	Lecture	Discussion

Source: Field survey (Alabison, 2024).

From Table 15, it can be observed that there was no difference between George ’s ideal teaching methods and his actual teaching methods in the classroom. However, the ideal and actual teaching methods did not conform to the stipulated teaching methods in the syllabus. Thus, there was a difference between the ideal and actual teaching methods of George and the prescribed teaching methods in the SHS Integrated Science syllabus.

Isaac’s Integrated Science Lesson

Isaac was teaching Integrated Science in SHS 1. Isaac holds a Bachelor of Science Education and was in his 10th year of teaching. He was aged between 40-49 years at the time of the study. Isaac acknowledged that he had a personal copy of the Integrated Science syllabus and use it frequently in his lesson preparation. Isaac taught Diversity of living and non-living things.

Teaching methods/Activities

In all three lessons observed in the classroom, Isaac started the lesson by reviewing the relevant previous knowledge of students. This was followed by a discussion of the various concepts in the diversity of living and non-living things. In the first lesson observed, Isaac asked the students to discuss the differences between living and non-living things. The teacher then wrote the core points on the chalkboard for students after the discussion. Students were put into groups in the second and third lessons to discuss the classification of living and non-living things respectively. Students then presented the outcome of their discussions. In all the lessons observed, the teacher only served as a guide in the classroom and the students actively participated in the lesson. Isaac employed the discussion method in his lesson delivery. After the lesson observation, the ideal teaching methods of Isaac, the actual teaching method

employed in the classroom, and the prescribed teaching methods in the classroom were compared. The summary of the ideal, actual and prescribed have been presented in Table 16.

Table 16: Results of ideal, actual and prescribed teaching methods of Isaac

Lesson	Topic	Sub-Topic	Ideal teaching methods	Actual teaching methods	Prescribed teaching methods
1	Diversity of Living and Non-living things	Difference between living and non-living Things	Discussion	Discussion	Discussion
		Classification of living Things	Discussion	Discussion	Discussion
		Classification of Non-living things	Discussion	Discussion	Discussion

Source: Field survey (Alabison, 2024).

From Table 16, it can be seen that there is harmony between Isaac 's ideal teaching method, actual teaching method and the prescribed teaching method in the SHS science syllabus. This was because Isaac indicated that his ideal teaching method was the discussion method which conformed to the prescribed teaching method in the syllabus. Discussion method was used in the classroom when Isaac's lessons were observed. This confirmed that Isaac 's actual teaching method conformed to the prescribed teaching method and his ideal teaching method.

Betty's Integrated Science Lesson

Betty was teaching Integrated Science in SHS 1 which comprised 44 students. Betty had a Bachelor's Degree in Science Education and was in his 4th year of teaching Integrated Science in the school. Betty indicated that he does not have a personal hard copy of the SHS science syllabus but the department has a copy of the syllabus which he normally uses for his lesson preparation. Betty's lessons were observed three times and the various teaching methods used were recorded with an observational checklist.

Teaching methods/Activities

In the first observation, Betty taught Particulate Nature of Matter: atoms, molecules and ions. Betty started the lesson by reviewing the relevant previous knowledge of the students on atoms, molecules, ions and compounds through the question-and-answer method. Betty asked the class to discuss the differences between atoms, molecules, ions and compounds in pairs. After the discussion, Betty clarified the confusion between molecules and compounds to students. On the second day of observation, Betty taught mixtures. Betty started the lesson by reviewing students' relevant previous knowledge of mixtures. This was followed by a discussion on the definition of mixtures and types of mixtures. On the last day of observation, Betty taught ionic and covalent compounds under matter. Betty started the lesson by explaining the concept of an ionic and covalent compound to students. Betty used several examples to explain the concept of ionic and covalent bonds through discussion method. The students were active in the whole teaching process making the lesson student-centred. Betty's ideal teaching method, actual teaching method and prescribed teaching methods were compared after the lesson observation to determine the difference

between the ideal, actual and prescribed teaching methods. The summary of the results has been presented in Table 17.

Table 17: An observation response depicting the teaching methods used by Betty in her lesson

Lesson	Topic	Sub-topic taught	Ideal teaching methods	Actual Teaching methods	Prescribed teaching method
1	Matter	Atoms, molecules, ions and compounds	Discussion	Discussion	Discussion
2		Mixtures	Discussion	Discussion	Discussion Practical work
3		Ionic and covalent compounds	Discussion	Discussion	Discussion Demonstration

Source: Field survey (Alabison, 2024).

From Table 17, it can be seen that Betty employed discussion method in teaching in the classroom which was the same as her ideal method of teaching the concepts under observation. This means that there is no difference between Betty's ideal teaching method and her actual teaching method in the classroom. Similarly, the ideal teaching methods of Betty and the actual teaching methods used in the classroom resonated with the stipulated teaching methods in the SHS science syllabus even though she failed to employ the second methods: practical and demonstration prescribed by the syllabus. This indicates that Betty's ideal teaching method was generally in line with their actual teaching method, which also coincides with the teaching method recommended in the SHS science syllabus. The only deviation from the syllabus appears to be in the application of the "practical and demonstration" methods, which Betty did not utilize.

The results of the study revealed that out of the 11 teachers observed the ideal teaching methods of 8 of them were discussions, demonstration and project work which fall under the student-centred approach. However, the teachers employed lecture method which is considered to be a teacher-centred approach in their classroom when observed. Thus, there was a dissonance between teachers' ideal teaching methods and what they actually practiced in the classroom.

The teachers sought to portray that their ideal methods were student-centred in nature. This means that teachers believed in the importance of student-centred teaching approaches in teaching Integrated Science in accord with findings by Borich (2011). However, the teachers failed to engage in these practices in the classroom. The disconnect between teachers' ideal and actual teaching methods agrees with the finding of Gelmez-Burakgaz (2020) who accentuated that the ideal methods of teachers differed from the teaching methods employed in the classroom in a study on teachers' fidelity and adaptation of science curriculum in Turkey. Although evidence (Borich, 2011; Gelmez-Burakgaz, 2020,) points to the effectiveness of the use of project work, group work and field trip in developing scientific concepts and improving learning outcomes among students, none of the teachers observed mentioned or employed these teaching strategies in teaching Integrated Science.

The evidence from the research shows that there was no conformity between teaching methods teachers used in the classroom and those prescribed in the SHS Integrated Science syllabus. The study revealed that teachers mostly employed lecture method in their lesson delivery. These methods used by science teachers did not reflect the student-centred teaching methods advocated

in the 2010 SHS Integrated Science syllabus. Thus, the teaching methods used in the classroom did not conform to the teaching methods prescribed in the SHS science syllabus. This means that the SHS Integrated Science teachers do not implement the curriculum with fidelity. In other words, the teachers were not implementing the curriculum faithfully. According Dusenbury et al. (2003), there is always a distinction between "prescribed curriculum" and "operational curriculum." There is evidence of a lack of fidelity in the way school curricula are implemented (Dusenbury et al., 2003), and this is corroborated by the results of the current study.

The results of this study is also in line with a study by Gbadamosi (2013) who assessed teachers' utilisation of prescribed innovative teaching methods in the secondary science syllabus in Nigeria. The results of Gbadamosi showed that teachers employed teaching methods in the classroom which did not conform to the prescribed innovative methods although they demonstrated high knowledge of the teaching methods. Gbadamosi argued that hindrances such as time and workload may account for teachers' non-usage of the prescribed teaching methods in the classroom. Otami (2019) also revealed that Integrated Science teachers at the Junior High level used teaching methods that did not conform to the prescribed teaching methods in the syllabus.

Difference in SHS science teachers' ideal teaching methods, actual teaching methods and the prescribed teaching methods seem to suggest that there is no synergy between what science teachers say they do in class (ideal methods), what they practice in the classroom and what the syllabus prescribes. This finding agrees with Annafo et al. (2018) that it is one thing having the knowledge of the prescribed teaching methods as a science teacher and it is

another thing to effectively implement that knowledge in your teaching activities. This means that teachers may have knowledge of the prescribed teaching methods but may find difficulties in implementing them in the classroom.

Research Question 4

What reasons account for teachers' usage or non-usage of prescribed teaching methods in the SHS Integrated Science syllabus?

The fourth research question for the study was in two parts. The first part gouged reasons for teachers' non-usage of prescribed teaching methods/activities in the Ghanaian SHS Integrated Science syllabus. The second part determined the reasons for teachers' usage of prescribed teaching methods in the SHS Integrated Science syllabus. Out of the 11 teachers interviewed, nine of them used different teaching methods other than those stipulated in the SHS science syllabus. These teachers were interviewed to provide reasons for their non-usage of the prescribed teaching methods. After the interviews, the views of the teachers were transcribed and the thematic analysis technique was employed to analyse the responses from the semi-structured interviews. These themes are the availability of teaching and learning materials, class size and time.

Availability of teaching and learning materials

Availability of teaching and learning materials was one factor that emerged during the interviews as a reason that accounted for integrated science teachers' non-usage of prescribed teaching methods by the syllabus. Teachers indicated that teaching and learning materials and equipment are unavailable and where they are available, they are insufficient for effective and efficient

science teaching and learning. Some of the teachers were of the opinion that materials such as science models, visual aids including charts and pictures, audio-visual aids, textbooks and others needed for the practical work that constitute the core of science are scarce and also expensive. Again, it was indicated by the teachers that their science laboratories were ill-equipped to support effective teaching and learning of science.

The teachers therefore attributed the non-usage of prescribed teaching methods to the non-availability or inadequacy of teaching and learning materials. They argued that the lack of teaching and learning materials compels them to employ the lecture method in teaching science concepts in the classroom. for instance, Teacher John noted that

> *"I don't use the teaching methods in the syllabus because there are no available teaching and learning materials to use in the classroom to teach them. The ones we have in the school are not enough so we use those materials to teach the general science students, physics, chemistry and biology".*

Similar views were expressed by Judith who argued that

> *I do not normally use the prescribed teaching methods in the science syllabus because there are inadequate teaching and learning materials in the school. The school lacks major equipment for the teaching of integrated science. For example, my school does not have enough glassware. So, we preserve the few we have for teaching the general science students, if we will want to use the few glassware for teaching integrated science, the students will break all of them and we will not*

get some to teach the elective courses like chemistry, biology and physics.

To Joshua, the approaches prescribed by the syllabus are hands on strategies which require equipment for successful enactment. However, the needed equipment is not available. He argued that

…the teaching methods the syllabus expects us to use require adequate teaching materials in the school. Our school does not have adequate teaching materials so we have to be using the lecture method because I cannot use my money to buy them and because of free SHS we cannot take money from the students to buy them so that is the only method left for us to use in the classroom.

Stephen argued from the perspective that as a science teacher, she is aware of the abstract nature of some science concepts and would love to bring such concepts to life. However, her school does not have the required tools to aid in his goal.

"… the abstract nature of the science we teach requires that we get a lot of models for the students to appreciate what we teach. Unfortunately, my school does not have any science models to enhance the teaching of science. I sometimes use my phone to show them some of the models but this is not enough and some students sometimes try to play with the phone instead of learning with it so I have stopped that..."

Time

Insufficient time to enact the content was another factor teachers assigned to their non-usage of the prescribed teaching methods in the SHS Integrated Science syllabus. Teachers argued that the content of the syllabus is

loaded but the duration for teaching and learning is too limited. Thus, they are torn between following the prescribed methods and not completing the syllabus and using teacher led approaches so that they can complete the syllabus. For example, John noted that;

> *"The SHS science curriculum is loaded, and teachers must complete the content within a limited period of time. When I use the prescribed teaching methods like discussion and practical it will delay my lesson and prevent me from finishing the numerous topics of the syllabus...*

This view was not expressed by John alone since Judith also recounted that

> *"Usage of prescribed teaching method delays the time in which you are supposed to complete the syllabus. In order to complete the syllabus, we can only use lecture method because you can teach a lot of concepts within the 40 minutes period"*

Joshua also asserted that;

> *"Due to limited time duration or contact hours, we tend to use the lecture method more often than the methods in the syllabus to complete the topics on time. If we don't do that, we will not finish the plenty topics in the syllabus and the students will not pass their final exams".*

Joshua further explained that some of the methods prescribed by the syllabus are tedious to enact. Such approaches go beyond the typical classroom time to enact concepts therefore using them takes too much time.

> "*When I check the syllabus, the syllabus expects us to send the students for a field trip to places like National Parks when teaching topics like ecosystem. The process for you to go through before taking the students out is tedious and takes a lot of time so by the time you organize and go*

for the field trip you will waste a full day that can be used to teach the whole topic in the classroom. So, when you use the lecture method it will rather help them reduce waste of time in going for the field trip".

Class size

The teachers interviewed also made mention of class size as one of the reasons that prevents them from using the prescribed teaching methods in the SHS science syllabus. The teachers accentuated that they find it difficult in implementing activity-oriented and student-centered teaching methods in the classroom because of large class size. Some of the teachers opined that large class size prevents them from performing practical work in the classroom or laboratory. This is because teachers are unable to effectively monitor students' participation in the classroom. Therefore, some students fail to participate in the practical work. Other teachers disclosed that large class sizes prevent them from employing certain teaching methods like discussion in the syllabus because the method increases the noise levels and distractive behaviors that make classroom management difficult and hence posed a negative impact on the learning process.

For example, John indicated that

"When teaching practically, especially sending students to the science laboratory, the large class size reduces the effectiveness of the practical teaching methods since students have to work in groups and some fail to participate. Only me must handle 44 students and I am not able to know if all the students are participating in the activity"

Joshua also argued that class size affects the approaches he use to teach science concepts.

"Large class size affects how I teach integrated science. I can only apply lecture method and sometimes demonstrations in the classroom. I cannot use the other methods like practical because of the size of the class".

The second part of research question four determined the reasons that account for teachers' usage of prescribed teaching methods in the 2010 SHS Integrated Science syllabus. Out of the eleven (11) teachers observed, two employed the prescribed teaching methods in the SHS Integrated Science syllabus. They were asked to indicate the reasons why they utilized the prescribed teaching methods in the classroom. Views of the teachers were transcribed and a thematic analysis technique was employed to analyse their responses. Two themes were carved from the views of the teachers. These themes are; students' conceptual understanding and development of practical skills.

Students conceptual understanding

Conceptual understanding of students was a major reason for teachers' utilisation of the prescribed teaching methods. The teachers showed that utilisation of the activity-oriented prescribed teaching methods in the syllabus facilitates students understanding of scientific concepts by helping the students to actively construct and apply knowledge in the classroom to solve scientific problems. Betty posited that;

... the teaching methods in the syllabus are activity oriented and it helps the students' understanding. Since most science concepts are abstract you will need activity-oriented teaching methods such as practical work in the classroom to bring the abstract science concepts to life for the

students to understand well. When we do group work in the classroom students construct their knowledge from their own friends and some of the friends teaches them."

Isaac added that;

"The teaching methods in the syllabus helps students to understand the science concepts. When I use discussion, the students participate and construct knowledge from their peers before I come to add another explanation which helps them to understand. I took my students to the school farm when teaching soil and they understood it very well and performed better when I gave them a test"

Development of practical skills

Development of practical skills was another theme obtained from teachers as the reason for their usage of the prescribed teaching methods. This was not surprising as the syllabus stipulates that the use of these teaching methods in the syllabus develops students' practical skills which is essential in solving scientific problems in this 21st century.

"When I use practical work, it helps to develop the skills which is psychomotor of students. Students work together and work with their hands with science materials especially when I take them out of the class to do practical work" (Betty).

Isaac added that

"Students' skills are very important, if you read the syllabus, it says we should develop practical skills and when I use the prescribed teaching

methods students apply their knowledge which helps to increase their practical skills".

The results of the research demonstrated that one of the main causes of SHS science teachers' non-use of the recommended/prescribed methods/activities of instruction in the classroom is the availability of teaching and learning resources. In other words, one of the reasons SHS science teachers were unable to carry out the SHS scientific curriculum faithfully was the lack of teaching and learning resources. The results of the present research support the claim made by Gelmez-Burakgazi et al (2020) that instructional methods or activities which call for extra materials and resources to be implemented successfully are likely to be used less faithfully than intended. Fullan & Park (1991) brought in their study that majority of teachers have failed in their attempt to implement curriculum with fidelity due to the insufficiency of teaching and learning resources. The resources prevent the effective execution of prescribed teaching activities/methods in the classroom. They claimed that in environments where there is pressure to do better, there needs to be easy access to help; else, the implementation process will be hindered or ultimately failed. Again, the finding of the study supports Anderman et al. (2012) argument that the availability of teaching and learning materials has been one of the major reasons why science teachers fail to employ certain constructivist teaching methods in the classroom. This limits the effectiveness of science lesson delivery and could hamper the development of certain competencies in students. Gelmez-Burakgaz (2020) explained that prescribed teaching methods in science curriculum requires several teaching and learning resources like laboratory, library, classroom space, equipment and materials for their effective

implementation in the classroom. Therefore, lack of these resources prevents the teachers from employing such teaching methods in the classroom. Thus, inadequate teaching and learning resources is a critical factor that hinder teachers' abilities to implement curriculum effectively.

Teachers in this research also indicated that limited time to enact the content in the SHS Integrated Science syllabus prevents them from using teaching methods such as field trip, practical work, project and group work. The finding agrees with the findings of McBrien et al (1997) who accentuated that although stipulated activity-oriented teaching methods are powerful motivators in the classroom, the activities are time-consuming. This is because students require enough time to complete the activities given which mostly consumes instructional hours. Similarly, Gelmez-Burakgaz (2020) revealed that student-centred teaching methods which are mostly prescribed for the teaching of scientific concepts are time-consuming and can prevent the completion of the content. Again, it was found by Anderman et al. (2012) that science teachers who continuously employ the stipulated student-centred teaching methods failed to complete the topics of the curriculum because more instructional time was used in teaching almost all the concepts in the curriculum. Hoesny, M. U. (2013) also found in a study in the USA that constructivist teaching methods prescribed for teaching science such as the project-based method require the active engagement of students' effort in the classroom over an extended period of time. This consumes instructional hours which prevents teachers' from completing the topics in the syllabus.

In Ghana, Abreh et al. (2018) found that SHS Integrated Science teachers are unable to complete the science curricula due to insufficient time. Therefore, teachers are forced to employ teacher-centred teaching methods such as lecture method in order to cover many content areas before their final examination. Although Abreh et al (2018) assessed the reasons for JHS science teachers' non-usage of the activity-based prescribed teaching methods in the JHS science syllabus, similar results were obtained in the study. Abreh found that insufficient time is one of the major hindrances to teachers' inability to employ prescribed teaching methods in their science classrooms.

Last but not least, class size was another factor that hindered teachers from implementing the SHS Integrated Science with fidelity. The finding is in consonant with Dagnew (2017) who revealed that the class size of various schools in Ethiopia is one of the numerous reasons teachers at secondary schools fail to use constructivist teaching methods prescribed in their curriculum. Similar results were obtained by Gelmez-Burakgaz (2020) who assessed the reasons teachers fail to use prescribed teaching methods in the classroom. It was found that teachers fail to utilize stipulated student-centered teaching methods in the classroom because of the large class size. According to teachers in different observational studies, the layout of classrooms and class size may have an impact on how teachers implement evidence-based teaching methods (Lund & Stains, 2015; Stains & Vickrey, 2017). Larger class sizes have also been linked to lower adherence (Zvoch, 2009), maybe because they are more challenging to control in a classroom (Binnie, 2002). On the other hand, two teachers who employed the prescribed teaching methods in the syllabus indicated that prescribed teaching methods increase students' conceptual

understanding. This is because the prescribed teaching methods are premised on constructivist teaching approach which are student-centered (MoE, 2010). Students therefore construct their own knowledge through the interaction of the environment and peers and teachers only serve as a facilitator in the classroom. The finding agrees with the findings of Sawant and Rizvi (2015) on the student-centred teaching methods on the conceptual understanding of students. Sawant and Rizvi admitted that student-centred teaching methods prescribed in curriculum help students to construct knowledge during classroom interactions which increases the conceptual understanding of the students. Similarly, Moreno (2010) found that student-centred teaching methods such as discussion and practical work increase the conceptual understanding of students, especially in abstract concepts.

Another reason that accounted for teachers' usage of prescribed teaching methods was the development of practical and scientific inquiry skills. This is because students are allowed to perform activities that help develop their practical skills and inquiry skills which have been proven to have a positive influence on students' performance in the subject (CRDD, 2010).

Summary of the Chapter

This section presented the results obtained from Integrated Science teachers and the discussion of the various outcomes of the research. Four research questions were answered. From research question one, it was observed that Integrated Science teachers are aware of the prescribed teaching methods of the syllabus. There was no statistically significant association in the awareness of teachers between male and female teachers. The study also revealed that there was an association between teachers' years of experience

and their awareness of prescribed teaching methods. It was seen from the results that teachers generally employ lecture method in teaching Integrated Science and there was no synergy between teachers' ideal teaching methods, actual teaching methods and the prescribed teaching methods in the syllabus. Reasons such as lack of teaching and learning materials, class size and insufficient time accounted for teachers' non-usage of prescribed teaching methods in the syllabus.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study investigated SHS science teachers' fidelity of the science curriculum in Ghana. This chapter, therefore, presents a summary of the whole study including key and significant findings obtained in the study, conclusions drawn from the various findings observed in the study, recommendations made from the study to inform policy directions as well as suggestions for future research.

Summary of the Research Process

The purpose of the whole research was to investigate SHS science teachers' fidelity of the science curriculum in Ghana. Specifically, the study determined teacher awareness of the prescribed teaching methods in the syllabus, explored the relationship between the gender of teachers and their teaching methods, the relationship between teachers' years of service and their teaching methods, explored how teaching methods used by SHS teachers in the classroom conform to the prescribed teaching methods in the SHS Integrated Science teaching syllabus and gouge reasons for teachers usage or non-usage of prescribed teaching methods in the syllabus. To obtain appropriate data on SHS Integrated Science teachers' fidelity to the SHS science curriculum, a triangulation mixed-method design was employed for the study. SHS Integrated Science teachers in the Sekondi-Takoradi in the Western Region constituted the accessible population for the study. One hundred and eighty-nine Integrated were used for tor the study. Questionnaire, observational checklist and semi-structured interview guide were used to collect both qualitative and quantitative data on SHS Integrated Science teachers' fidelity to the SHS science

curriculum. Data from the questionnaire, observational checklist and semi-structured interview guide were analysed with percentages, frequencies and themes as well as Chi-square. Sample statements from SHS science teachers used for the research during interview were given to support the themes. The findings were summarised under appropriate headings that generally mirrored the study's objectives

Key Findings

1. It was evident from the results of the study that sampled SHS Integrated Science teachers were aware of the prescribed teaching methods despite the fact that their awareness did not translate into utilisation.
2. It was found that there is no significant association between male and female teachers in terms of their awareness of the prescribed teaching methods in the Integrated Science syllabus.
3. Again, the results of the study showed that there is a significant association between years of experience and teachers' awareness of the prescribed teaching methods in the Integrated Science syllabus.
4. The study found that SHS teachers use the lecture method in teaching Integrated Science. This was demonstrated by their responses on the various concepts in the Integrated Science syllabus.
5. The study showed that there was no synergy between teachers' ideal teaching methods, actual teaching methods, and the prescribed teaching methods in the SHS Integrated Science syllabus. The teaching methods used by teachers in the classroom did not conform to the prescribed teaching methods in the syllabus.

6. The results finally revealed that availability of teaching and learning materials, time and class size were the major reasons that accounted for teachers' non-usage of the prescribed teaching methods in the syllabus. On the other hand, conceptual understanding of students and development of practical skills were the reasons some teachers employ the prescribed teaching methods in the syllabus.

Conclusion

Based on the findings of the study, it can be concluded that Ghanaian SHS Integrated Science teachers do not implement the Integrated Science curriculum with fidelity. This was because despite the fact that teachers indicated they were aware of the prescribed teaching methods, they generally employed lecture method in teaching Integrated Science which did not conform to the student-centred teaching methods prescribed by the syllabus. Judging from the findings, it can be concluded that teachers failed to implement the Integrated Science with fidelity because of lack of teaching and learning materials, class size and limited time.

Recommendations

Based on the findings of this study, the following recommendations were made;

1. Since the teachers indicated they were aware of the prescribed teaching methods although they do not put them into use in the classroom, teachers at the SHS level should be encouraged, supported and be motivated by stakeholders such as Ghana Education Service (GES) and Non-governmental organisations to enable them put the prescribed teaching methods into use in the classroom.

2. As teachers mainly used the lecture method in teaching Integrated Science at the SHS level, which is not in line with the recommendation of the 2010 Integrated Science teaching syllabus, it is recommended that the head masters and heads of departments should supervise the teaching of Integrated Science to ensure that teachers employ the student-centred methods in teaching Integrated Science.
3. In attempt to eradicate the issues that hinder teachers' utilisation of the prescribed teaching methods in the SHS Integrated Science syllabus, the Ministry of Education, GES and stakeholders in education should make budgetary allocation for schools to supplement the provision of teaching and learning materials and construct more classroom facilities to enable teachers to employ student-centred teaching methods prescribed in the syllabus.
4. The Curriculum Research and Development Division should review the content of the current Integrated Science syllabus in consultation with teacher organisations and the teachers in the classrooms so as to make the content of the syllabus achievable within the duration of the Senior High School period. This should be done by making the topics easy to follow and teach.

Suggestions for Further Research

Since the current research focused on SHS teachers' adherence to teaching methods/activities prescribed in the Ghanaian SHS Integrated Science syllabus as a mode of measuring teachers' fidelity of implementation, future studies could be conducted measuring quality of the curriculum delivery, participant responsiveness, curriculum differentiation and duration. Again, to

obtain a true picture of all Ghanaian teachers' fidelity of implementation of Integrated Science, efforts can be made to replicate this project in different parts of the country.

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APPENDICES

APPENDIX A

UNIVERSITY OF CAPE COAST

QUESTIONNAIRE FOR TEACHERS

Dear respondents,

The researcher is conducting research on the awareness and utilization of prescribed teaching methods by the syllabus. The information gathered is for academic purposes only and would be treated with the strictest confidentiality. Please read through the items as carefully as possible and offer your candid opinion.

SECTION A

Background Characteristics of teachers

1. Gender Male [ ] Female [ ]
2. Age range (in years) 20 – 29 [ ] 30 - 39 [ ] 40 – 49 [ ] above 50 [ ]
3. Highest Academic Qualification

   a) Diploma/HND [ ] Bachelor's Degree [ ] d) Master's Degree [ ]

   Other specify……
4. Highest professional Qualification (Education related qualifications)

   a) PGDE/PGCE [ ] b) B. Ed. [ ] c) M.Ed. [ ] d. MPhil [ ] e. PhD [ ]

   Other specify……
5. Teaching Experience in integrated science (Years). a) 1 – 5 [ ] b) 6 – 10 [ ]

   c) 11 – 15 [ ] d) 16 -20 above 20 [ ]

SECTION B

1. Do you have personal copy of the Integrated Science syllabus?

   a. Yes [ ] b. No [ ]

2. Does your department have the Integrated Science syllabus?

   a. Yes [ ] b. No [ ]

3. If Yes to 1, how often do you use the syllabus to prepare your lessons?

   a) Frequently [ ] b) rarely [ ] Never [ ]

4. If you do not have personal copy of the syllabus but use it to prepare lessons, how do you get access to one?

   a. Use departmental copy [ ] b. use colleagues' copy [ ] c. use online copy [ ]

5. Which form do you currently teach

   a. SHS 1 [ ]

   b. SHS 2 [ ]

   c. SHS 3 [ ]

1. Based on the form you teach please indicate the teaching methods you employ in teaching these topics.

Topics Under SHS 1	**Teaching methods (eg. Lecture)**	**Topics Under SHS 2**	**Teaching methods (eg. Lecture)**	**Topics under SHS 3**	**Teaching methods (eg. Lecture)**
Introduction to Integrated Science.		Acids, Bases and Salts		Metals and Non Metals	
Measurement		Soil conservation		Exploitation of minerals	
Diversity of living and non-living things.		Water		Organic And Inorganic	
Matter		Hydrological Cycle		Life Cycles of Pests and parasites	
Cells and cell division		General principles of		Crop Production	

		farm animal production			
Rocks		Excretory system		The Nervous System	
Air movement		Reproductive Systems and growth in mammals		Light Energy	
Nitrogen cycle		Circulatory System		Heat Energy	
Skeletal System		Electrical Energy		Electronics	
Reproduction and growth in Plants		Electronics		Variation and inheritance	
Respiratory System		Sound Energy			
Food and Nutrition		Nuclear Energy			
Dentition, Feeding and Digestion in mammals		Magnetism			

Transport-Diffusion, Osmosis and Plasmolysis		Forces, Motion and pressure			
Forms of Energy and Energy Transformation		Safety in the Community			
Solar Energy Photosynthesis		Endogenous Technology			
Electronics		Biotechnology			
Ecosystem		Work and Machines			
Atmosphere and Climate Change					
Infections and diseases					

OBSERVATIONAL CHECKLIST

Background information

The topic being taught…….. Date……

Class……. Gender of teacher ……

Topics and sub-topics /Lesson objectives	Teaching methods/activities employed in each stage
1	
2	
3	
4	
5	

INTERVIEW GUIDE

Reasons accounting for teachers' usage or non-usage of teaching methods/activities stipulated in the syllabus.

1. Are you aware of the prescribed teaching activities/methods by the syllabus in teaching and learning integrated science? Yes [ ] No [ ]
2. If **Yes,** do you follow the prescribed teaching methods in teaching in the classroom?

   Always [ ] Sometimes [ ] Never [ ]
3. What reasons account for the usage of the prescribed teaching methods in the syllabus?

   ……

   ……

   ……

   ……

   ……

   ……
4. What reasons account for the non-usage of the prescribed teaching methods in the syllabus?

……

……

……

…….

Challenges for effective utilization of prescribed teaching methods in the syllabus

1. What challenges do you encounter in the effective utilization of the prescribed teaching methods?

……

……

……

……

……

APPENDIX B

ETHICAL CLEARANCE

UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD SECRETARIAT
TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: UCC/IRB/A/2016/1611
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0011497

26TH OCTOBER, 2022

Ms. Felicia Alabison Dukpe
Department of Science Education
University of Cape Coast

Dear Ms. Dukpe,

ETHICAL CLEARANCE – ID (UCCIRB/CES/2022/35)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research **Investigating the Fidelity of Implementation of Senior High School Integrated Science Curriculum in Ghana.** This approval is valid from 26th October, 2022 to 25th October, 2023. You may apply for a renewal subject to submission of all the required documents that will be prescribed by the UCCIRB.

Please note that any modification to the project must be submitted to the UCCIRB for review and approval before its implementation. You are required to submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

Kofi F. Amuquandoh

Ag. UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST