UNIVERSITY OF CAPE COAST

TEACHING AND CLASSROOM ASSESSMENT PRACTICES OF INTEGRATED SCIENCE TEACHERS IN JUNIOR HIGH SCHOOLS

BY

CHARLES DEODAT OTAMI

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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 30-07-2019

Name: Charles Deodat Otami

Supervisors' Declaration

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

Principal Supervisor Signature.............................. Date 30/07/2019

Name: Prof. Joseph Ghartey Ampiah

Co-Supervisor's Signature...Date 30-07-19

Name: Prof. Douglas Darko Agyei

ABSTRACT

The study explored teaching and classroom assessment practices of teachers who taught Integrated Science in public and private junior high schools in educational districts overserved with teachers yet produced low students' performance in Integrated Science in Basic Education Certificate Examinations in the Central Region of Ghana. The study followed the Convergent Parallel Mixed Methods Research Design. Multi-stage sampling technique was employed to select a total of 246 teachers comprising 162 from public and 84 from private schools as well as 48 Form 2 junior high school students made up of 24 boys and 24 girls from the four overserved educational districts. Data on teachers' teaching and classroom assessment practices were obtained through Questionnaire, Interviews and Lesson Observation. The results revealed that one-half of teachers who taught integrated science in both school-type possessed no professional certificate. Of these, majority (88.1%) were from private schools. Also, majority (74.4%) of teachers from the public schools possessed no professional certificate but had a background in senior high school science. It was found that teachers mainly used the expository method to teach, which did not resonate with the teaching methods prescribed in the 2012 JHS integrated science syllabus. The study found that teachers used in-class exercise and homework for classroom assessment. In private schools, teachers used in-class exercise and homework more than those in public schools. Also, Integrated Science teachers used lower order questions which elicited factual knowledge for classroom assessment. It was recommended among others that only professional teachers with background in science should be made to teach integrated science in the junior high schools.

KEY WORDS

Classroom Assessment Practices

Educational Districts

Integrated Science

Integrated Science syllabus

Private Junior High Schools

Public Junior High Schools

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DEDICATION

To my wife and daughter: Juliette Dufie Otami and Eyram Maame Adwoa Sarpong Otami

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CHAPTER ONE

INTRODUCTION

The teaching syllabus for Integrated Science for Ghanaian Junior High Schools (JHS) prescribes teaching methods and classroom assessment strategies that teachers should employ in their instruction. This is to facilitate quality teaching and learning of Integrated Science through improved classroom practices to obtain desired learning outcomes. But, students at the basic level of education in Ghana continue to demonstrate weak understanding of basic concepts in Integrated Science as noted in the West Africa Examination Council's (WAEC) Chief Examiners' Reports (WAEC 2014, 2015, 2016, 2017) for Basic Education Certificate Examination (BECE). However, disparities exist in the performance of JHS students in Integrated Science in the BECE; those from private schools largely perform better compared to public schools (Okyerefo, Fiaveh & Lamptey, 2012; Ampiah, 2008). Furthermore, the Educational Sector Performance (ESP) Review Reports from 2012 to 2017 (MoE, 2012, 2013, 2014, 2015, 2016, 2017) indicate that some educational districts though classified to be overserved with teachers yet produce low students' performance in Integrated Science. Since these districts have adequate teachers, it is expected that if they employ the teaching methods and classroom assessment strategies prescribed in the 2012 JHS Integrated Science syllabus in their classroom instruction, students' performance would improve. One then wonders if the teachers in the overserved educational districts employ the teaching methods and classroom assessment strategies prescribed by the syllabus to teach. Thus, this study sought to investigate the teaching and classroom assessment practices of integrated science teachers in JHS in some selected overserved educational districts in Ghana.

Background to the Study

The last decade has witnessed increased search for suitable ways to teach science to students at the elementary level across the globe (Adamson, 2012; Darvas & Balwanz, 2013; Volkmann, Abell & Zgagacz, 2005; Udovic, Morris, Dickman, Postlethwait & Wetherwax, 2002). This is because numerous studies have reported that science teachers at the elementary (basic education in Ghana) level of education employ teacher-centred approaches like lecture, demonstration and dictation of notes to students as their main methods of teaching (Adamson, 2012; Anamuah-Mensah & Asabere-Ameyaw, 2004; Ogunkola & Olatoye, 2011; United States Agency for International Development [USAID], 2010; Ottevaanger, Akker & Feiter, 2007; Tobin & Fraser, 2003). Many authorities in science education have noted that such modes of teaching lead to development of "inert" knowledge (Whitehead, 2012) which students are unable to apply in appropriate contexts (Brown, Collins & Duguid, 2011; Hawkins & Pea, 2011) in order to understand the socially constructed, complex and dynamic nature of scientific knowledge and practice (Zimmerman & Bell, 2007; Nasir, Rosebery, Warren & Lee, 2006; Crowther, Lederman, & Lederman, 2005; Lindemann-Matthies, 2005; Tuan, Chi-Chin & Shyang-Horng, 2005). Additionally, the American Association for the Advancement of Science (AAAS) has indicated that the use of teacher-centred approaches to teach science at the elementary level of education makes "students unable to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire desirable skills unless they are permitted and encouraged to do those things over and over in many contexts," (AAAS, 2006, p.199). This concern by the AAAS prompted the development of new standards and guidelines for science education in

America ([National Research Council, NRC], 2012; Miller, 2010; AAAS's Benchmarks for Science Literacy, 2010; Science for all Americans, 2009; and National Research Council [NRC], 2007). These new standards and guidelines emphasize inquiry-based learning classroom environments where students build understanding of the scientific world as they work with others to make meaning of investigations and explanations of natural phenomena. The move by the Americans to reconstruct how science is taught to students at the elementary level of education, perhaps, motivated most developing countries like Ghana, to take a critical look at how the subject is taught to students at the basic level of education (Bybee, 2011; 2002; 1997; Fensham, 2006; Folaranmi, 2002). This is because many students in the developing world, especially those in Africa, though show much interest in science yet perform below expectations in International examinations such as Treads in Mathematics Science Study [TIMSS] and Programme for International Student Assessment [PISA](National Center for Education Statistics, 2012; Bybee, 2011; Clermont, Borko & Krajcit, 2010; Anamuah-Mensah & Mereku, 2005). This poor performance of students in science is a source of worry to many science educators, governments as well as students in Africa because teaching and learning of science at the elementary level is seen to be cardinal to development of scientific literate society (Johnson, 2011). Again, teaching science at the elementary level lays the foundation for developing students' interests and, thus, increases their chances of succeeding in studying science to the highest level (Bybee, 2011; Dzama & Osborne, 2005).

Anamuah-Mensah (2008) in outlining the importance of teaching science to students at the basic level of education emphasized inter alia that the world we live in today is moved by science and, a strong knowledge base in the subject constitutes a currency for social and economic transformation. He further opined that countries which have developed utilized the opportunities offered by knowledge in science and technology. Such nations, he indicated have scaled the poverty barrier and moved into a "club of rich countries" (p,14). Some of the countries mentioned are; Malaysia, South Korea and Singapore, which Anamuah-Mensah posited were at the same developmental level with most African countries in the 1960s but have witnessed improvement in their economies through development and application of science and technology. Anamuah-Mensah, therefore, suggested that for African countries to achieve the goal of "scaling the poverty barrier and move into the club of rich countries," (p, 14) there is the need for them to build a strong foundation in science for their students at the basic level of education to foster their interest and improve their performance in the subject to enable them pursue the subject, to the highest level.

Nevertheless, studies which have monitored students' performance in science at the early stages of their education across Africa indicate achievements in the subject are low (Onanuga & Saka, 2018; Osuolale, 2014; Olatoye & Ogunkola, 2011; Okebukola, 2007; United Nations Education Scientific and Cultural Organization [UNESCO], 2010). Factors such as inadequate funding for science education, inadequate teaching and learning resources to facilitate the teaching and learning of science in schools, inadequate suitably qualified teachers to teach the subject at the basic level, inappropriate teaching methods employed by teachers, as well as poor classroom assessment practices have been cited as major causes of students' poor achievements in science (AAAS, 2009; Braimoh & Okedeyi, 2001; Laugksch, 2012; Obanya, 2003; Ogundipe, 2003; Onanuga & Saka, 2018; Maarschalk, 2008; Polesel, Rice, & Dulfer, 2014).

Ghana is no exception to poor performance of students' in science at the basic level of education. For instance, the West Africa Examination Council's Chief Examiners' Reports for Integrated Science for BECE from 2010-2017, indicate that most students demonstrate weak understanding of basic scientific concepts and, are unable to apply these concepts to solve every day problems (Opoku-Agyemang, 2013; Frimpong, 2012; WAEC, 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017).

Basic education in Ghana constitutes six years of primary and three years of junior high school (Ministry of Education [MoE], 2012). Junior High School (JHS) serves as a transition between basic and the Senior High Schools (SHS). Basic education provides opportunities for students to discover their interests, abilities, aptitudes and other potentials (MoE, 2007). Additionally, it affords students the opportunity to acquire basic scientific and technical knowledge and skills to enable them consolidate knowledge and skills acquired at the primary level, induce in them the desire for self-improvement, cultivate the desire for lifelong learning, and prepare them adequately for further academic work at the SHS level (MoE, 2012)

Teachers with professional training in specified school subject areas are to teach at the JHS level referred to as subject teaching. Subject teaching enables students to develop positive attitudes and interests in a subject. It further helps students to decide on programmes they would pursue to the highest level of education. Thus, a good performance at the end of JHS education determines how one transitions to SHS (Frimpong 2012). In other words, if students do not perform well in Integrated Science in the BECE at the JHS level, it presupposes that they would not able to pursue further studies in science and other science-related programmes at the SHS level. Consequently, the required scientific literate persons needed to use science and technology to quicken the pace of socio-economic development (Elloitt, 2010; Imaz & Sheinbaum, 2017; MoE, 2012) will not be achieved. Therefore, science education at the basic level of education in Ghana is vital and deserves much attention considering its role in laying the foundation for further studies in science (Frimpong, 2012).

To find solutions to the poor performance of students in Integrated Science at the Basic level, Fletcher (2016) and Anamuah-Mensah (2008) have contended that teachers with requisite academic and professional qualifications in science should teach the subject. According to Opoku-Agyemang (2013) and Beccles (2012) students' performances in science have a strong relationship with the use of appropriate teaching methods as well as availability of adequate teaching and learning resources to enhance classroom instruction. Suleiman (2011) suggests that to improve students' performance in science at the basic level, higher order questions should be used to assess students' scientific understanding. The suggestions for improvement of achievements in science at the basic level of education offered, resonate with the view of McKinsey and Company (2012) who indicated that unless teaching and classroom assessment strategies of science teachers at the elementary level of education improve, students' performance in science will continue to be problematic.

Ghana has witnessed a number of curriculum reforms and reviews after the introduction and implementation of the 1987 educational reforms (Adu-Gyamfi, Donkoh, & Addo, 2016) The objective has been to make education in the country more responsive to the needs of the society through improved teaching (Ampiah, 2008). Many of the curricula review initiatives have come with new teaching syllabi which prescribes methods teachers should employ in their classroom instruction. This is the case for Integrated Science for JHS. For example, the current 2012 JHS Integrated Science Syllabus prescribes Activity-oriented methods, which are constructivist-based (MoE, 2012) as what teachers employ in the teaching of the subject. Proponents of this instructional approach (Woolfolk, 2010; Pitt & Kirkwood, 2007; Kirschner, Sweller, & Clark, 2006) believe that learners' conceptions emanate from engaging in processes of constructing interpretations of their experiences. Advocates of constructivist-based teaching at the basic level in Ghana envisioned it may help to enhance students' active participation in lessons, thereby helping them to understand concepts and, thus, improve learning outcomes in the subject (Ngman-Wara, Tachie & Mawusi, 2015; MoE, 2012; 2007). Constructivist-based teaching, therefore, creates a democratic learning environment which provides opportunities for interactions. This makes teaching more student-centred and students responsible and autonomous for knowledge acquisition, whereas teachers become facilitators (Woolfolk, 2010).

Although the 2012 JHS Integrated Science teaching syllabus prescribed teaching methods and classroom assessment strategies that teachers should employ to teach the subject, students' performances in Integrated Science continue to be poor (Arokoyu, 2012; WAEC, 2006-2008; 2009-2017). It is, therefore, critical that an investigation was done to explore the teaching and classroom assessment practices of teachers who taught integrated science in JHS.

Statement of the Problem

As part of efforts aimed at finding solution to the poor performance of students across all levels of Education in Ghana, the MoE through the GES embark on a yearly Education Sector Performance (ESP) review to monitor the education sector in the country (MoE, 2008-2015). According to the ESP review reports, Integrated Science remains one of the three problematic subject areas for students at the basic level of education (Asiedu-Addo, 2009; WAEC, 2008-2017). To reverse the trend of students' poor performance in Integrated Science at the basic level of education in Ghana, the Government through the Curriculum Research and Development Division (CRDD) of the GES under the MoE, carried out various curriculum review initiatives with the most recent being 2012 (MoE, 2012). Through the various curriculum reviews, the activity-oriented method of teaching was prescribed as teachers what should use to teach Integrated Science at JHS level. Activity-oriented teaching method is Inquiry-based and comes under the constructivist-based teaching methods (MoE, 2012; 2007; MoESS, 2008). The intent of prescribing activity-oriented methods for teachers at the JHS level was for them to move away from the behaviourists' mode of teaching which has characterized the teaching of Integrated Science in JHS classrooms to constructivist-oriented methods (MoE, 2012; 2010). It is expected that the proposed activity-oriented approach to teaching Integrated Science would enhance students' learning by facilitating development of their own ideas in science classrooms and, thus, making the subject more meaningful and relevant to their everyday lives (MoE, 2012; TIMSS, 2007).

Beside the modification of how Integrated Science should be taught to students in JHS, the current 2012 JHS Integrated Science syllabus further suggests that School-Based Assessment (SBA), which is actually Classroom Assessment, should be used to assess students learning at the basic level of education instead of the Continuous Assessment procedure which had been in place since 1987 (MoE, 2012). School-Based Assessment uses tests, quizzes, project work, homework and in-class exercise among others to measure learners' achievements throughout the period of teaching and learning

(Antoniou & James, 2014; Ashie, 2012; Afeafa, 2012; MoE, 2012). The modifications that the current 2012 JHS teaching syllabus for Integrated Science brought regarding teaching and classroom assessment, appeared to be in line with the claim that unless teachers pay attention to their teaching and classroom assessment practices, students' performance in science at the elementary level of education will continue to be weak (Banilower, 2009; Donovan, 2005; Michaels, 2008). McKinsey and Company (2012) in a study on the strategies and challenges of refocusing science instruction and classroom assessment in elementary schools (basic school in Ghana) in America, reiterated the need for teachers to take a critical look at their teaching and classroom assessment practices if learning outcomes of their students' in science were to improve.

In spite of the fact that the current 2012 JHS Integrated Science syllabus prescribed activity-oriented methods with minimal guidance, which is seen by most science educators as a superior mode of teaching science at the basic level, the national ESP review reports continue to highlight poor performance of JHS students in Integrated Science in the BECE (MoE, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017). Notwithstanding the fact that JHS students generally do not perform well in Integrated Science in the national BECE, students from private JHS comparatively perform better than their counterparts from public schools (Okyerefo, Fiaveh & Lamptey, 2012; Ampiah, 2008; Tooley, Dixon, & Amuah, 2007). This is confirmed by the ESP review reports from 2008 to 2017 (MoE, 2009-2017). For instance, in 2009 the ESP report indicated that among the 16% of students who performed well in Integrated Science, 75% of them were from private JHS with only 25% from public schools. The year 2010 was no different, as 78.6% of the 17.6% of those who did well in Integrated Science were from private JHS, with only 21.4% from public schools. Again, in 2011, whereas 23.6% passed in Integrated Science, 82.3% of them were from private JHS with only 17.7% from public JHS. The story was similar in 2012, though that year saw a rise in the achievements of the proportion of students in Integrated Science in general (28%), 78% of them came from private JHS whereas 22% of them were from public schools. Similarly, in 2013 out of the 23.7 % who did well in Integrated Science, 76.8 % were from private schools with the rest from public schools. In 2014, the trend was the same with the 27% who did well in Integrated Science 77.8% were from private schools, with only 22.2% coming from the public schools. The year 2015 saw a slight improvement in the achievement of students from public schools in Integrated Science. In that year, of the 28% of those who did well, 32 % were from public schools with the rest coming from the private schools. In the year 2016, of the 38% of students who perform well in Integrated Science in the BECE, 48% were from public schools with 52% coming from the private schools. Similarly, the case in 2017 was not too different. This is because out of 47% of students who did well in Integrated Science, 45% were from public schools with the remainder coming from the private schools.

Though there is a general underachievement of JHS students in Integrated Science across the country as indicated in the Chief Examiners' Reports (WAEC, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017), the ESP Review Reports further revealed that some Educational Districts in the Central Region of Ghana, despite being categorized as being over-served with teachers, produced low students' performance in Integrated Science in the BECE (MoE, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017). This is perplexing since it is expected that having adequate teachers coupled with a well-structured syllabus, teachers' teaching should reflect in students' performance. Unfortunately, it is not the case for these Educational Districts (MoE, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017). It was important, therefore, that a study was conducted to investigate how teachers who taught Integrated Science in JHS in the over-served educational districts in the Central Region employed the teaching methods and classroom assessment strategies prescribed by the 2012 JHS Integrated Science Syllabus.

Purpose of the Study

This study explored teaching and classroom assessment practices of Integrated Science teachers in Public and Private JHS in four educational districts. These districts were over-served with teachers yet produced poor students' performance in Integrated Science in the BECE. The study specifically examined the academic and professional qualifications of teachers who taught Integrated Science in both public and private schools in the selected educational districts, how the teachers taught the subject and how their teaching conformed to what the 2012 JHS Integrated Science syllabus prescribed. The study further investigated classroom assessment practices that the teachers used and how they conformed to what the 2012 JHS Integrated Science syllabus prescribed. Furthermore, the type of questions the teachers used for their classroom assessments and the cognitive demand it placed on the students were also explored. In addition, the study explored the extent of coverage of the topics in the 2012 JHS Integrated Science syllabus by the teachers in both school-types. Finally, teaching and learning resources available to the teachers for teaching integrated science and the extent of its usage in teaching were also investigated.

Research Questions

The study was guided by the following research questions.

1. What are the academic and professional qualifications of teachers who teach Integrated Science in private and public junior high schools?
2. (a) (i) What priorities inform the teaching of Integrated Science in private and public junior high schools?
   (ii) What priorities inform the teaching of Integrated Science by professional and non-professional teachers?
   (b) How do junior high school teachers teach Integrated Science how and does it conform to recommended practices in the teaching syllabus?
3. (a) What types of classroom assessments do junior high school Integrated science teachers use and how do they conform to what is suggested in the teaching syllabus?
   (b) What informs classroom assessment practices in public and private junior high schools?
   (c) What types of questions do Integrated Science teachers use for classroom assessments?
4. What is the extent of coverage of the Integrated Science Curriculum in public and private schools?
5. What teaching and learning resources are available to the Integrated Science teachers and how do they use them to teach the subject?

Significance of the Study

The study has significance for policy formulation and implementation in Ghana with respect to teaching and classroom assessment practices in JHS. By gaining insights into teaching and classroom assessment practices, the study contributes to knowledge in the following ways: First, it brings to the fore the academic and professional qualifications of teachers in the sampled over-served educational districts in the Central Region of Ghana who teach Integrated

Science. This may provide the MoE and GES with information about the caliber of teachers teaching Integrated Science in the over-served educational districts that could relate to the poor performance of students in Integrated Science.

Second, the information gained from the study would provide insights into how teaching methods and classroom assessment strategies suggested in the 2012 JHS Integrated Science syllabus are being used by teachers. This would provide valuable information on how future curriculum restructuring and teacher preparation programmes may better serve the needs and aspirations of schools.

Third, the outcome of this study would provide information about the facilities and resources available to teachers in JHS for teaching and learning of Integrated Science in the over-served educational districts and how these resources are used to teach. Again, through the study insights would be gained on how many of the topics in the 2012 JHS Integrated Science syllabus are covered by teachers in the districts. This may help unearth reasons that influence the coverage of the Integrated Science curriculum in schools which may relate to the poor performance of students in the schools.

Delimitations

Even though the study sought to investigate the teaching and classroom assessment practices of Integrated Science teachers at the JHS level, the emphasis was on educational districts with adequate supply of teachers yet produce poor results in BECE students' in Integrated Science.

Limitations

Since the study investigated teaching and classroom assessment practices of Integrated Science teachers in JHS in educational districts well supplied with teachers yet produce poor students' achievements in Integrated

Science in the BECE. The findings of the study could only be generalized to cover schools in the districts used for the study. It could only be applied to schools in educational districts which may have similar characteristics as the ones used for the study. Furthermore, since the teachers in the different school-types were teaching different topics at the time of the data collection, thus, they could be using different teaching methods in their teaching and therefore could colour their views on teaching methods they employ in teaching. This means that information on their views on their teaching method should be interpreted with caution.

Organisation of the Study

The thesis has four additional chapters organised to offer understanding into the concerns raised in this section. Chapter two was dedicated to review of related literature on issues relating to; teaching methods and classroom assessment practices proposed under the integrated science curriculum, with regard to the five research questions formulated to guide the study. Finally, the chapter closed with a framework, which conceptualized teaching and classroom assessment practices in JHS.

In Chapter three, the research methodology for the study is presented. It discussed the research design, the rationale for the design as well as its strengths and weaknesses, the participants and how they were selected. Again, a description of the structure of instruments used for data collection, and how the data obtained were analysed to gain insight into the teaching and classroom assessment practices of Integrated Science teachers in the educational districts sampled for the study.

Furthermore, the results obtained from the analyses of teaching and classroom assessment practices of integrated science teachers from both public and private junior high schools were presented and discussed in relation to the five main research questions formulated to guide the study in Chapter four. In addition, the chapter four contains some verbatim quotations from teachers and students to illustrate the perspectives of the participants on some of the issues discussed in alignment with principles of reporting qualitative evidence (Ampiah, 2004).

The chapter five presented an overview of the study and methodology used. A summary of the key findings and their interpretations with reference to the literature are also given. Implications and conclusions relating to the findings were also discussed in this chapter. In addition, areas for possible future research were suggested in the chapter.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter presents a review and discussion of literature related to teaching and classroom assessment practices. Based on the research questions raised to guide the study, the review is organised under the following sub-headings:

(a). historical background to teacher education in Ghana,

(b). junior high school science teacher preparation

(c). development of integrated science curriculum

(d). organisation of the 2012 JHS integrated science curriculum

(e). Theoretical frameworks underpinning the 2012 JHS Integrated Science curriculum

(f). behaviourism and science teaching

(g). constructivism and science teaching

(h). academic and professional qualifications of Integrated Science teachers

(i). priorities that inform teaching of Integrated Science

(j). teachers' perceptions of their teaching methods

(k). students' perceptions of their teachers' teaching methods

(l). students' participation in science lessons

(m). factors inhibiting effective science teaching

(n). looking beyond behaviourism and constructivism: introducing critical pedagogy

(o). context of classroom assessment in Ghanaian JHS

(p). role of classroom assessment in teaching and learning of Science

(q). teachers' classroom assessment practices (r). theoretical framework underpinning the use of classroom assessment

(s). barriers to teachers' use of classroom assessment

(t). issues of quality in classroom assessment practices

(u). questions used for classroom assessment

(v). taxonomy of questions use for classroom assessment

(w). theoretical framework of questions use for classroom assessment

(x). coverage of topics in JHS integrated science curriculum

(y). resources and facilities available for teaching and learning of Integrated Science

Historical Background to Teacher Education in Ghana

The history of teacher education in Ghana can be traced to the opening of the first teacher training institution, the Presbyterian Teacher Training College (PTC), in 1848 [now Presbyterian College of Education (CoE)], by Basel Mission at Akropong-Akwapim in the Eastern Region of Ghana (Pecku, as cited in Cobbold, 2010; Akyeampong, 2003). Other missions such as the Bremen, Wesleyan and Roman Catholic followed in these efforts, though their early attempts were largely unsuccessful (Akyeampong, 2000). It was not until 1909, that the Government intervened in teacher education in the country and started first teacher training college in Accra to train teachers for both government and mission schools (Benneh, 2006). Thus, laying the foundation for collaboration between governments and the missions (and more recently private individuals) in the provision of teacher education (Cobbold, 2010). Since then teacher education in Ghana has gone through several reforms in a bid to have well-qualified teachers to teach in schools.

Presently, there are 46 Colleges of Education-46 publicly funded and four privately run, with at least one located in each administrative/educational region of the country (Adu-Yeboah, 2012; Ahmed & Aziz, 2012). Seven of the 42 public CoE train female teachers only, one an all-male technical-oriented college, and the remaining 30 are co-educational. Forty-five colleges are residential with one operating in the Distance Mode. All CoE prepare teachers for both primary and junior high levels, though some have additional mandate to prepare teachers for the pre-school level and for science and mathematics. Nevertheless, Cobbold (2010) posited that the development and training of teachers in Ghana has most often followed ad-hoc programmes to meet emergencies and the needs of the education system. The result has produced a mass of teachers who are trained in courses of varied duration and nature and hold different categories of professional qualifications from various pre-tertiary institutions in the country (Akyeampong, 2003).

Junior High School Science Teacher Preparation

To qualify to teach at the JHS level, prospective teachers require two electives from either Science or Vocational-based subjects (Akyeampong, 2003). The training of JHS science teachers, therefore, mandates that trainees studied science as a core subject during the first and second years of training, sit for examinations at the end of each year, and pass (Benneh, 2006). The aim is to equip pre-service science teachers with the appropriate content knowledge and instructional skills. The professional component includes field-experience in which a master teacher mentors a pre-service teacher. Subjects availability vary from college to college, with some specialising in science subjects and others in General subjects (Institute of Education [IoE], 2013; 2005). Despite the variations in duration and the mode of delivery, all the three Diploma in Basic

Education programmes are fundamentally the same in content, except the "top-up" sandwich programme in which trainees cover fewer units.

Development of Integrated Science Curriculum for JHS

The development of Integrated Science Curriculum for JHS date back to 1862 (Rumble, 1942). This was after Integrated Science had been made part of school subjects for JHS in St Louis, America (Rumble, 1943). The rationale for developing Integrated Science curriculum was to show how knowledge across disciplines were interrelated in the natural world, and thus, single-subject curriculum narrowed learners' perspective and made them less efficient in the teaching and learning process (Darling-Hammond, 1996; Darvas & Balwanz, 2013; Leung, 2006; Yager & Lutz, 1994). Since then, the teaching of Integrated Science and the development of its curriculum has become part of education delivery in many countries of which Ghana is no exception.

In Ghana, the development of Integrated Science Curriculum for JHS started in 1987. This was done to reflect the demands of the educational reforms, which made JHS part of the county's educational structure (Antwi.1992; Bediako & Asare, 2010). The curriculum was called the General Science Curriculum. Prior to the development of the Integrated Science Curriculum for JHS in Ghana, science was taught as a general school subject and it was called General Science (Beccles, 2012). The objective of teaching general science at the basic level was to expose students to general concepts in physics, chemistry and biology which was to serve as foundation for further studies in science and other science-related subjects at the senior secondary level (MoE, 2002). In the early 90s, a review was carried out with the aim of smoothing the rough edges of the 1987 educational reforms. The recommendations of this review were implemented in 1995. As part of the review, the general science curriculum was revised and its name changed to Integrated Science. The revised science curriculum (i.e Integrated Science) was implemented across the country until 2007. The rationale for Integrated Science Curriculum was to ensure that every Ghanaian JHS student saw science as a unified body of knowledge and not as a collection of isolated topics (Adu-Gyamfi, Donkoh, & Addo, 2016; MoE 2002). Furthermore, in a bid to strengthen the country's educational system especially at the pre-tertiary levels, another educational review was carried out in 2003 but it was not until September 2007 that implementation of its recommendations was initiated across the country. Consequently, the Integrated Science Curriculum which was in place since 1995 had its objectives redirected to focus on the quality and flexibility of instruction to accommodate diverse student abilities (MoE, 2007).

Based on the new foci of the curriculum, students-centred approach to teaching was strongly recommended for teaching Integrated Science at the basic level in Ghana. The modifications gave birth to the 2010 Integrated Science Curriculum (MoE, 2010). The 2010 Integrated Science Curriculum was reorganised and its implementation started in 2012. An overview of the current 2012 Integrated Science Curriculum is presented in the next section.

Organisation of the 2012 JHS Integrated Science Curriculum

The Integrated Science Curriculum for JHS in Ghana has undergone amendments in contents as well as methods that teachers should employ in its delivery in order to meet the needs of students and make learning of the subject more relevant to society (MoE, 2012; 2007; 2002). The 2012 Integrated Science Curriculum for JHS is a fifty paged-document, which is based on the premise that scientific knowledge is very critical in everyday life and, thus, it is important the subject is taught to reflect every individual student's needs (MoE, 2012). The goal of the current curriculum, therefore, is to enable every student acquire scientific skills, insights, attitudes and values needed to be successful in one's chosen careers and daily lives by increasing their self-oriented learning abilities to the maximum (MoE, 2012). Thus, the 2012 Integrated Science Curriculum for JHS focuses on students and, it aims at helping them to:

1. develop a scientific way of life through curiosity and investigative habits;
2. appreciate the interrelationship between science and other disciplines;
3. use scientific concepts and principles to solve problems of life;
4. use basic scientific apparatus, materials and appliances effectively;
5. take appropriate measures for maintaining machinery and appliances used in everyday life;
6. acquire the ability to assess and interpret scientific information and make inferences;
7. recognise the vulnerability of the natural environment and take measures for managing the environment in a sustainable manner;
8. appreciate the importance of energy to the living and non-living things and adopt conservation methods to optimize energy sources;
9. take preventive measures against common tropical diseases; and
10. live a healthy lifestyle (MoE. 2012, p 12),

Furthermore, the 2012 JHS Integrated Science Curriculum is organised into five major themes, which has as its major feature to support students to relate science in the classroom to their everyday experiences, and also, to commonly observe phenomena in nature and draw links between seemingly different topics to allow eventual integration of scientific ideas. The five major themes of the curriculum comprise Diversity of matter (the Living and Non-Living things), Cycles, Systems, Energy and Interactions of matter. The issues to be covered under Diversity of matter aims at making students appreciate that there are major varieties of living and non-living things in the world and that there is a connection of all living things and a factor of unity in diversity of non-living things in their classification. Cycles covers issues with respect to repeated patterns in changes in nature. Systems seek to enable learners appreciate that a system is anything that has parts which when put together work. In addition, Energy seeks to enable students realize the pivotal role energy plays in affecting living and non-living things. Lastly, the Interactions of matter looks at the connections between living and non-living things within systems that enable one to aware of the environment and the role he/she has to play in it. The themes under the Integrated Science curriculum are divided into 45 units/topics. The topics under each theme are similar and related to each other to facilitate teaching and learning. The section for JHS 1 has 16 units, JHS 2, 19 units and JHS 3, 10 units. An overview of the units as contained in the 2012 Integrated Science Curriculum for JHS is presented in Table 1. An examination of the contents of the Integrated Science Curriculum to be covered each year does not indicate which or how many of the units/topic topics should be taught in a term.

Table 1: Organisation of the 2012 Integrated Science Curriculum for JHS in Ghana.

Units	JHS 1	JHS 2	JHS3
1.	Introduction to Integrated Science		
2.	Measurement		
3.	Matter	Elements, Compounds and Mixtures	Acids and Bases

4.	Nature of Soil	Metals and Non Metals	Soil and Water
5.	Hazards	Chemical Compounds Mixtures Water	Conservation
6.	Life Cycle of Flowering Plants	Carbon Cycle	Life Cycle of a Mosquito
7.	Vegetable Crop Production	Weather, Season and Climate	The Solar System
8.	Farming Systems	Reproduction in Humans	Dentition in Humans
9.	Respiratory System of Humans	Heredity	Digestion in Humans
10.	Sources of Energy	Diffusion and Osmosis	Heat Energy
11.	Conversion and conservation of Energy	Circulatory System in Humans	Basic Electronics
12.	Light Energy	Photosynthesis	
13.	Basic Electronics	Food and Nutrition	
14.	Ecosystems	Electrical Energy	Magnetism
15.	Air Pollution	Basic Electronics	
16.	Physical and Chemical change	Infectious diseases of humans and plants	Science Related to Industries
17.		Pests and Parasites	
18.		Force and Pressure Machines	

Source: MoE, (2012)

Nevertheless, it rather encourages the teachers to ensure students progressively acquire a good understanding and application of the material specified for each year's classwork (MoE, 2012).

Theoretical Frameworks underpinning the 2012 JHS Integrated Science Curriculum

Pedagogy frames classrooms learning experiences (Osborne & Dillon, 2008). Hence, the 2012 JHS Integrated Science Curriculum prescribe activity-oriented methods as what teachers should employ to teach the subject. This approach to teaching, as proposed in the curriculum, is based on constructivism-which supporters a change in teachers' role from custodian of knowledge to facilitators of teaching-learning process (Ampiah, 2008). The curriculum requires teachers to:

1. create learning situations and provide guided opportunities for students to acquire as much knowledge and understanding as possible through their own activities;
2. emphasise student-centred activities and communication;
3. foster interest and self-confidence in the learning of mathematics by providing students with opportunities to explore various scientific situations in their environment to enable them make their own observations and discoveries;
4. apply various instructional practices to cater for individual students' needs;
5. utilise concrete manipulatives to help students to compare, classify, analyse, look for patterns and spot relationships and draw their own conclusions; and

6. consider students' evaluation as an integral part of the teaching learning process and evaluation exercises should challenge students to apply their knowledge to issues and problems and engage them in developing solutions and increasing investigative skills (MoE, 2012, p 12).

Though both the old and the current Integrated Science Curricula suggest teachers should use constructivist-based teaching methods to teach, analysis of the two curricula indicate that both Behaviourists and Constructivist theoretical perspectives influence its implementation in JHS classrooms (Adu-Gyamfi, 2014; Eminah, 2007). A discussion of behaviourists and constructivists theories which underpin implementation of the JHS Integrated Science Curriculum in Ghanaian JHS are presented in the next section.

Behaviourism and Science Teaching

According to the behaviourists, learning is a change in human behaviour which comes about as a result of conditioning; i.e. a process achieved by interactions with one's environment (Traianou, 2012; Boghossian, 2006). Thus, from the behaviourists' perspective, internal and cognitive processes which are not visible cannot be studied scientifically. Therefore, outward behaviours are key indicators of human learning. Major contributors to this theory of learning are Bandura, Piaget, Skinner Pavlov, Thorndike and Watson (Boghossian 2006).

Science teaching within behaviorists' contexts calls for structuring of learning because controlled environment leads to controlled learning (Deaton, 2013; Strand, Barnes-Holmes & Barnes-Holmes, 2003;). Thus, science classroom environment is 'authoritarian' where supreme power is vested in the teacher who is perceived as an expert in having all the scientific knowledge and therefore, is able pour it into passive students who wait as empty vessels to be filled (Strand, Barnes-Holmes & Barnes-Holmes, 2003). The tenets of Behaviourism, as noted by Brown (2004), are that:

1. learning consists of building connections between stimuli and responses and only responses to external stimuli are considered important.
2. tasks are subdivided into their components so that objective of learning and, if necessary, the pre-requisites for tackling a task, can be set-in other words, what one must be able to do before tackling the next task. Thus, simplest components of ideas are first taught, reinforced, and then built upon increasingly to complex hierarchies.
3. reinforcement shapes behaviour and this reinforcement consists of knowledge of results and 'rewards' for fulfilling the requirements of a task. Reinforcement schedules shape behaviour. An example is the use of rewards in the form of marks linked to achievement of 'intended learning outcomes (p, 46).

Nature of behaviourists-based science lessons

According to Guey, Cheng, and Shibata (2010) and Pattalitan Jr. (2016), behaviourists-based science teaching follows a typical sequence of reviewing learners' prior knowledge on concepts first. It is then followed with an introduction of new material to be taught in the form of rules, principles and procedures, as well as how to solve problems using specified methods (Ampiah, 2008). Behaviourists-based science instruction generally focus on mastery of content with less emphasis on development of scientific skills and attitudes. Furthermore, with behaviourists-based instructions, students become receivers while the teacher the dispenser of knowledge. In most classroom contexts, teachers are preoccupied with academic activities in pursuit of schools' successes; often in the form of their students attaining good scores. This allow students to master procedures or approaches of solving problems for future applications. Science instruction in behaviourists contexts are usually characterised by presentation of content in small frames, which makes students work individually at their own pace to provide feedback (Swan, 2006). Students under behaviourists' contexts develop new knowledge by imitating their teachers' demonstrations and working on examples from textbooks, which involves memorising and learning procedures needed to solve problems.

Deaton (2013) posit that teachers' role in science lesson delivery under behaviourists context is one which they serve as pots of knowledge on which students rely for their own knowledge. Thus, teachers present new concepts and skills, whereas the students work through short and closed problems. Deaton (2013) further intimated that such lessons are mostly characterised by students answering factual questions with understanding being the sole decision of the teacher. According to Hao, Jiang, & Zhang (2006) explanations offered by students in behaviourists' science teaching contexts differ from what teachers normally consider to be invalid. Besides students' misconceptions are not given attention. This obstruct independent knowledge construction by students Hao, Jiang, & Zhang (2006). The responsibility of teachers in behaviourists-based science teaching, therefore, is to choose teaching methods which would enable students solve different problems.

Concerns with behaviourists-based science teaching

Opponents of behaviourism have argued that though knowledge creation involves some level of stimulus-response approach. For instance, Wenning (2005) asserts that stimulus-response approach cannot account for all types of learning or knowledge that an individual acquires, because it does not take into account the activity of the mind but only focus on external environment and how it affects learning. Oulton, Day, Dillon and Grace (2004) have argued that behaviourism is a one-dimensional approach to behaviour and it does not take into account free will and internal influences such as moods, thoughts and feelings of the individual. Conversely, a learner's use of external experiences to construct new knowledge is dependent on thoughts and ability to comprehend these experiences internally. The creation of new knowledge, therefore, goes beyond observable external behaviour, which avoids reference to meaning, representation and thoughts (Abrams & Lockard, 2004; Rickinson, Dillon, Teamey, Morris, Choi, Sanders, & Benefield, 2004). Abrams and Lockard (2004) explained that "the core of behaviourism, which is reinforcement of principles, does not adequately explain the complexity of thinking, memory, problem solving, and decision making" (p. 6). Jita (2002) notes that teaching of scientific concepts in behaviourism goes beyond the mere stimulus-response approach but active participation of students in the learning process. Rickinson, Dillon, Teamey, Morris, Choi, Sanders, and Benefield (2004) underscore the fact that behaviourists science classrooms are characterized by competition and individual work with teachers targeting brilliant students at the expense of the average and below average.

In spite of the weaknesses associated with behaviourists' based science teaching, the Ghanaian Integrated Science Curriculum for JHSs has for a long time had some linkage with behaviourists paradigm (Adu-Gyamfi, & Ampiah, 2016; Akyeampong, Pryor & Ampiah, 2006). Somuah and Agyenim-Boateng (2014) confirmed this when they reported that teaching of Integrated Science in Ghanaian JHS was characterised by behaviourism, that is, once students are able to produce the correct responses, learning is believed to have taken place. Nonetheless, as argued by Jenkins (2009) behaviourism cannot be completely ignored when it comes to teaching and learning of science. This is because it is relevant to some aspects of science learning, such as memorisation and rehearsal practices associated with behaviourists theory. In the case of the Integrated Science Curriculum for Ghanaian JHS, some aspects require students to remember concepts and skills (MoE, 2012; 2010). Teaching method associated with behaviourism as normally used in Ghanaian classrooms are discussed in the next section.

The expository method of teaching

This method of teaching is often referred to as the 'traditional' or the "chalk and talk" method (Ampiah, 2008). Its characteristic feature is whereby an instructor informs learners about what they will learn, followed by introduction of new terms and concepts within the context of dictation (Adu-Gyamfi & Ampiah, 2016; Somuah & Agyenim-Boateng, 2014). Expository teaching hinges on the notion that teachers are embodiment of knowledge and give out what they know to students. Teachers practically make all the decisions under expository teaching, regarding mode of instruction, organisation of learning experiences and materials, sequence, pacing and style of information dissemination. Thus, teachers are repositors and actors, while students are listeners, who speak only when called upon to answer questions, ask questions or demonstrate a procedure. The expository approach to teaching science has some positives associated with it. For example, it saves time by not involving 'useless' students' ideas, since they are guided with given processes and procedures which must be applied to get results (Garavalia & Gredler, 2002). Nevertheless, it must be noted that studies on the effects of using expository method to teach science have produced contradictory results in relation to students' outcomes in science classrooms.

In a study by Ibe (2013) to explore the effects of Guided Inquiry and Expository Methods on senior high school students' performance in Biology in Imo state, using an experimental design with a sample of 90 students, reported that those instructed with Guided Inquiry Method out-performed their counterparts exposed to expository teaching. The report further explained that using expository method of instruction only promoted procedural learning among students, mastery of rules and procedures to solve problems rather than gaining a conceptual understanding of concepts and principles in Biology. Ibe summarised the study by stating that although there is no golden method for teaching every topic, teaching science with the exposition method does not help to develop skills students need to make informed judgments and apply knowledge in real life contexts.

Similarly, Agbulu and Idu (2008) to explored the Effects of Expository and Participatory Instructional Approaches on Senior High Schools Students' Academic Performance in Agriculture Science in Benue State, Nigeria. Using 50 students the study reported that those taught with the Participatory Instructional Approach obtained higher scores in the subject compared with those instructed with the Expository method.

On the other hand, Lim (2007) in a Meta-analysis of teaching and learning of science in Elementary Schools involving China, Hong Kong, Thailand and Taiwan stated that most science lessons were characterised with passive transmission, rote drilling and memorisation of scientific facts and procedures. Yet, students from these countries top most international comparative science achievement studies, despite being instructed within the context Behaviourism.

Udo and Udo (2007) in a study to find the Effects of Expository and Demonstration Methods on Reasoning in Biology in a Non-major Biology Class, using 148 students from two Secondary Schools in Nigeria, found that those taught with Expository Method showed better reasoning ability in biology compared with those instructed through Demonstration.

The demonstration method of teaching

Ojogan and Oganwu (2006) described the demonstration method of teaching as a way of explaining a procedure on how to perform a function to students. Thus, it is a visible presentation of ideas, skills, attitudes, processes and other intangibles in the classroom. Teaching through the demonstration method involves presentation of facts and principles about how something works. It has as its major advantage that students have to just mimic what they see and hear. However, Hennessy, Deaney and Ruthven (2016) have noted that teaching science with the demonstration method only makes the teacher a source of knowledge whereas the students became less creative as well as worked less collaboratively. A poorly planned and executed demonstrative lesson does not promote optimum learning and does not make room for individual differences.

Gurel (2016) in an investigation into the Effects of Teaching Science through Demonstration Method on K-12 Students in American found that students became more actively involved in the lesson and started asking questions about the content to clear their misconceptions about the concepts taught. Gurel's finding buttresses that of Ekeyi (2013) who highlighted that those instructed with demonstrative method spent less time in writing notes from the chalkboard because they are able to remember the things they learnt at any given time. In summary, teaching science with Expository and Demonstration methods is mostly characterized by passive learning experiences in which students memorize knowledge generally in the form of laws, formulae or theories and enforces them for it to be reproduced during examination. Thus, there is very little scope for learners to do insightful learning and develop skills for problem solving and reflective thinking. However, if students actively participation in science lessons within the behaviourists context effective learning could be achieved.

Constructivism and Science Teaching

Constructivism has gone through series of changes to get to its present form of social constructivism, which sees learners' social environment as critical to teaching and learning (Taber, 2014; Jenkins, 2009; Windschitl, 2002; & Yager, 1991). Although views on various forms of constructivism differed from learners being active participants to being social organisms, the key focus of all forms of constructivism has been the learner taking charge of his or her own learning. Some of the proponents of this theory of learning has been Piaget, Vygotsky and Dewey (Taber, 2014)

Piaget's contribution to constructivism focused on individual's construction of knowledge which results from passing through visible developmental phases. Vygotsky on the other hand worked on the construction of knowledge, which comes from social participation with the view that education is largely dependent on social environment in which an individual develops. For Dewey, his attention was on social activity and constructive learning.

Science teaching within the constructivists paradigm, looks at how learners are directly involved in knowledge generation with an elaboration of their prior knowledge resulting in some changes in their knowledge state due to their interaction with teachers and peers in the classrooms (Taber, 2014). Thus, knowledge is facilitated rather than transmission. In the words of Taber (2014),

> "If we believe that knowledge is highly contextual, and that the fundamental difficulty in developing new understandings is to extend them to new situations, then we need to plan for students to be exposed to a range of situations in which a particular science insight can be used. This would imply, for instance, that one-off activities followed by discussion are ineffective. Students need to be explicitly helped in extending new ideas to different situations as part of the conceptual change process" (p. 30).

Concerns with constructivist-based science teaching

In spite of the emergence of constructivism as a leading metaphor for human learning due to its principle of promoting individual learner's active participation in teaching and learning, it cannot be without issues (Taber, 2014; Elkind, 2004). For instance, Adams (2007) has opined that learning affects the entire web of being, which goes beyond cognitive knowledge, as emphasized in the constructivists paradigm. Adams further stresses that application of 'real constructivist' approach to teaching science is tricky, and most teachers find it difficult to implement in their classrooms because of the problems associated with its application in the teaching and learning of abstract concepts. Moreover, constructivism presents a number of challenges, when employed in teaching and learning of science such that it may lead to conceptual misunderstanding because placing students in groups and telling them to work does not necessarily promote learning that teachers could see (Adams, 2007). Contrary, Hyslop-Margison and Strobel (2007) have noted that participation in an otherwise passive class improves when constructivists' strategies were employed. However, they intimated that seeing pairs of students talking animatedly to each may be satisfying but does not tell if learning occurred or not.

In spite of the fact that the 2012 JHS Integrated Science Curriculum, encourages teachers to use student-centred approaches to teaching i.e. Activity-oriented method, the objectives spelt out in the curriculum do not fully match the epistemology of constructivism. The skills and competencies outlined in the current 2012 JHS Integrated Science Curriculum still encourage teachers to show, demonstrate and explain things to students, which reflects behaviourism. Thus, the current Integrated Science Curriculum limits teacher effect in teaching and learning by pushing them to be active participants rather than mere facilitators in the classroom. In addition, majority of the teaching and learning activities outlined in the 2012 curriculum does not differ from those in the old general science curriculum, which fail to link real life situations to the numerous scientific concepts and skills stated therein. Some of the teaching methods aligned with constructivism are discussed in the section that follows. However, many teachers do not have clearer insights into appropriate pedagogies they should be using to enhance teaching and learning of science. Thus, most of the teachers resort to using transmitive or "chalk and talk" methods to teach Integrated Science in their classrooms (Ampiah, 2008). This, greatly affects the teaching of Integrated Science ranging from techniques of teaching to methodologies.

Activity-based method of teaching

This method of teaching is sometimes referred to as learning by doing (Adu-Gymafi, 2014). It presents to learners the opportunity to develop and construct their own knowledge through interactions with their environment, which according to Adu-Gyamfi (2014) facilitates students' conceptual understanding. Through Activity-oriented teaching does not only allowing students to learn content, but also, help them to develop other desirable scientific skills. The reasons as state in the 2012 JHS Integrated Science syllabus for teachers to use Activity-based teaching are to:

1. create learning situations and provide guided opportunities for students to acquire as much knowledge and understanding as possible through their own activities;
2. emphasises student-centred activities and communication;
3. foster interest and self-confidence in the learning of mathematics by providing students with opportunities to explore various mathematical situations in their environment to enable them make their own observations and discoveries;
4. apply various instructional practices to cater for individual students' needs;
5. utilise concrete manipulatives to help students to compare, classify, analyse, look for patterns and spot relationships and draw their own conclusions; and
6. consider students' evaluation as an integral part of the teaching learning process and evaluation exercises should challenge students to apply their knowledge to issues and problems and engage them in developing solutions and increasing investigative skills (MoE, 2012; p, 12).

The outline relates with a study by Vasantha-Devi, Rajagopalan and Jayakumar (2015) which explored the Effectiveness of using Activity-based method to teach Science to Grade-nine Students in India which revealed that students' ideas on some scientific concepts do not only change over time, but also they willingly with enthusiasm internalize and implement scientific ideas relevant to their needs in

Similarly, a study by Adu-Gyamfi (2014) on the Effects of Activity Method on junior high school students' performance in energy transformation at the Sekyere South District of the Ashanti Region of Ghana, showed that students from the experimental group performed creditably well compared to the control group in the post-test. He, therefore, concluded that the activity method enhanced the performance of students in energy transformation.

Fallon, Walsh and Prendergast (2013) have indicated that Activity-based science teaching at the elementary school level gives reality to learning with the provision of varied experiences to the students to facilitate the acquisition of knowledge, experience, skills and values. These experiences help build learners' confidence and develop their understanding of the subject matter.

Driessen and Sleegers (2000) in a survey on the effect of using the Activity-based method on high school science students learning in UK found that students were motivated and more stimulated to contribute to lessons and improved their problem-solving abilities. The study further reveals that learners retained content learnt for a longer period and were able to find patterns in information given to them on their own.

Inquiry-based method of teaching

Inquiry-based teaching as explained by Crabtree, (2004), and Lepareur and Grangeat (2018) is the process of teaching where students are made to engage in more activities and exercises. As explained by Kahn and O'Rourke (2007) teaching science through inquiry promote understanding which stimulating students thinking through the use of questions to test plausible hypotheses to arrive at logical conclusions about natural phenomena. Thus, teaching science through inquiry enable students to "work scientifically" through investigating, and understanding. Minner, Levy, and Century (2010) categorised Inquiry-based teaching into three levels (i.e. structured inquiry, guided inquiry and open inquiry). According to them, in structured inquiry, teachers engage learners in problem-solving activities and this is done by providing them with procedures and materials to discover and generalize their results from data collected. Essentially, this approach prescribes what learners should observe and data to be collected. In guided inquiry, materials and problems to be investigated are provided to students to manipulate and solve the problems on their own. Open inquiry is somehow similar to guided inquiry on the basis that it requires students to formulate their own problem for investigation.

In a study by Olagoke, Mobolaji and Daramola (2014) to explore the Effects of Inquiry and Expository Teaching Methods on Students' Performance in Integrated Science in Junior High Schools in Ekiti State in Nigeria it was revealed that students taught with the inquiry-based approach performed better than their counterparts instructed with the expository method. The study further indicated that students exposed to the inquiry-based teaching showed higher-level cognitive processes like thinking and questioning. This implied that using inquiry-based approach to science could help develop cognitive abilities, which might then go a long way to enhance learning outcomes.

In a meta-analysis by Minner, Levy, and Century (2010) to investigate Inquiry-based science instructions on students learning, from 1984-2008 involving elementary and upper secondary school students, the authors documented that many of the studies they assessed indicated learners had higher interest in materials taught, and the activities they undertook. They also noted that where inquiry have been used, learners demonstrated critical thinking, asked questions and discussed issues on investigatory paths that fitted lesson contents and apply their knowledge gained in class to solve problems out of school context.

However, the Ghanaian JHS Integrated Science Curriculum only draws teachers' attention to teach the science using inquiry-based approaches (MoE, 2012; 2010; 2008). Hence, as noted by Adu-Gyamfi (2014) it is rare to see teachers using inquiry-based method;

> "many .... teachers hardly arrange any laboratory work for their students probably because preparation for laboratory work makes much demand on their time and energy......The rigid, laborious and descriptive nature of its teaching has discouraged many intelligent students from pursuing their study of this discipline" (p. 12).

Earlier Frimpong (2012) in what seems to be an explanation to why teachers hardly teach Integrated Science with inquiry posited that the Integrated Science syllabus was too content-laden and, thus, push teachers to adopt strategies which will enable them cover the contents without looking to strictly adhere to its prescriptions.

Project work

According to Deniş, Çeliker, and Balım (2012), project work inculcates in learners independent thinking and ability to make decisions. Hence, the Ghanaian Integrated Science Curriculum for JHS requires that teachers give one project work per to their students (MoE, 2012). This is to allow the students to get a first-hand experience of developing something on their own. The teacher's role is to plan and explain to learners what is expected of them.

A study by Kibirige, Maake and Mavhunga (2014) which explored the effect of project work on 10^{th} Graders on performance in science in Mankweng Circuit, South Africa using a quasi-experimental design. The finding showed that practical work improved learners' understanding science concepts. The implication therefore is that project work should be take serious with the view to promoting students understanding of Scientific concepts.

Abrahams and Reiss (2010) in a similar which investigated students' performance under a period of experimental exercises in elementary school reported transformation from particularly traditional laboratory skills of observations and recordings to manipulative skills which helped students understood concepts which they had earlier found very difficult to understand. They further noted that students became more interactive when they were asked to use the results of their practical work their actions and explain other scientific phenomena.

Wolf and Fraser (2008) in exploring learning environment, attitudes and achievement among middle-school science students using inquiry-based laboratory activities, reported that students did not only demonstrate more meaningful understanding of the scientific concepts, but also, they were able to apply the knowledge and skills acquired from the project to write analytic or investigative reports.

Grant and Branch (2005) in exploring the intellectual outcomes of 9^{th} graders who had engaged in project work reported that students' gained ownership over concepts they learnt as they 'discover' the knowledge themselves in the course of doing their project works. They further opine that the critical thinking abilities of the students got simulated after they had worked on their projects.

Practical work

Practical work is core to the teaching and learning of school science (Abrahams & Saglam, 2010; Millar & Abrahams, 2009; Science Community Representing Education [SCORE] report, 2008; Egenrieder, 2007). According to SCORE (2008) science practical work provides a strategic framework for students to practice the correct use of apparatus. In addition, it helps students to develop their manipulative skills as well as their abilities to form concepts and communicate results of findings. Studies have established that achievement and skills improved when students are taught science with practical work (Hanuscin & Zangori, 2016; Abrahamsa & Millarb, 2008). Thus, it helps to develop learners' understanding of scientific ideas, clarify theories and extend their experiences of natural situations.

To employ the methods discussed for effective teaching to improve students learning, there is the need to have teachers who are grounded in knowledge in pedagogy. Hence, the methods cannot be used effectively in school classrooms if the teachers are not well equipped to do so.

Academic and Professional Qualifications of Integrated Science Teachers

Teachers occupy a very significant position in any educational system. Hence, teacher quality is a major determinant of success or failure of any educational enterprise (Abe, 2014; Ahiauzu & Princewell, 2011). To this end, teachers are required to possess strong academic as well as professional backgrounds to be able to function effectively in classrooms (Abe & Adu, 2013). This is because academic and professional backgrounds of teachers are found to correlate students' learning outcomes (Abe, 2014). Hence, science teachers need to have right academic and professional qualifications to be able to effectively facilitate learning (Ololube, Egbezor & Kpolovie, 2008).

To buttress the consequences of not having teachers with requisite academic and professional qualifications teaching science, Fletcher (2016) opines that the poor performances of students in Integrated Science at the basic level of education in Ghana are due to many unqualified teach who find their way into the classrooms to teach science. Fletcher referred to them as unqualified teachers. Though in this study they are referred to as out-of-field science teachers (Hattie, 2013). These teachers just possess general education (academic) qualifications such as Bachelors of Science (B.Sc.), Bachelors of Arts (B.A), Master of Science (M.Sc.) and Masters of Arts (M.A) degrees without teaching qualifications.

Donkor (2016) in an investigation into difference in junior high school teachers' knowledge of Integrated Science base on their academic and professional qualifications, revealed that higher qualifications lead to increased teacher knowledge, a desired mark of good science teacher. The author further pointed out that teachers needed to possess good understanding of subject matter in order to facilitate meaningful learning in their classrooms.

In a study by Abe (2014) to examine the effect of students' performance in science in junior high schools in Ikere Local Government Area of Ekiti State Nigeria the results revealed that public school teachers appeared to be more qualified than private school teachers in terms of their education and years of teaching experience the results further indicate that a significant difference existed in the performances of students taught by professional teachers and non-professional teachers, between students taught by NCE teachers and B.Sc Ed. Teachers and also between B.Sc teachers and B.Sc Ed. teacher.

In a study by Ampiah (2008) on how input factors are utilised at the classroom level to promote quality education in some selected public and private basic schools in the Central Region of Ghana, made the following revelations:

(i) a higher number of qualified teachers in both rural and urban public schools compared to the private ones.

(ii) the teaching strategies used by the teachers from both public and private schools were no different with chalk and talk method i.e. expository teaching dominating.

(iii) that the type of questions used by the teachers in their teaching elicited lower order knowledge (Ampiah, 2008, p.34)

In an earlier study to explore the academic and professional qualifications of teachers teaching in public and private schools in Ghana, Tooley, Dixon and Amuah (2007) reported that teachers in public schools have higher academic and professional qualifications compared with their counterparts in private schools. According to the authors while public schools have certain minimum requirements for teachers including certification and specific degrees, private schools have much greater leeway. It, therefore, meant that teachers in private schools strictly did not require any specific certification or degrees to teach. Further, according to Sjoer and Meirink (2015) teachers in public schools have high integrated science experienced compared to private schools. This as earlier noted by Danielson and Warwick (2014) teachers with more 6 years of teaching experience are more effective compared to those with less fewer years.

The findings of the various studies related well with that of World Bank (2002) that skilled and effective teaching and learning were expected from professionally trained teachers. Thus, without a professional teaching qualification no meaningful progress could be achieved in the teaching profession.

Priorities that inform teaching of Integrated Science

Effective teaching frames students' learning outcomes (Amin & Raba 2017). Therefore, teachers teaching is to maximise students' learning through creation of supportive, well-controlled classroom environment with a clear focus on understanding (Lieberman, & Maca, 2010). This means students require to understand in order to be able to make informed judgements and to apply the knowledge they acquire to solving problems. Therefore, teachers teaching priorities significantly impact on how curriculum is delivered to the students in the classroom by using appropriate student-centred teaching approaches.

The current 2012 JHS Integrated Science syllabus has as its main objective to help students understand the natural world through the study of the subject (MoE, 2012). Therefore, it is expected that when students understand scientific concepts taught to students it will cultivate in them interest, positive attitudes and love for science which will motivate some of them to seek further educations in science in preparation for careers in science (MoE, 2012). It is important that teachers teaching priorities are explored with respect to their classroom teaching practices within the context of implementation of the 2012 Integrated Science Syllabus in educational districts over-served with teachers yet student's poor performance poorly.

Teachers' Perceptions of their Teaching Methods

According to Ahmad and Aziz (2009), teachers' perception of their classroom instruction is important because it reinforces their decision-making on how to handle classroom situations. Thus, teachers' belief systems shape their understanding of teaching as well as priorities they accord to different dimensions of teaching. It is, therefore, possible to understand how and why teachers teach the way they do by understanding how they interpret their teaching practices. Keskitalo (2011) reports that teachers widely interpret their role as facilitators of students' learning, with their teaching marked by the principles of constructivism as documented in most science curricula.

However, Olayinka and Abdu-Raheem (2015) posit that although teachers' perceptions of their teaching practices have always supported constructivist ideas and principles, their actual teaching practices have always been completely at variance with underlining principles of constructivism. Similarly, Keskitalo (2011) has said that teachers have always perceived their teaching as student-centred yet, observations of their lessons reveal they are mostly unadventurous with their teaching and used approaches that most often contradict their own interpretations. Keskitalo intimated that teachers' interpretations or perceptions of their teaching have mostly been influenced by the content of curriculum being enacted, the teachers' initial training and continuing professional development. He further posited that teachers interpret their teaching practices to concur with the ideas documented in the national curriculum.

An earlier study by Bybee, Trowbridge and Powell (2008) indicated that teachers have always been confident and have strong personal views about their perceptions and interpretations of their teaching practices. Therefore, teachers' interpretations of their own teaching as the basis for examining or measuring teachers' teaching practices provides inaccurate picture of teachers' instructional strategy. For instance, as noted in a study by Ahmed and Aziz

(2009) collecting data from students regarding their teachers' teaching provides a meaningful snapshot of what their teacher does, because their perceptions are often "coloured by challenging and interesting experiences that allow them to observe teaching and learning behaviours more intimately than their teachers" (p.19). Thus, Ahmed and Aziz seem to suggest that to explore teaching practices of Integrated Science as in the context of this study it is imperative that data is collected from both teachers and students to gain deeper insights.

Students' Perceptions of their Teachers' teaching Methods

Teachers' teaching methods have always had a strong influence on students learning outcomes. Thus, teaching methods shape classroom-learning environment which inspires students' learning. Anderman, Sinatra and Gray (2012) in a study to investigate perceptions of teachers' teaching styles as perceived by their students in elementary schools, found that teachers' views of their teaching aligned with what is indicated in the national curriculum which suggested and that teachers employed more interactive and inquiry-based strategies in their teaching. Nevertheless, the views of the students as well as in-class lesson observations portrayed teaching styles which were expository.

Kurniati and Surya (2017) in a similar study to investigate junior high school students' perceptions of their teachers' teaching styles in India, using Teacher's Teaching Style Questionnaire, found that most of the teachers studied employed Activity-based teaching method. However, it was reported that the views of students were similar to that of their teachers as observed in the lesson. Gifford's study appeared to have confirmed a similar study by Chin (2007) when the latter explored teachers' and students' viewed on the teaching styles employed by their teachers. Using 34 teachers and 519 students, the results exposed a disparity between teachers and students' views on teaching approaches employed. While the teachers indicated they were using inquiry-based teaching methods, those of the students indicated they used expository methods.

Furthermore, Ampiah (2008) in a study which explored how input factors were utilised at the classroom level to promote quality education in some selected public and private basic schools in the central region of Ghana. The findings of his study revealed that teaching methods employed by the teachers in both school groups were predominately expository (chalk and talk method). This method according to him only emphasises lower ability knowledge skills.

Using Grasha's Teaching Style Inventory on a sample of 175 participants, Chin (2007) reported no significant gender differences in students preferred and perceived teaching styles. However, the students preferred teaching approaches, which were more learner-centered as against the teacher-centered methods mostly used by their teachers.

Students' Participation in Science Lessons

The views of Vygotsky on teaching and learning challenges the wisdom of traditional pedagogical practices quite significantly (Karpov, 2003). According to Vygotsky (as cited in Karpov, 2003) cognitive learning takes place through social interactions in which knowledge is internalised. The traditional science classroom regards learning as a process of student absorption of scientific knowledge given by teachers. However, new approaches to learning science emphasises active learner participation. To this end, the 2012 JHS Integrated Science Curriculum for Ghanaian JHS emphasizes students' participation in classroom context because effective learning requires students to be active in the teaching and learning process (Ampiah, 2008). In an active learning environment, students get encouraged to engage in processes of building and testing their own mental models on information they receive. Thus, to promote active science learning, the challenge lies in helping students understand the necessity of becoming active. This process may be facilitated by using exercises that direct students' attention to issues which affects learning.

Factors inhibiting Effective Science Teaching

Attaining the global aim of making every citizen scientifically literate through quality science teaching is a major challenge facing many countries (Şengül, Çetin, & Gür, 2008).). Studies around the world indicate that inadequate human and material resources, overloaded curriculum, large class size, lack of qualified and competent teachers, lack of textual materials, inadequate laboratory apparatus and equipment, poor teaching methods and poor students' attitude in science limit the quality of science education (OECD 2016; TIMSS 2015; Ngman-wara, 2015; Adu-Gyamfi, 2014; Anamuah-Mensah, 2008). As pointed out by Frimpong (2012) some critical factors inhibit effective science education in Ghana. These are as follows:

1. school-related factors; such as overloaded examination syllabus, lack/inadequate laboratory and workshops, poorly equipped library and lack of vital instructional materials such as textbooks, teacher's guide and audio-visuals.
2. curriculum-related factors; such as overloaded syllabus and insufficient time allotted to teaching of science in schools (Frimpong, 2012, p. 3-4).

To better understand teaching and classroom assessment practices of Integrated Science teachers in the selected educational districts of the Central Region, this study explored some the key factors identified by Frimpong,

Looking beyond Behaviourism and Constructivism: Introducing Critical Pedagogy

Considering the criticisms associated with behaviourism, as well as constructivism, and the gaps in the new national integrated science curriculum for JHS, no one particular theoretical perspective can facilitate effective teaching of integrated science at the basic level of education in Ghana. Both theoretical perspectives (i.e. behaviourism and constructivism) introduce the possibility of investigating teaching practices of science teachers by combining different theoretical perspectives.

The teaching of Integrated Science at the JHS level in Ghana must go beyond the ideals of the dichotomies of behaviourism and constructivism and create an alternative framework for understanding how Integrated Science is taught or should be taught. Based on this, instead of focusing on the two theoretical perspectives, there is the need for the Critical Pedagogy Framework which emerged in the early 1980s to be considered if the teaching and learning of Integrated Science in Ghanaian junior high school classrooms are to improve significantly. Critical pedagogy defines teaching as a social and cultural practice. This theoretical framework is drawn from many theoretical traditions, such as the Feminist, the Multicultural, and the Post-Structural as well as from the recent wave of curricula reforms around the globe. Critical pedagogy also relies on certain notions of Vygotsky, such as the apprenticeship, scaffolding, the Zone of Proximal Development and the Activity Theory (Matusov, 2008). Critical Pedagogy interacts with social movements and try to incorporate experiences of classroom teaching.

In the context of using the Critical Pedagogy to frame the teaching of Integrated Science in Ghanaian JHS, the focus must be on transformative teaching and learning where learners are deeply involved in decision-making in the classroom. Teachers specifically ought to be critical thinkers and transformative intellectuals rather than just transmitters of scientific knowledge or managers of day-to-day activities in the classroom (Gilbert, 2006; Fusco & Barton, 2001; Giroux, 1988). Critical pedagogy takes nothing for granted and tries to comprehend the causes of problems rather than deal with it symptomatically (McGregor, 2003). As far as scientific knowledge in the context of critical pedagogy is concerned, it is human made explanation of how the world works which is quite subjective although rigorous. Furthermore, explanation of scientific concepts is culturally linked to explanations of natural phenomena since science itself is perceived as a social activity (Fusco & Barton, 2001). In other words, science is not seen as separate from the individual or societal history but it is constructed through social acts (Hodson, 2010;1999).

According to Basu, Barton, Clairmont, and Locke (2009) knowing is somewhat more than knowledge itself, it includes the skill of working in a community and this aims at making a difference. Learning science, therefore, is an agency for Critical Pedagogy and its impact has to be authentic, feasible and attractive (Fusco & Barton, 2001). According to Giroux (1988), the teacher's role is not to "impose certain ideas or to form certain habits in the child, but...to select the influences which shall affect the learner and to assist him in properly responding to these influences" (p. 9). Giroux, therefore, advocate for teaching method where teachers and students participate in experiences with the teacher only classified as natural leader in a shared activity because of greater maturity and wider knowledge (Giroux 1988). In other words, the teacher does not only have to act as a facilitator in the teaching and learning process, but also, as a partner who is actively involved in the creation and acquisition of new knowledge.

Critical pedagogy is compatible with elements of Piaget's and Vygotsky's constructivism. Which is based on the fact that "teaching and learning are processes of inquiry; also it is process of constructing social imagination which works within a language of hope. If teaching is cast in the form of . . . a language of possibility" (Giroux, 1988 p. 197) then a greater potential exists for making learning relevant, critical, and transformative. Knowledge is relevant only when it begins with the experiences students come with from their surrounding culture; it is critical only when these experiences are shown to be problematic (i.e. performance); and it is transformative only when students begin to use the knowledge to help empower others, including individuals in the surrounding community. The central idea of Critical Pedagogy hinge on the premise that learners and teachers or educators are co-authors and the classroom discourse is a two-way affair and, no individual is an observer of the world, but embedded in the world (Kincheloe, 2008).

Effective teaching and learning affect the learner in totality and, this goes beyond cognitive knowing, as emphasized in the Constructivist theory, which seem to be the theoretical backbone of the 2012 JHS integrated science curriculum for Ghanaian. Gilbert (2006) described critical pedagogy as a theory for education for sustainability, which should be considered as an alternative to Constructivism. Even though constructivism and critical pedagogy may share some common aspects such as their views about the role of knowledge creation and acquisition, the two have different theoretical perspectives. For instance, Constructivists believe that:

> "humans actively construct their own meanings of situations; meaning arises out of social situations and it is handled through interpretive processes; behaviour and, thereby, data are socially situated, context related, context dependent and context rich" (Basu, Barton, Clairmont, & Locke, 2009, p.368).

Knowledge to the constructivist is private and belongs to the individual; this private knowledge can only be developed through continuous interaction of the individual learner with the environment (McGregor, 2003). From the critical theoretical perspective, changes in how science is taught and learned should be aligned with the belief that learning is "a participation in the world; a co-evolution of the knower and known that transforms both" (McGregor, 2003; p.64). Teaching practices envisioned by critical pedagogy, therefore, differ from either the 'adult-led', which is associated with behaviourism or 'learner-led' instruction associated with constructivism (Hopson, 2010, p.201). In critical pedagogy, learning occurs when individuals act and interact with each other. This suggest teachers who intend to employ critical pedagogy in their teaching must not be seeking to facilitate nor direct the learners on what to do and think, but promotes participation and genuine interaction to encourage learning.

The teacher's active participation in the teaching and learning process is paramount, as there may be some scientific concepts that students cannot learn alone and that assistance of a teacher to trigger students' learning is necessary (Gilbert 2006). By this, the teacher has to put him/herself within the action and acts vigorously in the learning space to trigger something in the learners. The implementation of a real cooperative learning approach, as suggested by constructivist theory, becomes problematic if the teacher is actively taking part and sometimes lead the process (Gilbert, 2006). In conclusion, to make sense of what happens in science classrooms one needs a framework which can provide a holistic view of teaching and learning of science with multiple perspectives (Giroux, 1988). It is based on this that future curriculum Integrated Science curriculum for JHS should hinge on the Critical Pedagogy.

Context of Classroom Assessment in Ghanaian JHS

Classroom Assessment (School-Based Assessment) as noted in the Teachers' Handbook for SBA for JHS as well as the 2012 JHS teaching syllabus for Integrated Science was designed to standardize the practice of internal school-based assessment across school classrooms to replace the continuous assessment system which had been in place until 2010. The SBA is based on three Profile Dimensions (Knowledge and Comprehension 20%; application of Knowledge 40%; and Experimental and Process Skills 40%) (MoE, 2012; 2010). Guidelines for constructing assessment items and other assessment tasks are indicated for teachers. Classroom assessment forms 30 percent of students' final score for the BECE. The Basic Education Certificate Examination which students take at the end of their third year in JHS forms 70 percent of the student's total score. This serves as a means of selecting students into various senior high schools, Technical and Vocational institutions (MoE, 2010). The framework for SBA emphasizes learners' outputs or products, as opposed to teachers' inputs. Knowledge of content is no longer the principal focus classroom assessment but rather application and demonstration of required skills and values within specific contexts (MoE, 2012; 2010).

Role of Classroom Assessment in Teaching and Learning of Science

Classroom assessment provides immediate feedback to teachers on students' understanding in order for them to adjust their lesson accordingly (Koloi-Keaikitse, 2017; Black, Harrison, Lee, Marshall & Wiliam, 2004; Stiggins

& Conklin, 1992). Hence the call for closer connection between classroom assessment and meaningful instruction (Zhang & Burry-Stock, 2003). However, according to Sato and Atkin (2006) classroom assessment does not only improve learning and give learners specific guidance on their strengths and weaknesses, but also, feedback which is central for teachers to improve their day-to-day assessment of their students.

Classroom assessment comes under formative assessment (now referred to as assessment for learning). Brookhart (2004) had earlier asserted that assessment is only formative if the information gained is used to improve outcomes and instruction. Brown (2008) seem to share Brookhart's view, when he pointed out that classroom assessments should identify appropriate standards regarding classoom performance and criteria of making judgments about quality of classroom instruction.

Teachers' Classrooms Assessment Practices

Classroom assessment as noted by Guskey (2003) is "best suited to guide improvements in students learning ..." (p. 6). According to Klenowski (2009), teachers assess learning for a wide variety of purposes, such as to evaluate teachers' instructional effectiveness; inform learners about their own achievements; maintaining learner motivation and, cooperation and attention. Thus, classroom assessment involves collection of data to facilitators of learners' understanding (Rahim, Venville, & Chapman, 2009).

Teaching learners to understand and for them to monitor their own performance is key to providing feedback in classroom assessment. Thus, learners' intention to study and using classroom assessment information to regulate the nature and amount of their learning fosters motivation to learn (Koloi-Keaikitse, 2017: Nenty, Adedoyin, Odili, & Major, 2007)

In a study by Koloi-Keaikitse (2017) to assess teachers perceived skills for classroom assessment practices, Data were obtained from 691 teachers selected from government primary, junior secondary, and senior secondary schools in Botswana. The results showed that generally teachers felt more skilled in test construction than other practices such as using classroom assessment results to make informed decisions in their teaching and learning processes. In a related study, Frey and Schmitt (2010) examined classroom assessment practices of 3rd- through 12th-grade teachers in a Midwestern State and the results showed that though teachers design their own classroom assessments they routinely relied on tests or items written by others.

Nenty, Adedoyin, Odili and Major (2007) in a study which explored primary school teachers' classroom assessment practices which involve items that measure the levels of knowledge in Bloom's taxonomy of Cognitive learning in Botswana and Nigeria using 191 primary school teachers from Gaborone district in Botswana, and 300 from Delta State in Nigeria, the result showed no significant difference in the use of items that covered levels of Bloom's cognitive behaviours. Most of the items measure only knowledge and, thus, were not able to provide for the development problem-solving ability.

Beckmann, Senk and Thompson (2005) studied classroom assessment and grading practices of 19 high school science teachers. Their study revealed that the most frequently used assessment tools were class tests and homework, and these determined about 77% of students' grades. Twelve out of the 19 teachers used other forms of assessment, such as written projects or interviews with students. These other forms of assessment accounted for about 7% of students' grades. The study further revealed that test items were of low level, involved very little reasoning and were almost never open-ended.

Theoretical Framework underpinning Classroom Assessment Practices

Classroom assessment is linked to improved students' learning. Hence, it forms the basis for teachers' use classroom assessment to be examined within the context of overserved districts which produce poor students outcomes in Integrated Science. To understand teachers classroom assessment practices in the overserved educational districts in the Central Region of Ghana, Hargreaves, Earl and Schmidt (2002) theoretical perspective on classroom assessment was adopted. The theory attempt to comprehend the factors which influence teachers' classroom assessment practices. It scrutinised the hows and whys, and not merely the commonness of use of classroom assessment tools, techniques and methods (Kearney, 2012; Inbar-Lourie & Donitsa-Schmidt, 2009). The model is based on the acknowledgement that classroom assessment hinges on reflective value and epistemological beliefs about teaching and learning. The theoritical framework has four perspectives underpinning teachers' classroom assessment practices. These are technological, cultural, political and postmodern.

The first perspective emphasises the technological aspects of applying classroom assessment. It involves technical views of time allocation and management, organisational structure and the availability of resources. It also involves teachers' expertise in developing and conducting classroom assessment as well as likely gaps between home and school expectations pertaining to classroom assessment. These technical aspects influence teachers' classroom assessment practices.

The second perspective dwells on cultural dimension which makes references to interpretation and integration of classroom assessment into schools' social and cultural context. In this perspective, classroom assessment is seen as a continuous activity and a multifaceted process integrated with learning in which learners actively participate in the different stages of classroom assessment strategies (Hargreaves, Earl & Schmidt, 2002). This view further takes into consideration partnerships among various stakeholders such as the learners, teachers, parents, community members and administrators. Teachers who support these principles appear to be more dedicated to the use of different assessment tools, techniques and methods.

The third perspective highlights the political dimension, which centres on “the exercise and negation of power, authority and competing interests among groups” (Hargreaves, Earl & Schmidt, 2002, p.76). This view is associated with the pressure of external evaluation of classroom assessment; top-down inspection and supervision performed by standardised tests; as well as bureaucratic meddling or institutional preferences and requisitions. Teachers who are powerfully influenced by the political perspective are likely to conduct classroom assessment according to external, standardised existing models.

The last perspective, the post-modern views of classroom assessment is from the environment of ambiguity that distinguishes the current period in history; thus critically questioning, the credibility, and trustworthiness of assessment practices and beliefs. Such a critical position may lead teachers to challenge or dispute the implementation of assessment methods, tools and techniques in their classrooms. The post modern view takes a wide perspective in relation to teachers’ assessment practices, aiming at both the micro and the macro contexts. It, thus, acknowledges a multifaceted analysis of the issues underpinning classroom assessment from a critical standpoint, and incorporating related social, political and philosophical factors (Hargreaves, Earl & Schmidt, 2002). Simultaneously, it includes issues at a local level, such as availability of resources and partnership among the various stakeholders in the school context. Thomas (2012) argued that using different forms of assessment is not merely a technical innovation but an intensely conceptual one.

This study, therefore, aims to use Hargreaves, Earl and Schmidt (2002) framework in a different setting using both qualitative and quantitative to approaches to understand integrated science teachers' classroom assessment practices in Ghanaian JHS. Consequently, light would be sherds on aspect of classroom assessment practices, whether emerging from teachers' pedagogical practices, or are affected by forces and considerations external to the school setting (Mertler, 2009). This is relevant in Ghana's educational system which has been advancing classroom assessment paradigm while concurrently embracing top-down standardised testing, culminating in tension between formative assessment and high-stakes external examination (McMillan, 2008; Ohlsen, 2007; Cavanagh, Waldrip, Romanoski, Dorman, & Fisher, 2005).

Barriers to the practice of Classroom Assessment

Traditionally, classroom assessment has long been perceived as an unpleasant burden resented by learners, while interrupting the core duties of educators, namely teaching and learning (Widiastuti, 2018; McMillan, 2008; Brookhart, 2004). Brookhart and Bronowicz (2003) have argued that learners often perceive classroom assessment as an instrument of identifying failure rather than documenting development and success. This is because learners' have most of the time perceive their scope of learning as primarily rooted in identifying and reproducing a correct answer to a well-defined problem that has an exact and predetermined solution (Greene, Miller, Crowson, Duke, & Akey, 2004). Opinions, conceptions, beliefs and perceptions of teachers and learners on classroom assessment practices indicate that assessment has over the years become an end in itself without any link to specific needs in education (Brown & Hirschfeld, 2008). According to Alkharusi (2007) learners perceive classroom assessment as fixed, predetermined procedures of recollection and reproduction, then the whole purpose of education is defeated, because higher order learning skills and outcomes cannot be achieved if assessment classroom does not allow for learners' capacity to develop and grow. Mertler (2009) argues that learners' responses on classroom assessment practices often reveal more than what is written in assessment theory.

Serin (2015) in his investigation on the challeges associated with classroom assessment practice and the possible ways of addressing them noted that classroom assessment is more of an agent for reform by stimulating learners' thinking abilities and learning as opposed to mere assimilation of content. He indicated that classroom assessment makes greater mental demands on learners, not only their knowledge of certain fields of content, but most importantly, in the areas of comprehension, application and demonstration of skills.

According to Mertler (2009) teachers experience growing challenges on classroom assessment practice on a daily basis, such as demands for social reform, provision of educational resources, differing approaches of role players to educational reforms, the establishment of a culture of teaching and learning, and controversies around the meaning, management and measurement of classroom assessment. Mertler opined that classroom assessment is perceived as the most significant source of problems for schools and teachers.

An empirical study by Akyeampong, Pryor and Ampiah (2006) indicated teachers relied on children's facial expressions to determine how well the lesson was going and followed up by questions to confirm any suspicion of lack of understanding. This kind of assessment the authors lamented determined the way some teachers managed or visualized effective classroom learning. Since the attitude of such teachers towards classroom assessment was not very positive. The arguments raised by these teachers were that when circuit supervisors visited their schools they only looked at registers and lesson notes, or marked work and continuous assessment records. Therefore, any systematic formative assessment during teaching and learning in the classroom was neither monitored nor encouraged.

Several empirical studies on classroom assessment indicate that teachers have different views and understanding of it (Akyeampong, Pryor & Ampiah, 2006; City,2009; Stefanou & Parkes, 2003). For instance, Brown and Hirschfeld (2008) in their study on classroom assessment practices of experienced teachers, noted that while the teachers declared a commitment to the formative purposes of classroom assessment and maintained that the full range of learning was frequently assessed, they engaged in practices which militated against formative assessment such as not providing feedback to students on their performances. Most teachers indicated the primary purpose of assessment was to grade or rank students, but the more developmental purposes of motivating students, diagnosing learning and evaluating teaching were not discounted. Thus, all pedagogical acts, including teachers' perceptions and evaluations of learner behaviour and performance (i.e. assessment) are affected by the conceptions teachers have about the act of teaching, the process and purpose of the assessment, and the nature of learning (Brown, 2004). Warren and Nisbet (1999) in a study of Australian teachers' uses of assessment, found that primary teachers used assessment more often to inform the teacher with regard to teaching than to inform the learner with regard to learning, and that using assessment for reporting to others was not as important as informing teaching and learning.

Overall, the review reflected the assertion that there are possibly various challenges facing teachers' classroom assessment practices, which they deal with in their own different ways, and this has major influences on effective teaching and learning.

Issues of Quality in Classroom Assessment Practices

For teachers to be effective in the implementation of classroom assessment, quality-aligned criteria should be observed. In other words, there is the need for reliability, validity and fairness to be considered in classroom assessment tasks. Validity and reliability are crucial for decision making with respect to fairness of quality of evidence collected in school classrooms

Validity

Validity in classroom assessment refers to the extent to which an assessment measures what it purports to measure (Ogunkola & Archer-Bradshaw, 2013). Thus, the extent to which the evidence gathered genuinely reflects the characteristic a teacher wants to know. Additionally, classroom assessment has to do with three major types of validity issues. The first is content validity, which serves as agreement between curriculum objectives and the objectives beings assessed. This has to do with some aspect of construct validity which emphasizes the need for classroom assessment evidence having a bearing on the appropriateness of the knowledge, skills and abilities being measured (Lalley & Gentile, 2009). The second is consequential validity, which talks about the way classroom assessment has to be used to benefit teaching and learning. This makes teachers focus on classroom activities which support learning and are responsive to learners needs. Kwawukume (2010) posited that consequences of classroom assessment are potentially important because it focuses on the influence it has on learning. The third type of validity is Ipsative validity; this looks at what teachers take into account in their learners' performance that is formatively assessed during lessons, and not past records or performance as a valid criterion to judge their learning abilities. This type of validity places learners at the centre of assessment activity and provides diagnostic information on the progress of the individual. It is also referred to as pupil-referenced validity.

Reliability

Classroom assessment is reliable when there is limited contrast in learners' scores or in judges' ratings across different occasions with different judges (Stears & Gopal, 2010). As a result, reliability is based on performance instead of distinctive scores which has no preset criteria (Towndrow, Tan, Yung, & Cohen, 2010). Classroom assessment is dependable when a learner gets a question right or wrong, depending on the nature of the question itself (Towndrow, Tan, Yung, & Cohen, 2010).

Fairness

The issue of fairness remains the most important challenge in classroom assessment (McMillan, Myran, & Workman, 2011). According to Rosas (2014), fairness refers to treating all individuals the same way and providing an equal opportunity to contribute to the learning process. In stressing fairness in classroom assessments or tests, Brown (2004) argues that teachers generally have to ensure that their personal feelings do not interfere with their assessment scores. Fairness or equity principles, as noted by Sato and Atkin (2006) require learners to be given abundant opportunities to demonstrate what they can do and be assessed through multiple methods. Sato and Atkin further stressed that fairness is critical in planning and designing assessment; that the content is closely examined to make sure that culturally unfamiliar concepts or pictures do not decrease learners' chance to demonstrate their learning. To Tierney, (2013) fairness in assessment starts with fairness in the learning process. Tierney, further indicates that learners should be given opportunity to analyze outcomes and assessment standards at the beginning of their learning task, with a mid-year review conducted to evaluate the learners' standings and levels of performance against particular standards.

Fairness is not with issues in authentic assessment. Hammerman (2009) posited that authentic assessment might aggravate the difficulties with culturally unfamiliar content, and again, if the content related to a particular theme is unfamiliar, the learner may be unable to respond to any questions contained in the assessment

Questions use for Classroom Assessment

Questions have long been used to assess students' knowledge and understanding as well as stimulating critical thinking (Tofade, Elsner, & Haines, 2017). Thus, questions help uncover what is learnt. Well-crafted questions lead to gaining of new insights, generating discussion, and also promote comprehensive exploration of subject matter. Poorly constructed questions, however, stifle learning by creating confusion, intimidate students, and limit creative thinking (McNeill & Pimentel, 2010; Yang, Newby, & Bill, 2014; Christenbury & Kelly; 1983). Thus, effective questioning support student learning by probing for understanding, encouraged creativity, stimulate critical thinking, and increase students' confidence in the classroom (Brualdi, 2010).

The art of asking/constructing right questions is not innate (Chin, 2007). Classroom question has long been associated with cognitive domain of learning of the Bloom's taxonomy (Chin, & Osborne, 2008). Questions which elicit responses in knowledge, comprehension, and application domains are frequently considered lower-order questions, while questions in the analysis, synthesis, and evaluation domains are considered higher-order questions (Wragg & Brown, 2001). Higher-order questions promote deeper and critical thinking and, therefore, teachers are encouraged to use them, but are not barred from asking lower-order questions (Erduran & Osborne, 2005). Appropriate use of questions addresses all the cognitive domains as long as the desired learning outcome is the target. A good mix of questions should be use for classroom assessment. Yet observations of classroom-based instructors have repeatedly shown that lower-order questions are far more frequently used (Lee & Kinzie, 2012).

A longitudinal study by Lustick (2010) found that during practice-based experiences, teachers asked lower-level questions 91.2% of the time. Further, instructors' years of experience did not correlate with their propensity to ask lower- or higher-order questions. Multiple observational studies, according to Chin (2007), have found that as many as ninety percent of teachers' questions focus on low-level cognitive skills such as memorization and recall.

In a survey by Hand, Vaughan, and Carolyn (2015) which explored questions used during classroom-based instructions by 91 teachers at the senior secondary school level. The results showed that out of the 3,407 questions used that were categorized based on the type and level of each question posed, majority of the questions asked were lower-level questions (68.9%)

Taxonomy of Questions use for Classroom Assessment

Questions used by teachers for assessment are classified based on their fundamental essence. According to Wilson and Smetana (2011), questions are either convergent or divergent. Convergent questions elicit specific responses or narrow lists of possible responses. This type of questions draws single "best" response from learners. Divergent questions on the other hand aims at eliciting wide range of responses which require substantive elaboration which stimulate dialog and explore in detail issues under consideration.

Similarly, according to Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, (2001) questions may be classified depending on the knowledge dimensions they seek to explore. This could be factual, conceptual, procedural, and metacognitive knowledge. The dimensions range from the concrete to abstract (Anderson, et al. 2001). Anderson and his colleagues further explained that factual questions elicit factual knowledge which often require leaners to recall specific elements from a reference source, they address lower-order thinking. Questions which elicit conceptual knowledge require learners to justify an answer based on underlying of principles or theories, or to classify elements into categories. Questions that elicit Procedural knowledge require learners to use well-established methods to gather information or use most appropriate procedure in a particular situation. Metacognition questions require learners to articulate a cognitive strategy required to complete a task or examine personal motivations and values. But, the nature of question used by teachers in JHS science classrooms does not include Metacognition. This is because the questions asked in the BECE do not include those of metacognition which could influence the reasons why teachers may not be using them for their classroom assessment. Since format of questions used in the BECE have remained the same over the years (Parker, Osei-Himah, Asare & Ackah, 2018) they rarely measure power of self-expression and interpretations.

Furthermore, questions could be classified into Open-ended and Close ended. Open-ended questions promote students reasoning when they learn new concepts. Close-ended questions include those that do not promote student reasoning. The open-ended question types are subdivided into: (1) asking for explanation, (2) asking for self-evaluation of reasoning, and (3) asking for self-evaluation of others' reasoning. The first sub-type of open-ended question originated from the work of NRC (2000) and Dillon (1988). They emphasized the importance of explanation of learning process. The second and third sub-types of open-ended questions originate from Berland & Reiser (2009), Zembal-Saul, Munford, Crawford, Friedrichsen, & Land, (2002), and NRC (2000). They emphasized the importance of evaluating ideas in the learning process.

The close-ended questions have two sub-types (1) asking for factual information and (2) asking for confirmation (2). These two sub-types of close-ended questions originated from the work of Driver, Newton, & Osborne (2000) Osborne, Erduran, & Simon (2010) and Sandoval & Millwood (2005). They subdivided close-ended questions into types that require students to provide formation or definitions of concepts that they are learning without going through reasoning processes (e.g. reiteration and memorization) and to respond in terms of confirming what they understand without going through reasoning processes in a simple way.

Theoretical Framework of Questions use for Classroom Assessment

Social development theory by Vygotsky serves as the theoretical foundation for teacher questioning (Dixon-Krauss, 1996; Massey, Pence, Justice & Bowles 2008). Bransford, Brown, and Cocking (2006) interpreted Vygotsky's theory as means to understanding the effect of teacher questioning on student learning because students do not learn in isolation from social contexts. For example, interactions with more experienced or knowledgeable people lead students to construct a better understanding of concepts. The Zone of Proximal Development (ZPD) explains this idea. It illuminates individual's development as a distance between learner's abilities to undergo a task under the guidance of an adult and/or with the collaboration of a peer and the students' abilities to solve the problem on their own. Bruner (as cited in Dixon-Krauss, 1996) termed teacher's help within an individual student's ZPD as "scaffolding". For instance, if a student encounters a daunting task that he/she is not able to resolve on his/her own, a teacher would be able to effectively scaffold the student's problem solving by motivating them to use alternative strategies within their ZPD range such as showing pictures for clues instead of telling the student the correct answer immediately (Bodrova & Leong, 2013).

Teacher questioning plays crucial role in helping students to move to the next cognitive level (Cotton, 2011). Particularly, open-ended questions lead students to realise what they know and what they do not because open-ended questions require divergent answers (i.e., multiple answers) compared to closed-ended questions which require convergent answers (i.e., one correct answer). This means open-ended questions promote student reasoning and do not pressure students to respond with a single right answer. With open-ended questions, students are able to acquire knowledge through trial and error and derive knowledge using argumentation components as in Bloom's revised taxonomy higher position components (e.g., creating, analysing, or applying). Through this process, students are able to realize what they know and what they do not know for themselves. Therefore, they are able to acquire knowledge by correcting their misunderstanding on their own. Open-ended questions assist students to realise how to learn on their own because they provide students opportunities to reason ideas through argumentation. In contrast, close-ended questions do not lead students to the next cognitive level because they emphasise memorising or reiterating knowledge without utilising much reasoning process. Student learning takes place when they move up to the next cognitive level with the help of teacher open-ended questioning. Overall, the

Zone of Proximal Development [ZPD] illustrates how teacher questioning should be structured in order to promote student learning.

Studies on questions used for classroom assessment by teachers have indicated that higher cognitive questions (application, analysis, synthesis, and evaluation) should make up a higher percentage of questions asked above the primary grades (Lemons & Lemons, 2013). They further indicated combination of lower and higher questions is more effective than the exclusive use of one or the other. They noted that increasing use of higher cognitive questions can produce superior learning gains for older students, particularly those in secondary school, and does not reduce student performance on lower cognitive questions. According to Lemons and Lemons (2013) simply asking higher order questions do not guarantee higher responses or greater learning gains. Students need explicit instruction in answering these types of questions. This instruction which should be in conjunction with the use of higher cognitive questions, will positively impact student achievement.

Wragg and Brown (2001) in exploring questions asked by teachers in elementary school science classrooms found that most of the questions focused on factual recall with few on students' higher order thinking. They concluded that insufficient use high-quality (open-ended) questions was because the teachers perceive their students to be weak. This finding does not mean elementary school teachers should avoid all higher cognitive questions. Elementary students need to have chances to speculate, imagine, and manipulate information presented to them. However, it is suggested that in dealing with elementary students these questions should be used more sparingly.

Coverage of Topics in the 2012 JHS Integrated Science Curriculum

A critique of the 2012 Integrated Science curriculum has been that it is overloaded (Adu-Gyamfi, 2014; Adu-Gyamfi, 2016: Somuah & Agyenim-

Boateng 2014; Mensah & Somuah, 2013; Parker, Osei-Himah, Asare, & Ackah, 2018; Somuah & Orodho, 2016). As a result, it is suggested that the aspects that deals with Agriculture should be separated and treated as a subject on its own, as it was the case some time back. The curriculum being overloaded is often cited as the reason why teachers do not completely cover all the topics in it. A study by Arokoyuto (2012) compare the extent of coverage of the topic in Integrated Science syllabus in private and Government owned basic secondary schools in Yenagoa of Bayelsa State of Nigeria. The results showed differences in the coverage of topics in the Integrated Science syllabus and this was in favour of the private schools. Nevertheless, Ampiah (2008) reported no difference in the coverage of the curriculum by teachers in public and private schools in Ghana. In addition, Eminah (2007) observed that only 25 percent coherence existed in the transfer of principles of the Integrated Science curriculum that emphasised student-centered classrooms by the teachers into their own classroom practices.

Resources and Facilities available to Teachers for teaching Integrated Science

Teaching and learning resources play a very important role in enhancing students' learning outcomes (Adu-Gyamfi, 2016: Somuah & Agyenim-Boateng 2014; Somuah & Orodho, 2016; Parker, Osei-Himah, Asare, & Ackah, 2018). Availability of these resources influence the instructional approach that teachers employ in their lesson (Opoku-Asare, 2000). Adu-Gymafi (2014) in exploring challenges integrated science teachers faced in teaching the subject in Ghanaian junior high schools found that most schools lack materials and equipment for the teaching and learning of Integrated Science and in situations where some materials and equipment were available, they were inadequate. He, however, indicated that the current 2012 Integrated Science syllabus (MOE, 2012) were available in almost all the schools. Somuah and Mensah (2013) in an investigation into the state of teaching of Integrated Science in Ghana found that most of the JHS lacked facilities such as science laboratory to conduct simple scientific experiments.

Conceptual Framework for Teaching and Classroom Assessment Practices of Integrated Science Teachers in JHS

The theoretical and empirical issues discussed with reference to teaching and classroom assessment practices of Integrated Science teachers in JHS draw attention to certain actions that are central to ensuring effective enactment of prescriptions of the 2012 JHS Integrated Science syllabus (McKinsey & Company, 2012; Woolfolk, 2010; Ampiah, 2008; Anamuah-Mensah, 2008; Pitt & Kirkwood, 200). Consequently, this study proposes a conceptual framework adopted from McKinsey and Company (2012, Woolfolk (2010), Ampiah (2008), and Anamuah-Mensah (2008) which links fundamental elements to effective teaching and assessment in JHS level. The framework as indicated in Figure 1 depicts an interaction between these elements. The Figure portrays that for an effective implementation of teaching and classroom assessment strategies as suggested in the 2012 JHS Integrated Science syllabus there must be some pre-conditions that a teacher (actor) should possess in order to be seen as being competent to deliver the curriculum. These pre-conditions are some levels of academic and professional qualifications. Academic qualification in science coupled with a professional qualification in education equip the teacher in content knowledge as well as pedagogical skills which will enable the teacher to teach the content effectively, using the appropriate methods and also assess the students so as to monitor learning as indicated in the curriculum for JHS.

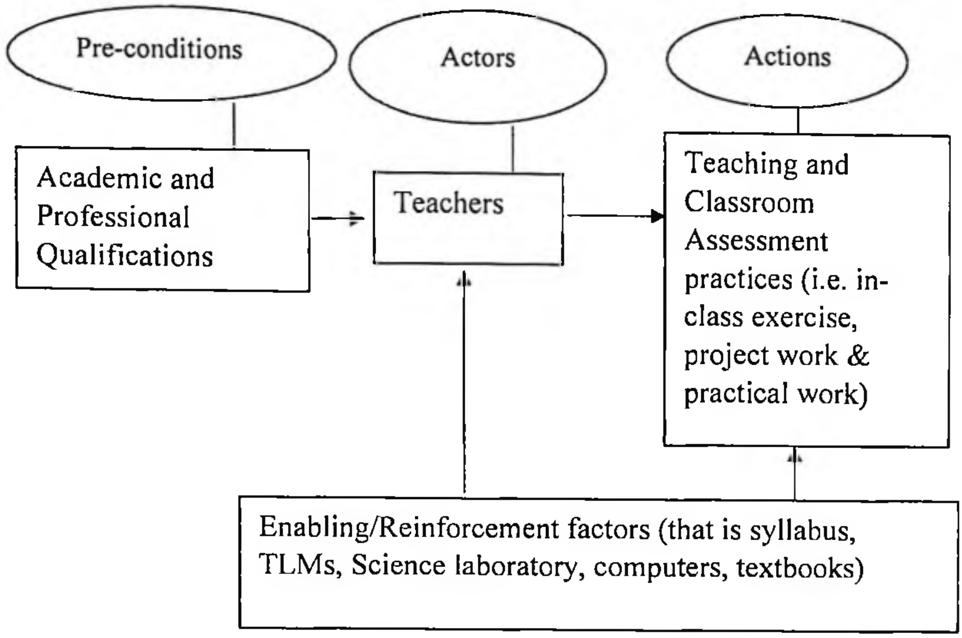

Figure 1: Conceptual Framework of Teaching and Classroom Assessment Practices in JHS

Source: Author's Construct (2018)

For instance, to qualify as an Integrated Science teacher, it requires minimum qualification of Diploma in Basic Education with specialty in science (IoE, 2015). This implies that teacher is trained at an initial teacher training institution where knowledge in methodology as well as the content area are gained. The Integrated Science teacher is expected to use activity-oriented teaching strategy proposed by the integrated science curriculum and assess students in order to monitor learning with SBA strategies such as in-class exercises, homework, project work with the aim to effectively enact the Integrated Science curriculum. For integrated science teachers with requisite academic and professional backgrounds to teach and assess students as per what is recommended largely depends on certain enabling and reinforcement factors. If the enabling and the reinforcement factors are not considered an effective implementation of the curriculum may be hindered. The enabling and reinforcement factors include the materials and equipment needed to facilitate the teaching and learning of Integrated Science such as science laboratory, computers, other science equipment. It must, however, be noted that the stages of the framework come as a whole and, therefore, should not be considered as individual unit. A break in one stage of the framework might lead to a failure to achieve the expected implementation of prescription of the 2012 JHS Integrated Science curriculum classrooms

CHAPTER THREE

RESEARCH METHODS

This chapter provides a detailed description of how the study was conducted. It discusses the research design, the participants and how they were selected. The chapter closes with a description of the instruments used for data collection and how the data obtained were analysed to gain insights into teaching and classroom assessment practices of Integrated Science teachers in both public and private junior high schools.

Research Design

This study followed the convergent parallel mixed methods design (Creswell & Plano Clark, 2011; Creswell, 2009; Bazeley, 2004). Thus, both quantitative and qualitative methods were used concurrently to obtain complimentary data on teaching and classroom assessment practices of Integrated Science teachers in both public and private JHS. The quantitative and qualitative datasets obtained were analyzed separately and the results were discussed along the research questions. Interpretations were made, to gain insights into the teaching and classroom assessment practices of teachers from both school-types.

To determine the academic and professional qualifications of teachers who taught Integrated Science in the schools selected in the educational districts used for the study, a survey method was employed using the Teachers' questionnaire. The questionnaire sought information from the teachers on their academic and professional qualifications, the priorities that inform their teaching and classroom assessment practices, how much of the topics in the Integrated Science syllabus they cover, and resources and facilities available to them for teaching and learning of Integrated Science. The responses from the individual science teachers as well as the school-types were used as the units of analysis.

At the same time, a sub-sample of teachers who had taken part in the survey and had taught Integrated Science for five years and above in their present schools were purposively selected for individual lesson observation and interviews in order to gain deeper insights into how Integrated Science was taught and students assessed in the classrooms. To achieve this, eight teachers (four each from public and private schools) were selected. The basis for purposively selecting the teachers was that they have taught students who had completed JHS with poor results in Integrated Science in the selected educational districts. Thus, they would provide a good picture of teaching and assessment practices in the schools in the educational districts. Furthermore, information was obtained through inspection of students' integrated science exercise books, teachers lesson notebooks and integrated science syllabus.

Focus-grouped discussions with selected students were conducted to enable their views to be triangulated with those of their teachers. To do this, six Form 2 students were purposively selected (three boys and three girls, to include two above average, two average and two below average with a boy and a girl in each category). The reason for selecting Form 2 students was that at the time of data gathering they were not being prepared to write the BECE. Hence, it was expected that they would be going through normal teaching instead of coaching and, therefore, could provide accurate information about the teaching methods of their teachers (Ampiah, 2008). Additionally, the selection of the students was based on their performance as assessed by their teachers. Their names were crossed-checked with their class registers to ensure they were regular at school. The information elicited from students included classroom assessment practices, coverage of topics in the curriculum and resources available in the schools for teaching and learning of Integrated Science and the extent to which the teachers used it in teaching. The interviews enable information on how Integrated Science was taught and students assessed in the classroom, how much of the topics in the syllabus are treated, and the extent to which resources and facilities available in the schools were used by the teachers to teach the subject. Major strategies used to obtain additional qualitative information included inspection of students' Integrated Science exercise books, teachers' lesson notebooks, Integrated Science teaching syllabus as well as past questions of Integrated Science from WAEC.

A schematic diagram of the convergent parallel mixed methods design used in this study is presented in Figure 2.

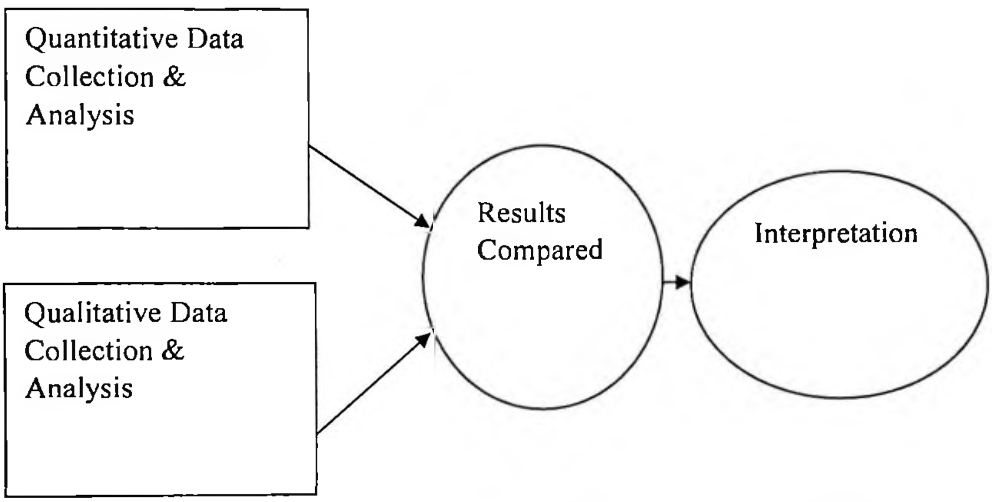

Figure 2: Convergent Parallel Mixed Methods Design (Creswell & Plano Clark, 2011)

Rationale for the design

The use of the convergent parallel mixed methods design was occasioned by its ability not only to gather large amounts of information capable of providing appropriate generalisation of the findings into the population of the study, but also, the tendency of the qualitative aspect to proffer reasons as to why certain actions and reactions as taken by the teachers. The survey method, which constituted the quantitative part, allowed large number of teachers who taught Integrated Science in the schools in the selected educational districts to be covered in order for generalisation to be made from the data obtained regarding teaching and classroom assessment practices (Fraenkel, Wallen, & Hyun, 2012; Gray, 2009; Cohen, Manion, & Morrison, 2007). On the order hand, the qualitative techniques used offered valuable and in-depth information about the classroom contexts of the teaching of Integrated Science in both school categories (Sarandakos, 2013).

The convergent parallel mixed methods design used in this study was appropriate in view of the nature of the research questions which guided the investigation (Ampiah, 2004; Fraenkel, Wallen, & Hyun, 2012). This is because it enabled in-depth information to be obtained to describe and interpret the teaching and classroom assessment practices of teachers who taught Integrated Science in both public and private junior high schools of the selected educational districts (Fraenkel, Wallen, & Hyun, 2012; Gray, 2009; Cohen, Manion, & Morrison, 2007). However, the results obtained from the two strands of datasets gathered through quantitative and qualitative techniques could yield different results and this could be a weakness of the design used for this study.

Population

The Central Region had 20 educational districts in 2017/2018 academic year. Twelve of the educational districts, according to data from the Central Regional Education Directorate, fell within those classified as over-served with teachers (GES, 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016, 2017). Hence, no newly trained teacher had been posted there since 2013. Five out of the 12 districts produced poor students' performance in Integrated Science in the BECE as revealed by the ESP reports (GES, 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016, 2017). Teachers who taught Integrated Science and their students from the five districts formed the accessible population of the study. In these five districts, there were 508 junior high schools (405 public and 97 private) with a total integrated science teacher population of 674 (416 in public and 258 private) from both school-types in the 2017/2018 academic year according to data from the Central Regional Directorate of Education (GES, 2008; 2009; 2010; 2011; 2012; 2013; 2014; 2015; 2016, 2017).

Sampling Procedure

A multi-stage sampling technique was used to select teachers and students for the study (Cohen, Manion & Morrison, 2007). To do this, four educational districts were selected out of the five using simple random sampling technique through computer generated random numbers. This was because there was the need to use four educational districts for the main study and the other for pilot testing of the instruments developed for the study. The four educational districts consisted of 354 JHS comprising 234 of public 162 and 120 private junior high schools. Convenience sampling technique was applied to select a total of 246 teachers with 162 from the public and 84 from private teaching Integrated Science.

All 246 teachers who taught Integrated Science in both school-types (i.e. private and public) in the four educational districts selected took part in the survey on the teachers' academic and professional backgrounds. The 162 teachers from the public schools consisting of 121(74.7%) males and 41(25.3%) females and the 84 teachers from private schools had (81.0% males and 19.0%). The age range of the teachers sampled from the public schools were between 20 to 54 years and 19 to 51 years from the private schools.

To obtain in-depth insights into how the teachers taught Integrated Science, eight of them from eight schools were purposively selected for case study. To achieve this, only teachers who have taught integrated science at their present schools for five years and above were selected. Two teachers (one each from public and private) were selected from the schools in each of the four educational districts. This was done to ensure the teachers were selected from the schools in all the four educational districts used for the study. The schools are, thus, referred to in this thesis with pseudo names using Alphabets. School A was a single stream co-educational institution established in 1962. Student enrolment during the 2017/2018 academic year (when the lesson was observed) was 146, with 53.2% males and 46.8% females. The two Integrated Science teachers were professionally trained. Only one of these agreed for his lessons to be observed.

School B was also a single stream co-educational institution established in 1972. Student population at the time of lesson observation in 2017/2018 academic year was 132, with 51.2% males and 48.8% females. School B had nine teachers but only one taught Integrated Science. He was professionally trained.

School C was a single stream co-educational institution established in 1984. The school in 2017/2018 academic year had a student population of 127, with 54.2% males and 45.8% females. School C had nine teachers of which two were teaching Integrated Science. Only one was professionally trained and he agreed for his lessons to be observed

School D, established in 1948, was single stream co-educational institution. Student enrolment at the time of lesson observation in 2017/2018 academic year was 143 with 58.2% males and 41.8% females. The school had twelve teachers with three teaching Integrated Science. Two of the three science teachers were professionally trained. The lessons of one of the professionally trained teachers was observed.

School E was a single stream co-educational private institution established in 1996. Student enrolment at the time of lesson observation in 2017/2018 academic year was 94, with 53.2% males and 46.8% females. The school had eight teachers with a female teacher teaching Integrated Science She was not a professionally trained teacher.

School F was a single stream co-educational private institution established in 2001. The school in 2015/2016 academic year had 83 students with 50.2% males and 49.8% females. The school had seven teachers of which one was teaching Integrated Science. He was professionally trained teacher.

School G was single stream co-educational private institution established in 1999. Student enrolment at the time of observation for the study in 2015/2016 academic year was 73, with 57.2% males and 48.8% females. The school had nine teachers and two taught Integrated Science. None of the science teachers was professionally trained. Though there were two science teachers in the school the lesson of the one teaching the JHS 2 class was observed.

School H was a single stream co-educational private institution started in 1996. The school had a population of 67 students in 2015/2016 academic year with 62.2% males and 37.8% females. The school had seven teachers of which two taught integrated science. None of the two teachers was professionally trained. A lesson of one of the teachers who taught JHS 2 class was observed.

A sample of students used in the study were selected using purposive sampling technique. Twenty-four students each from both school-types were selected based on their performance (two above average, two average and two below average which included one girl and one boy from each category) for focus-group discussions. In all, 24 boys and 24 girls were used. The purpose was to have students in each of the school categories. Those from the public schools had a mean age of 15.8 years with a Standard Deviation of 1.7 and those from private schools having an average age of 15.6 years with a Standard Deviation of 1.4.

Data Collection Instruments

The instruments developed for the study were:

1. Teachers' Questionnaire on Teaching and Classroom Assessment Practices (TQCAP)
2. Teachers' Interview Protocols on Teaching and Classroom Assessment Practices (TIPCAP)
3. Students' Interview Protocols on Teaching and Classroom Assessment Practices (SIPTCAP)
4. Checklist on Availability Resources for Teaching Integrated Science (CARTIS)
5. Integrated Science Lesson Observation Protocol (ISLOP)

Teachers' Questionnaire on Teaching and Classroom Assessment Practices (TQCAP)

To obtain information on academic and professional qualifications of the teachers, priorities that inform their teaching and classroom assessment, resources and facilities available for teaching, and coverage of topics in the integrated science curriculum, a multidimension questionnaire was developed [see Appendix A]. The instrument had a mixture of both closed and opened-ended items and had sections A to E.

Section A of TQCAP was in two parts. The first part contained items that required teachers to provide demographic information about their sex, age range, and the school-type in which they taught integrated science. The second part of Section A had 14 items which elicited information from the teachers on their academic and professional qualifications, the years they have taught integrated science, and their areas of specialization during their academic training. The items contained in section A of TQCAP were developed based on an extensive review of literature on the academic and profession qualifications needed for one to teach Integrated Science at the JHS level in Ghana (MoE, 2015; Asare & Nti, 2014; Adu-Yeboah, 2013; IoE, 2005).

The section B of TQCAP contained statements which sought information on priorities that inform the teaching of Integrated Science. Teachers were required to rank in order of importance priorities from 1-5, with number (1) representing the most important priority and five (5) being the least. The priorities were to help students to understand the content, to motivate students to have an interest in science, to help students appreciate the importance of science, to prepare students to pass their examinations, and to complete the syllabus. Items in Section B of TQCAP elicited information on whether the teaching priorities of the teachers were in congruency with the 2012 JHS Integrated Science teaching syllabus' main objective for the teaching Integrated Science at junior high school level (MoE, 2012).

Section C of TQCAP was in two parts. The first part had six teaching method which the teachers were required to indicated the ones they normally used to teach Integrated Science. The items required the teachers to indicate on a Likert type scale of 1-4, their reason with (1) being Almost always and (5) representing Often. The second part was an open-end item which further required the teachers to give reason(s) for their most preferred teaching method(s). The development of the items in Section C were based on the teaching methods associated with the two main theoretical frameworks influencing the teaching of Integrated Science in the schools (MoE, 2012)

Section D was in two parts. The first part required the teachers to indicate the reasons that influenced their classroom assessment practice. The items required the teachers to indicate on a Likert type scale of 1-4, their reason with (1) being Almost always and (5) representing Often. The reasons were for grading and filling of report cards for parents, to feedback on students learning, for identification of students learning difficulties and to inform teaching of Integrated Science (MoE, 2012)]. The development of the items in Section D of TQCAP were influenced by the objectives of classroom assessment as indicated in the Handbook for School-Based Assessment for teachers in JHS Ghana (MoE, 2012). The second part of section D of TQCAP sought information on teachers' choice of using classroom assessment strategies prescribed by the 2012 JHS Integrated Science syllabus. They were required to indicate the assessment strategies they used and how often they used them. The assessment strategies were In-class exercise, Class test, Homework and Project work. The development of items in the second part of Section D of TQCAP was based on the Handbook for School-based Assessment for teachers in JHS (MoE, 2012).

In Section E of TQCAP were the list of topics in the 2012 JHS Integrated Science teaching syllabus for each academic year. Teachers were required to indicate the topics that were not taught before the close of the academic year. This was used to guide the coverage of the topics in the Integrated Science syllabus. Finally, two open-ended items were included to enable teachers provide reasons why those topic(s) in the syllabus were not covered.

Section F of TQCAP had four items and sought information on availability resources and facilities in the schools for the teaching and learning of Integrated Science. The section contained a list of resources and facilities which the teachers were required to indicate whether they were available in their schools, and those available, they were to indicate if they were adequate or not. The items in Section F of the instrument were developed based on responses provided to an initial question given to six Integrated Science teachers to indicate in writing resources and facilities needed to facilitate effective teaching and learning of Integrated Science at the JHS level.

Teacher Interview Protocols on Teaching and Classroom Assessment Practices (TIPCAP)

A semi-structured Interview protocol was developed to collect information from the Integrated Science teachers [See Appendix B]. It sought information from teachers to gain further insights into priorities that inform their teaching of Integrated Science, the teaching methods they employ, their classroom assessment strategies, resources available for teaching and the extent to which they were used, as well as the extent to which the Integrated Science curriculum was covered. This was developed because not all the actions of the teachers in their classrooms could be captured with the questionnaire used in the survey (Ampiah, 2008).

Students' Interview Protocols on Teaching and Classroom Assessment Practices (SIPTCAP)

The SIPTCAP was developed to elicit information on the teachers' teaching methods, classroom assessment strategies, coverage of the integrated science syllabus, coverage of topics in the Integrated Science syllabus and resources available for teaching and learning of Integrated Science in their schools [See Appendix B] (Ampiah, 2004).

Checklist on availability of Resources for Teaching of Integrated Science (CARTIS)

The CARTIS was developed to obtain information on whether the resources available for teaching of Integrated Science in the schools were adequate or inadequate. The items in the CARTIS was developed based on the list of resources available in the schools.

Integrated Science Lesson Observation Protocol (ISLOP)

In order to gather information on the teachers in their natural classroom settings, ISLOP was developed. The information obtained with ISLOP complemented the ones gathered with the questionnaire and the interview protocols. The Integrated Science Lesson Observation protocol was designed such that it captured most of the issues that the questionnaire targeted which was informed by the purpose of the study and the research questions that were raised to guide this study. The protocol had two sections. The first section was used to elicit background information (school name and school type, teacher's gender, number of students, topic and class level) of the class being observed. The second section was used to collect data about the lesson design and implementation with significant emphasis on the teaching methods, and type of questions used by the Integrated Science teachers in their classroom assessment during lessons.

Validity

The validity of TQCAP was established with 30 Integrated Science teachers (15 each from public and three private JHS) and my team of supervisors, who were Professors in Science Education. This was to ensure the items in the instruments adequately captured the domain of issues investigated. The TQCAP was field-tested with other 10 Integrated Science teachers. This resulted in the revision of the TQCAP to obtain the final version administered on the teachers for information.

Again, to ensure the credibility of the interviews and the lesson observation protocols, they were applied on six Integrated Science teachers (three each from public and three private JHS) in the educational district which shared the same characteristic as the four selected for the main study (i.e. adequately supplied with teachers yet produced poor results in BECE). The data obtained were shared with the teachers for clarification of all issues raised about the items. This helped in making some modifications to obtain the final version of the interview and the lesson observation protocols which were used for the main study. Further acceptability of the interview and lesson observation protocols used were checked by reporting the data obtained with no biases.

Pilot testing

After obtaining the final version of the instruments, based on the inputs from my principal supervisor and the six Integrated Science teachers, they were pilot-tested. The instruments were administered on teachers who taught Integrated Science as well as focus groups of students from both school categories in Komenda-Edina-Eguafo-Abirem (KEEA) educational district of the Central Region of Ghana. The KEEA district was used for pilot testing of the instruments because it was one of the educational districts in the region classified as being adequately supplied with teachers but low students' performance in Integrated Science as indicated in the Central Regional Educational Sector Performance review reports (MoE, 2010; 2011; 2012; 2013; 2014; 2015; 2016; 2017). Thus, the district had a similar characteristic as the ones selected for the main study. The pilot testing of the instruments facilitated the determination of their validity and reliability. Hence, the KEEA educational district was not used in the main study.

Reliability

The reliability Section E of the teachers' questionnaire was determined after it had been administered on 73 teachers from both category of JHS. The internal consistencies of the items were estimated with the help of Cronbach's Alpha Coefficient of Reliability. This was because the items were not to be scored dichotomously. Since the questionnaire was multi-dimensional in nature, reliability coefficients were estimated for each dimension. Classroom Assessment was 0.76, and Resources available was 0.74 and the coverage of the curriculum was 0.77. Hence, the instrument was found to be internally consistent and appropriate for data collection because the reliabilities estimated exceeded the threshold value of 0.70 recommended for research work (Cohen, Manion & Morrison (2012).

Data Collection Procedures

Before data were collected for the study, an Introductory Letter was obtained from the Department of Science Education to the Central Regional Directorate of Education seeking permission for schools in the selected educational districts to be used for the study. The Regional Education Directorate further wrote to introduce me to the District Directors of Education requesting that I should be allowed to conduct my study with JHS in their respective districts. The District Directors of Education subsequently introduced me to the heads of JHS by way of another introductory letter for permission to be granted for me to use their schools for the study. The heads verbally agreed and then introduced me to their teachers who taught Integrated Science.

After I had been introduced to the teachers in the schools, rapport was established during which the purpose of the study as well as the methods of administering the Instruments with its instructions for completion were discussed. In all the schools visited, the teachers were willing to take part in the research after I had assured them that their responses to the items on the instruments would be treated anonymously.

Fieldwork commenced in April 2017 and ended March 2018. The Teachers' questionnaire used for gathering quantitative data was administered on teachers who taught integrated science in the public and private JHS in the selected educational districts of the Central Region. This was done by distributing the questionnaire to the individual teachers to complete in order to obtain information on their academic and professional qualifications, priorities that inform their teaching and classroom assessment strategies, resources and facilities available for the teaching of the subject and the extent to which they were used, and the coverage of the integrated science curriculum. The questionnaire administration was done with the help of four trained Research Assistants from the Department of Science Education of the University of Cape Coast. To ensure high completion and response rate of the questionnaire, it was ensured that teachers completed and handed them over the same day. Despite the willingness of the respondents to participate in the study, there were some concerns with the completion and returning of the instruments as some of the respondents wanted to complete it in their spare time. I, therefore, had to ask them to give me dates and times that were convenient for me to come for them. This procedure resulted in a return rate of 94.6 %.

The qualitative data on the other hand were collected using techniques such as Integrated Science lesson observations, individualised interviews with selected teachers and focus-grouped discussions with some selected students from both school-types as well as inspection of teachers' science lesson notebooks. The qualitative data were collected from teachers (four each from the school-types used) who had indicated to have taught integrated science in their present schools for five years and above.

The lessons of the teachers were observed individually using the Integrated Science Lesson Observation Protocol as a guide. The topics taught and their accompanying lesson objectives as well as how the main lessons were delivered were recorded. After, interviews were conducted with the individual teachers to gain deeper insights into their teaching methods, classroom assessment strategies, the type of questions they used in their assessment tasks, the extent to which they covered the Integrated Science curriculum, and resources available and the extent to which they employed them in their teaching. The individual interviews with the teachers lasted between 30 and 40 minutes.

Form two students from classes of teachers whose lessons were observed were selected to take part in the focus-group discussions on the same issue raised with their teachers with the aim of triangulating the information obtained from the teachers. All interviewees were assured of confidentiality and anonymity at the beginning of each interview session in each school. All interviews took place in a comfortable environment with little possibility of distraction so that they could express themselves freely. All interviews were recorded using an audio tape-recorder supplemented by note-taking with permission of the interviewees (Dowling & Brown, 2010).

Data Processing and Analysis

Information obtained with the instruments were analysed based on the research questions formulated to guide the study. The first research question sought information on the academic and professional qualifications of teachers who taught Integrated Science in the sampled public and private junior high schools in educational districts used for the study. These were analysed with frequencies and percentages to construct the academic and professional profiles of the teachers.

The second research was in two parts; the first part numbered (a) had two sub-questions numbered (i) and (ii). The question numbered (i) sought information the priorities that informed teaching of Integrated Science by the teachers was answered using Kendall's Coefficient of Concordance. The purpose of using Kendall's Coefficient of Concordance was to obtain the priorities that teachers ranked as what informed their teaching of integrated science. The ranks were (1) being the most important and (5) the least important. Furthermore, the Kendall's Coefficient of Concordance enable the level of agreement amongst the teachers with respect to the ranked priorities to be determined. The level of agreement among the teachers on the ranks were determined with calculated Kendell's Coefficient of Concordance (W). The value of (W) range from 0 to 1, where (0-0.4 indicate low agreement, 0.5-0.7 moderate agreement, and 0.8 to 1.0 high agreement as noted by Gearhart, Booth, Sedivec and Schauer, 2013). The least Ranked Order Value (R) indicates the most important priority. The question numbered (ii) of the research question numbered (a) was answered using Kendall's Coefficient of Concordance to explore the priorities that inform professional and non-professional teachers teaching of Integrated Science.

The second part of research question 2 numbered (b) explored how integrated science teachers taught the subject and how it conformed to what is prescribed in the teaching syllabus was answered with transcription of lessons using open coding and constant comparison. After the open coding and constant comparison, meanings were made, and themes were formed out of them. The instructional methods the teachers used to teach the lessons were then compared to the prescriptions of the 2012 JHS integrated science teaching syllabus to determine the extent to which they conform. Sample statements from individual interviews with the teachers after the lesson observations were used to gain broader insights in the methods employed by teachers from both school-types.

Research question three was in three parts. The first part numbered (a) explored what classroom assessment integrated science teachers used and how it conformed to what was suggested in the teaching syllabus was answered with Bar graphs and proportions. Information on how often the teachers used the classroom assessments were also answered with Bar graphs and proportions. The second part of research question three numbered (b) which explored informed classroom assessment practices of integrated science teachers was answered with Frequencies and Percentages. To explore differences, if any, existed in what informed classroom assessment practice of the teachers from the different school-type was answered with One-way Multivariate Analysis of Variance Analysis (MANOVA). The reasons dependent variable consisting of grading and filling report cards for parent, to provide feedback on students learning, identification of students' learning difficulties, and to inform teaching of integrated science. The independent variable was the school-types (i.e. public and private schools). Further information from transcribed interviews with selected teachers were used to gain understanding of their practice of classroom assessment. Information from focus-grouped discussions with students were used to confirm the teachers' classroom assessment practices. The third part of research question three numbered (c) was answered with the taxonomy table for the classification of questions developed by Anderson et al. (2001). To do this, all questions used by teachers of both school-types were recorded with field notes from students Integrated Science exercise books, and their teachers' lesson notebooks were sorted into the domains of Anderson and Krathwohl's Frameworks for analyzing teachers' questions.

Research question four which sought information on how much of the topics in the Integrated Science syllabus were covered by the teachers in the different school-types. Propositions and bar graphs were used to determine the extent to which teachers from both school-types covered the topics in the Integrated Science curriculum. Sample statements from individual interviews with some selected teachers on the coverage of the curriculum as well as past BECE Integrated Science questions from WAEC were used to compare and gain broader insights into what influenced the coverage of the topics in the syllabus.

The fifth research question on what teaching and learning resources were available to teachers for the teaching of Integrated Science and how they used it to teach was answered using frequencies and percentages. To determine whether the resources and facilities indicated to available were adequate or not in both school-types, frequencies and percentages were used. Sample statements from individual interviews with teachers and focus-grouped discussion with students were used to explain the information got with the frequencies and percentages.

Ethical Consideration

The nature of the study required mutual respect, the development of productive relationship and establishment of cooperative environment between the participants, the researcher, and the students. After the initial contact meeting, letters explaining the purpose of this study was sent to all the schools heads and the teachers who were teaching Integrated Science which outlined the study and established agreement to be part of the study. The students involved were asked to give their consent to participate in the study. Initial interviews were held with the teachers that outlined the extent to which my presence might impact on their science lessons. At all times during data collections, I accommodated changes to the scheduling of the lessons and the requirements of the teachers.

Furthermore, since the participants were assured of anonymity (Shuck & Kearney, 2006) pseudonyms were used to refer to the participating teachers, students and schools in this report. The aim was for the participants' identity to remain anonymous in the thesis and any additional reporting (conference presentations, journal articles) that would emanate from this study.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, the results obtained from analyses of data on teaching and classroom assessment practices of Integrated Science teachers from public and private junior high schools in the selected educational districts are presented and discussed with respect to the five research questions formulated to guide the study.

Academic and Professional Qualifications of Integrated Science Teachers

The first research question sought to explore the academic and professional qualifications of teachers who taught Integrated Science in the public and private junior high schools sampled. Frequencies and percentages were used to construct the academic and professional profiles of the teachers as shown in Table 2.

Table 2: Academic qualifications of Integrated Science teachers in public and private junior high schools

Academic qualifications	School type					
	Public (N=162)		Private (N=84)		Total (N=246)	
	Frequency	%	Frequency	%	Frequency	%
GCE A level	0	0	1	1.2	1	0.4
SSCE/WASSCE	10	6.2	48	54.1	58	23.6
Cert. A Post Sec	2	1.2	1	1.2	3	1.2
Diploma	52	32.1	8	9.5	60	22.0
Bachelor's degree	90	55.6	24	28.6	114	46.3
Masters	8	4.9	2	2.4	10	4.1

Source: Field Survey, Otami (2018)

The results in Table 2 show that out of the 246 integrated science teachers from the schools sampled, majority (72.4%) possessed either a Diploma or above as their highest academic qualifications with the rest holding either GCE A' levels

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Masters	8	4.9	2	2.4	10	4.1

Source: Field Survey, Otami (2018)

The results in Table 2 show that out of the 246 integrated science teachers from the schools sampled, majority (72.4%) possessed either a Diploma or above as their highest academic qualifications with the rest holding either GCE A' levels or SSCE/WASSCE. With respect to categorisation of the teachers based on the different school-types sampled, out of the 84 teachers sampled from the private schools, majority (54.1%) had SSSCE/WASSCE as their highest academic qualification whiles 40.1% possessed a Diploma, Bachelor's or Masters degrees. Also, of the 162 teachers from the public schools sampled, majority (92.6%) were holders of either a Diploma, Bachelor's or Masters degrees as against only (6.2%) who possessed SSSCE/WASSCE as their highest academic qualification. The results as presented in Table 2 depicts that generally, higher proportion of teachers who taught Integrated Science in the junior high schools sampled from the over-served educational districts possessed a Diploma or higher as their highest academic qualification. The results further suggest that higher proportion of the teachers who taught Integrated Science from the public schools sampled possessed higher academic qualifications compared to the private schools.

On professional qualifications of teachers who taught Integrated Science in the schools sampled, the results are presented in Table 3.

Table 3: Professional qualifications of Integrated Science teachers in public and private junior high schools

	School type					
	Public (N=162)		Private (N=84)		Total (246)	
Professional Qualification	Frequency	%	Frequency	%	Frequency	%
Cert. in Educ.	20	2.5	3	6.0	23	2.0
B.Ed	62	38.3	5	2.4	67	27.2
PGDE / PGCE	25	12.3	2	2.3	27	8.9
UTDBE	3	1.9	1	1.2	4	2.0
None	52	32.1	73	86.9	125	51.0

Source: Field Survey, Otami (2018).

The results in Table 3 reveal that one-half out of the 246 teachers who taught Integrated Science from the schools sampled possessed no professional qualification. With respect to school-type, only 11.9% out of the 84 teachers from the private schools possessed either Certificate in Educ., BEd, PGDE/PGCE or the UTDBE as their professional qualifications. The case was different for teachers from public schools sampled. Out of the 162 integrated science teachers selected, majority (67.9%) possessed either Cert in Educ, BEd, PGDE/PGCE or the UTDBE) as their professional qualification. The results as indicated in Table 3 show that generally, only (49%) of the teachers who taught Integrated Science in over-served schools of the educational districts used for the study, possessed some professional qualification. Nonetheless, a higher proportion of the teachers from the public schools sampled were professionally qualified compared to the private schools.

To obtain information on the teachers who taught integrated science in the schools sampled with respect to whether they were professionally trained or not, and whether they had a background in science or not, the results are presented in Table 4.

Table 4: Professional and non-professional Integrated Science teachers with and without a background in SHS level science and above

School type	Subject Area			
	Professional (N=121) with science background		Non-professional (N=125) with science background	
	Frequency	%	Frequency	%
Public	97	80.2	93	74.4
Private	24	19.8	32	25.6
Total	121		125	

Source: Field Survey, Otami (2018)

The results in Table 4 indicates that one-half of the teachers who taught Integrated Science in the schools sampled possessed no professional qualification though they had a background in at least SHS level science. Out of the number majority (74.4%) were from the public schools. However, majority (80.2 %) of the teachers who some possessed professional qualification and also had a background in science were from the public schools.

To further explore Integrated Science teaching experience of the teachers from the schools sampled, the results are presented in Table 5.

Table 5: Years of Integrated Science teaching experience of teachers in public and private junior high schools

Teaching	Public (N=162)		Private (N=84)	
Experience	No	%	No	%
1-2	47	29.0	43	51.2
3-4	45	27.8	32	38.1
5-6	39	24.1	9	10.7
7-8	18	11.1	0	0
9-10	8	4.9	0	0
Above 10	5	3.1	0	0

Source: Field Survey, Otami (2018)

The Table shows that majority (87.4%) of the teachers who taught integrated science in the schools sample had a maximum of 6 years' experience in teaching the subject. With respect to school-type, of the 84 teachers sampled from the private schools, none of them had taught integrated science for more than 6 years. On the other hand, only 19.1% of the 162 teachers from the public schools had taught integrated science for 7 years' and above with the majority (56.8%) having less than that 5-years of integrated science teaching experience. The majority (67.8%) had only 4 years of integrated science teaching experience. The results in Table 5 generally depict that higher proportion of teachers from the public schools sampled comparatively have more integrated science teaching experience.

From the analysis of research question one which sought to explore the academic and professional qualifications of teachers who taught integrated science in the sampled schools in the overserved educational districts used for the study, the results showed that majority (74.8%) of the teachers possessed a Diploma, a Bachelor's or Master degrees as higher academic qualification. This could be as a result of the Ministry of Education policy which require a minimum teaching qualification at the basic level in public school to be a Diploma in Basic Education (Abe, 2014; Ampiah, 2008; Tooley, Dixon & Amuah, 2007; IoE, 2005; MoE, 2005). Hence, the University of Cape Coast through the teacher training institutions (i.e the Colleges of Education) award Diploma in Basic Education after training (IoE, 2005). However, the proportion of Integrated Science teachers who possessed higher academic qualifications from the public schools sampled were more than those from the private schools. This is because the products of the Colleges of Education who are awarded Diploma in Basic Education are posted directly by the GES to the public basic schools. This also could account for the large numbers of teachers in the public schools having higher academic qualification compared to those from private schools. Again, the large number of academically qualified teachers in the public schools could also be attributed to the fact that when teachers in private schools obtain the requisite minimum academic qualification for teaching at the basic level, they join the public schools because of enhanced conditions of service there. The results support the findings of (Ampiah, 2008; Tooley, Dixon, & Amuah, 2007) who have noted that teachers in public basic schools were more academically qualified compared with those from private schools. In spite of the fact that the minimum academic qualification required to teach at the Basic School level in Ghana is a Diploma in Basic Education (IoE, 2005; MoE, 2005), the increased number of teachers in the sampled public schools with Bachelor's degree could be that most of the teachers might have taken advantage of Distance Education top-up programmes in Bachelor of Basic Education run by the University of Cape Coast and University of Education, Winneba to upgrade themselves to the Bachelor degree level.

One-half of teachers who taught Integrated Science in the schools sampled from the overserved educational districts were not professionally qualified. This could be due to the different pathways of teacher recruitment in the basic schools in Ghana (Asare & Nti, 2014). For instance, most of the private schools do not necessary look out for professionals (Ampiah, 2008; Tooley, Dixon, & Amuah, 2007). They only look at academic background in a specified subject area (Tooley, Dixon, & Amuah, 2007). Furthermore, professionally qualified science teachers from the Government Colleges of Education are not posted to private schools. Also, avenues exist for non-professionally trained teachers in public schools to upgrade themselves professionally through Government sponsored programmes such as Untrained Teachers Diploma in Basic Education (UTDB) (MoE, 2017; MoEYS, 2004). This is because professionally qualified teachers contribute immensely to achieving high academic performance (Fletecher, 2016; Ololube, Egbezor, & Kpolovie, 2008; Ampiah, 2008).

One-half of the teachers who taught Integrated Science in the schools sampled had no background in at least SHS level science. Thus, these teachers may be engaging in out-of-field teaching which could affect the quality of Integrated Science teaching in the basic schools since such teachers may teach the subject with weak content knowledge and pedagogical skills. This resonates with Harrell (2010) and Fletcher (2016) who have reported that majority of teachers teaching science at the Basic level of education do not have background in science.

Again, majority (87.4%) of teachers who taught Integrated Science in the schools sampled were in-experienced with respect to the years they have taught the subject. This was profound in the private schools. This confirms the general assertion that teachers in private schools were most often inexperienced (Ahmed & Aziz, 2009; Ampiah, 2008). Consequently, the quality of science teaching might be affected because as noted by Sjoer and Meirink (2015) science teachers' teaching experiences greatly influence their classroom science teaching thus, teachers with less than 5-years teaching experience may not be as effective as teachers with more than 10-years' experience (Danielsson & Warwick, 2014). Therefore, it could be said that teachers from the private schools may be ineffective in teaching Integrated Science.

Priorities that informed teaching of Integrated Science

Research question two was in two parts. The first part had two subsections (i) and (ii). The section (i) sought to explore the priorities that informed the teaching of Integrated Science by teachers from both school-types and (ii) sought to explore the priorities that informed the teaching of Integrated Science by professional and non-professional teachers. The second part of research question two investigated how Integrated Science teachers teach the subject and whether their teaching methods conform to what is prescribed in the teaching syllabus for Integrated Science.

Teaching priorities

To answer the first part of research question two numbered (i), the integrated science teachers were asked to rank five priorities of teaching integrated science drafted to reflect the focus of teaching in order of importance by the teachers. The priorities were analysed using Kendall's Coefficient of Concordance. The results are presented in Table 6.

Table 6: Kendall's W rank order of teaching priorities of Integrated Science teachers (N=246)

Priorities	R	Mean rank	The ranking	W	P
to help students understand the content	412	2.12	1st	0.346	0.001
to motivate students to have interest in science	584	2.57	2nd		
to help students appreciate the importance of science	620	2.71	3rd		
to prepare students to pass their exams	722	3.13	4th		
to complete the syllabus	1059	4.47	5th		

Source: Field Survey, Otami (2018)

The results show that teachers who taught integrated science in the schools sampled ranked *'to help students understand the content of science'* with the least R-value of (412) as the most important priority which informed their teaching of integrated science and '*to complete the syllabuses* with R-value of (1059) as the least important priority. To explore the degree of agreement amongst the teachers with respect to ranking of the priorities, Kendall's Coefficient of Concordance (W) was calculated to be 0.346, with a p-value of 0.001. The calculated value falls in the range of 0 to 0.4 which indicate a weak agreement amongst the teachers on the ranked priorities.

Since the agreement amongst the teachers was low regarding the most important priority which informed their teaching of integrated science, school-type differences in the ranking of the priorities were investigated with Kendall's Coefficient of Concordance. The results as presented in Table 7 show that

Table 7: Kendall's W rank order of teaching priorities of Integrated Science teachers in public and private schools

	School type									
	Public (N=162)					Private (N=84)				
Priorities	R	Mean rank	The ranking	W	P	R	Mean rank	The ranking	w	p
To help students to understand the content	483	2.16	1st	0.344	0.001	239	2.03	3rd	0.362	0.001
To motivate students to have an interest in science	316	2.46	2nd			155	2.77	4th		
To help students appreciate the importance of science	406	2.74	3rd			214	2.63	5th		
To prepare students to pass their exams	364	3.21	4th			220	2.98	1st		
To complete the syllabus	692	4.44	5th			367	4.52	2nd		

Source: Field Survey, Otami (2018)

teachers from both school-types in the ranking of the aims as those in public schools was '*to help students to understand content*, as their most important aim of teaching integrated science' and '*to complete the syllabus*' as the least. Those from the public schools ranked in the order of importance as follows:

i.help students understand the content'

ii.help students to understand integrated science

iii. motivate students to have an interest in science

iv.prepare students for their exams

v.complete the syllabus

The first three are most beneficial for nurturing conceptual understanding of integrated science concepts. The ranking of teachers from private schools of the aims were as follows:

i. prepare students to pass their exams

ii. complete the syllabus

iii.help students understand the content,

iv. motivate students to have interest in science

v. help students appreciate the importance of science

Thus, the teacher who taught integrated science in the private schools without a focus to help students develop conceptual understanding of integrated science concepts. The results in Table 7 seem to suggest that students require understanding in order to be able to make informed judgements and to apply the knowledge they acquire to solving problems. Private schools sampled seem to prepare students to pass their exam and finishing the syllabus. Extracts from interviews with the teachers explained the rankings from which their priority was derived was as follows:

"I try to deliver my integrated science lesson in a way that will improve the knowledge of my students..." (Teacher A from Public School A).

"All I do is to let my integrated science lessons give deeper knowledge to my students. nothing more, nothing less... with this, they will not struggle in exams (Teacher B from Public School B)

Teachers from Private Schools gave reasons to back their aim of not focusing on conceptual understanding of Integrated Science concepts as follows:

"I try to completing the integrated science syllabus ... so that my students could have knowledge about all the questions in exams" (Teacher D from Private School D).

"when student understand science, they see the importance of the subject, and then learn it" (Teacher C from Private School C).

Generally, results from the first part of research question two show that the teachers from different school-types have different priority that inform the teaching of integrated science. Those in public school prioritised development of conceptual understanding of scientific concepts needed for the application of scientific knowledge to solve everyday problems. The implication is that integrated science teachers' public school would employ student-centred teaching approaches in their teaching.

Teaching priority of professional and non-professional teachers

To answer first part of research question 2 numbered (ii), on priority that informed professional and non-professional teachers teaching of Integrated Science was explored using Kendall's Coefficient of Concordance and the results are presented in Table 8.

Table 8: Kendall's W rank order of teaching priorities of professional and non-professional Integrated Science teachers

	Professional Qualification									
	Professional (N=121)					Non-professional (N=125)				
Priorities	R	Mean Ranks	Ranking	p	w	R	Mean Ranks	Ranking	p	w
To help students to understand the content	249	2.04	1st	0.001	0.457	484	3.07	5th	0.001	0.588
To motivate students to have an interest in science	375	2.36	2nd			285	2.07	4th		
To help students appreciate the importance of science	493	2.57	3rd			378	3.00	2nd		
To prepare students to pass their exams	546	3.78	4nd			320	2.19	1st		
To complete the syllabus	622	4.12	5th			776	4.52	3rd		

Source: Field Survey, Otami (2018)

The calculated value of (w=0.588; p=0.001) obtained as reported in Table 8 show that the professional and non-professional teachers had a moderate agreement about aim of their teaching of Integrated Science. The professional teachers ranked the aims in order of importance as follows;

i.help students understand the content'

ii.help students to appreciate the importance of science

iii. *motivate students to have an interest in science*

iv.*prepare students for their exams*

v.complete the syllabus.

Whereas the non-professional teachers ranked the aims in order of importance as

i. prepare students for their exams

ii.help students to appreciate integrated science

iii.complete the syllabus

iv.help students understand the content'

v. *motivate students to have an interest in science*

From the rankings professional teachers prioritised teaching to develop students conceptual understanding over completing the Integrated Science syllabus and preparing students to pass their exams as compared to non-professional teachers.

Interviews with some of the professional and non-professional teachers to explore why they differ in the priority that inform their teaching of Integrated Science were conducted. Extract of an interview with two professional teachers was as follows:

the most important thing to do, as a teacher, is to make sure your students understand whatever is taught.....so that is what I always aim at (Professional Teacher B from Public School B).

Another Profession Teacher C from Private School C explained that "*when students understand science... they will see it not difficult...*"

Two of the selected non-professional teachers noted that;

> "*I have to make sure we finish the syllabus so that they will do well in their exams*" (Non-professional Teacher D from a Public School D).
>
> "*I know when I finish the syllabus my students not to be afraid of science*" (Non-professional Teacher D from a Private School D)

Thus, the ranking of the professional teachers suggest that they were more likely to use teacher-centred approached to teach (Amin & Raba, 2017; Lieberman & Maca, 2010; MoE, 2012). This is not surprising because professional teachers are exposed to methods of teaching in their professional training which suggest that they are aware of the tenants of the syllabus which require that teachers teach to develop students' conceptual understanding of concepts as against the completion of the syllabus and preparation of students to pass their exams which are also important. Thus, the professional teachers were more likely as well to employ student-centred teaching approach in teaching Integrated Science per their ranking of the priorities which resonate with teaching methods advocated in the Integrated Science syllabus for teaching.

Methods used to teach Integrated Science

The second part of research question 2 explored how JHS teachers taught Integrated Science and how their teaching conformed to what is prescribed by the 2012 JHS Integrated Science syllabus. To answer the research question, 24 lessons (12 each from public and private schools) of eight teachers (four each from public and private schools) were observed. Three integrated science lessons of each teacher observed and the teaching methods used to teach are presented in Table 9.

Table 9: Teaching methods observed in Integrated Science lessons (N=24)

School	No. of observed lesson	Teacher's method	The recommended method in the syllabus
A	3	Expository	Activity and Discussion
B	3	Expository	Activity and Demonstration
C	3	Expository	Discussion and Activity
D	3	Expository	Demonstration, Discussion, and Project Work
*E	3	Expository	Discussion, Demonstration and Activity
*F	3	Expository	Activity, Demonstration, and Discussion
*G	3	Expository	Demonstration, Discussion and Activity
*H	3	Expository	Demonstration, Activity and Discussion

* Are Private schools

Source: Field Survey, Otami (2018)

Table 9 shows that generally teachers whose integrated science lessons were observed in the public and private junior high schools sampled used the expository method to teach. The method used by the teachers did not resonate with what is prescribed by the 2012 JHS Integrated Science syllabus for teaching the topics taught in the lessons observed. The recommended methods by syllabus required that teachers give students opportunity to be active participants in lessons and, thus, move away from behaviourists mode of teaching such as the expository method used by the teachers to teach the lessons observed. Examples of integrated science lessons of the teachers are presented.

Lessons Observation

Mensah's integrated science lesson

Mensah's lesson was at JHS 2 class. The class had 49 students, with 65.3% boys and 34.7% girls. Mensah had taught integrated science for 7 years in the school. He had Bachelor of Education in Basic Education. He was a trained teacher from one of the Colleges of Education in Ghana majoring in integrated science. Mensah had to help students understand the content of science as his teaching priority. His preferred instructional methods indicated on the TQCAP [see appendix A] were Activity and Demonstration which reflected what the 2012 JHS integrated science syllabus had recommended for teaching *Balancing of Chemical Equations.* Mensah's lesson taught on the 5th week of the second term of the school year is presented as follows:

Review of students' previous knowledge

The lesson started with a question from Mensah to the students which required them to mention chemical formula for some binary compounds. Some students put up their hands to answer the question and one was called to the chalkboard to write it. Mensah said the topic for the day and wrote it on the chalkboard. The topic *Balancing of Chemical Equation* was prescribed by the syllabus to be taught at JHS 2 and Mensah's introduction of the topic was in agreement with the Lesson Plan developed for the lesson.

Instructional methods

Mensah used the expository 'chalk and talk' method to teach the lesson. He first explained to the students how to balance chemical equations. Then wrote a word equation; converted it to chemical equation and balanced it systematically on the chalkboard for students to follow. However, the syllabus, prescribed that to teach the topic, *Balancing of Chemical Equations*, students should be made to change word equations into chemical equation which Mensah did by himself. As indicated in the syllabus, *write word equations for some simple chemical reactions. For example, reaction between*

Sodium and Chlorine

Nitrogen and Hydrogen

Calcium and Chlorine (MoE, 2012, p. 23).

The approach of writing word equation and converting it to chemical equation as used by Mensah was in alignment with what was recommended by the syllabus. However, no specific teacher-learner activity for teaching balancing of chemical equation was indicated to bring out the teaching method. For example, *balance simple chemical equations*

$H_2 + O_2 \rightarrow H_2O$

$N_2 + H_2 \rightarrow NH_3$

$Na + Cl_2 \rightarrow NaCl$

$Mg + O_2 \rightarrow MgO$ (MoE, 2012, p. 23). This indicate that Mensah had room to select appropriate teacher-learner activity to teach his lesson. This perhaps explains why Mensah chose to use the expository approach to teach.

Students' participation

Students' participation in the lesson was occasioned by their responses to the teacher's questions. For example, an extract of students' involvement was as follows:

Mensah: Mention the chemical formula for any binary compound?

Students put up their hands.

Mensah: Yes, Ama

Ama: CO_2

During the development stage of the lesson, students were called to the chalkboard to solve problems as well as into their notebooks. This meant Mensah tried to involve the students in the lesson. This reflected the general aim of ensuring active involvement of students through problem solving as prescribed by the syllabus.

Mensah: Balance this reaction, Sodium + Chlorine → Sodium chloride

None of the students put up a hand to be called to answer the question. After sometime, Mensah called George to go to the chalkboard and answer the question.

George: balanced the equation as Na +Cl → NaCl which Mensah drew George's attention to the missing valences and indicated the answer was incorrect and then wrote the correct balanced equation for the reaction on the chalkboard as: $2Na+Cl_2 \rightarrow 2NaCl$. The questions given to the students to practice were the same as those indicated in the teacher's lesson plan as well as the syllabus. *Try this example in your notebooks:*

Hydrogen + Oxygen→

Sodium + Oxygen→

Carbon + Oxygen→

Nitrogen + Hydrogen→

Mensah observed as students tried to balanced it.

After the lesson, I interacted with Mensah and some selected students on the instructional method(s) used. Though Mensah claimed Activity and Demonstration methods were used to teach the lesson observed, in actual fact the 'Chalk and Talk' method was used. Mensah's claim is in line with the general prescription of the JHS Integrated Science Syllabus (MoE, 2012) which require teachers to teach integrated science with activity-oriented methods but his method of teaching was not. An extract of my interaction with Mensah was as follows:

Interviewer: what teaching method did you use for the lesson?

Mensah: I combined both demonstration, and activity methods because it was demonstrated on the chalkboard to the students how they should convert word equations to chemical equations.

Interviewer: oh...really, what of the Activity method?

Mensah: It was embedded in the demonstration... I walk them through balancing of the equation on the chalkboard as they follow and tried it.

Interviewer: do you always use this method to teach science?

Mensah: no..., I can't use this method (demonstration) to teach every topic. It really depends on the topic I am teaching.

From the interaction, Mensah was aware of what the syllabus required regarding how integrated science should be taught but did not follow it in his lesson.

Interviews with the selected students from Mensah's class regarding the method used to teach integrated science confirmed that the 'chalk and talk' method as observed in the lesson was used to teach the subject. An excerpt of the interviews was as follows:

Interviewer: did you enjoy today's science lesson?

Students: yes, sir.

Interviewer: why?

Students: because of the way our science teacher taught

Interviewer: do you want your science teacher to teach science as he did today?

Students: no, yes ... (disagreement amongst the students).

Interviewer: okay, those saying no, why?

Students: we want to also do experiments so that we will not copy notes from the chalkboard.

Interviewer: why are you saying that?

Students: because... always copy notes from the chalkboard.

Adu's integrated science lesson

Adu's lesson was in JHS 2 class. The class comprised 48 students, with 66.7% boys and 33.3% girls. Adu had taught Integrated Science in the school for 8 years. Adu possessed a Bachelor of Education degree in Basic Education as well as Cert 'A' from a College of Education with a generalist professional background with integrated science as one of the subject areas of concentration and selected to help students understand the content of science as his teaching priority. Adu's selected Activity and Demonstration as his preferred methods of teaching integrated science. Adu's lesson *Properties of Metals and Non-Metals* was taught on the 5th week of the second term of the school year and was as follows:

Review of students' previous knowledge

The lesson started with a display of a chart on the first 20 elements of the Periodic Table on the chalkboard and students were asked to mention the names of some of them. They were then asked to group the elements into metals and non-metals and write them in their books. Adu monitored answers of two students, and wrote the topic for the day on the chalkboard and asked the class to read it aloud. Adu's use of a chart to display the first twenty elements of the Periodic Table is in line with the suggestion of the 2012 Integrated Science syllabus which required that students are made to categorize the first 20 elements of the Periodic Table into Metals and Non-metals. For example, the specific objective of the topic according to the syllabus is: *group the first twenty elements of the periodic table into metals and non-metals* (MoE, 2012, p. 23). The topic as indicated in the 2012 syllabus was to be taught at JHS 2. The display of the first 20 elements of the periodic table and making students group them into metals and non-metals reflected what Adu had indicated in his Lesson Plan.

Instructional methods

Adu used the Expository 'chalk and talk' method to teach the topic. This did not resonate with the Activity method prescribed by the syllabus. Adu mentioned, explained and wrote four properties each of metals and non-metals on the chalkboard for the students to follow. Three chemical properties as well as uses of metals and non-metals were outlined on the chalkboard for students' attention. What Adu did was not reflective of what the syllabus had suggested for teaching of the topic *properties of metals and non-metals.* For instance, the syllabus recommends as activity as follows:

i. *drop a small piece of Zinc metal into a diluted solution of Hydrochloric acid or Vinegar and observe what happen.*

ii. *drop a small piece of sodium metal into water and observe what happens.*

iii. *drop a piece of silver metal into dilute solution of Hydrochloric acid or Vinegar and observe what happen. Compare the observations with that of zinc reaction above.*

iv. *burn a piece of Magnesium ribbon and observe what happens.*

(MoE, 2012, p. 23).

From the activities, properties of metals and non-metals could be deduced from the reactions which was to be carried out as part of the lesson but not used by Adu.

Students' participation

Students' participation in the lesson was initiated by their responses to the teacher's questions at the introduction stage of the lesson. The 'chalk and talk' method used to teach the lesson has a tendency to make students passive participants in the lesson and could affect their understanding of the topic taught. An extract of students' participation was as follows:

Adu: pasted a chart showing the first twenty elements of the periodic table on the chalkboard

Students observed the chart.

Adu: what is the name of this element? (points to sodium on the chart).

Students put up their hands

Adu: yes... Osei

Osei: Sodium

Adu: Good

Adu: group the elements into metals and non-metals and write your answers in your books

Adu: checked answers of two students, then wrote the topic of the lesson on the chalkboard and asked the students to read what is written on the chalkboard,

Students: properties of metals and non-metals (chorus)

At the development stage of the lesson, students' participation was characterized by copying notes from the chalkboard into their notebooks. There was not question from any of the students to the teacher and no student-student interaction observed throughout the lesson. The method used by Adu to teach the lesson observed could account for lack of active participation of students in the lesson.

After the lesson, I interacted with Adu and some selected students from the class on the instructional method used to teach integrated science. Adu's claimed he used the Activity method to teach the lesson which was incorrect because the 'Chalk and Talk' method was used. An extract of interaction with Adu was as follows:

Interviewer: what teaching method did you use for the lesson?

Adu: Activity method because I involved students in the lesson.... the science syllabus tells us we should teach the subject with the activity method at this level (trying to reach for the JHS Integrated Science Syllabus to back his argument)

Interviewer: do you always teach science using this method?

Adu: no... I don't use it (Activity method) for all the topics... but, I try to use the activity method to teach as the syllabus demands.

The method used by Adu to teach the lesson did not reflect his preferred teaching methods which are Activity and Demonstration. However, what Adu indicated to have used to teach the lesson observed matched with what the 2012 JHS Integrated Science Syllabus prescribed (MoE, 2012). This suggest that Adu had knowledge of the methods required of teachers to teach integrated science by syllabus but seems to have little knowledge about what activity methods of teaching entails.

An interview with students from School B of Adu's class to explore the method used to teach integrated science confirmed that the expository method was used. An excerpt of my interaction with the students was as follows:

Interviewer: did you enjoy today's science lesson?

Students: yes, sir

Interviewer: why?

Students: we were given some questions to solve in class today.

Interviewer: why, so you mean your science teacher doesn't give you questions to solve in class?

Students: yes.

Interviewer: so, what do you do in science class?

Students: teacher gives us notes to copy into our notebooks

Adam's integrated science lesson

Adam's lesson was at JHS 2 class which comprised 62 students, with 52.8% boys and 47.2% girls. Adam had taught Integrated Science in the school for 7 years. He had a Diploma in Basic Education from a College of Education with a generalist background. Adam had indicated to help students understand the content of science as his teaching priority and selected Activity and Group work as his preferred instructional methods to teach integrated science. Adam's lesson on *Electrical Energy s* taught at the 6th week of the second term of the school year was presented as follows:

Review of students' previous knowledge

Students were asked to draw symbols used to represent some electric components of electrical circuit diagram in their notebooks. Adam checked answers of three students without comment and wrote the topic of the lesson on the chalkboard and asked the class to read it aloud. The topic taught by Adam as indicated in the syllabus was to be taught in JHS 2. The introduction of the lesson did not reflect what was indicated in the Lesson Plan. This is because students were to mention some sources of energy and further explain some terminologies like electric current and Potential Difference.

Instructional methods

Adam used the 'Chalk and Talk' method to teach the topic of the lesson. He first mentioned some components needed for construction of an electric circuit. He then explained how the components could be connected to generate electricity and wrote all the processes on the chalkboard for the students' consideration. He drew a simple electrical circuit diagram and wrote the functions of the component on the chalkboard. But, to teach the *Electric Energy*, the teaching syllabus required that the Discussion Method was used as:

i. *Discuss sources of Electrical energy*

ii. *Discuss the terms electric current, potential difference and resistance as applied to electric circuits and assigned appropriate units* (MoE, 2012, p. 23).

Thus, the method used by Adam to teach the lesson observed did not reflect the one prescribed by syllabus.

Students' participation

Participation in the lesson was at the introduction stage when the whole class was made to read the topic on the chalkboard. The method used to teach the lesson appeared to have made the students passive, thus unable to participate in the lesson as was evident at the development stage, characterized by writing of points from the chalkboard into their notebooks without questions. An excerpt of students' participation is as follows:

Adam: what is on the board

Students: Electrical Energy

In the lesson observed, Adam indicated to have used the Demonstration method to teach the lesson which contradicted his preferred instructional methods (i.e. Activity and Group work) indicated in our interactions. An excerpt of interaction with Adam was as follows:

Interviewer: what teaching method did you use for the lesson?

Adam: the demonstration method, because we don't have science laboratory ....so I had to draw the diagram on the chalkboard and demonstrate to students how the components of electric circuit are connected to show current flows.

Interviewer: do you always use this method to teach science?

Adam: most often. I have to use it to show how things work on the chalkboard for students to understand what I am teaching.

From the interaction, Adam's claim to have used the Demonstration method was incorrect. Again, seems to have little knowledge about what the Demonstration Method entails as he referred to chalkboard illustrations as one.

An interaction with some students from School C confirmed that the "Chalk and Talk' method was used to teach integrated science. An excerpt was as follow:

Interviewer: did you enjoy today's science lesson?

Students: yes, sir

Interviewer: how?

Students: the way our (science)teacher teaches

Interviewer: does he always teach as he did today?

Students: yes, ... he always gives us note.

Adam's preferred teaching methods Activity and Group work as indicated reflect the ones prescribed by the 2012 integrated science syllabus. But Adam's classroom instructional practice as observed in the lesson different from (MoE, 2012).

Owusu's integrated science lesson

The lesson was in JHS 2 which had 48 students, with 54.8% boys and 47.2 % girls. Owusu had taught Integrated Science for 7 years in the school. He possessed a Bachelor of Education in Basic Education as well as a Diploma in Basic Education with a generalist background from a College of Education. Owusu's selected to help students understand the content of science as his teaching priority and Activity and Demonstration methods as his preferred teaching methods. Owusu's lesson *Sources of Energy* was taught on the 7th week of the second term of the school year is presented as follows:

Review of students' previous knowledge

Owusu began the lesson by asking students to mention some sources of energy in their communities and; one of the students `was called to give oral response. Owusu then wrote the topic for the day on the chalkboard. The topic *Sources of Energy* according to the 2012 integrated science syllabus, should be treated at JHS 1 (MoE, 2012) though in the case of Owusu it was taught at JHS 2. The syllabus gives teachers the room that concepts that would serve as a prerequisite for understanding of other concepts could be taught at any level irrespective of what is indicated in the syllabus (MoE,2012). Thus, teaching a JHS 1 concept in JHS 2 was not a violation of the delivery of the content of the syllabus. However, the introduction of the lesson reflected what had been in the Lesson Plan.

Instructional methods

Owusu used the expository method to teach the topic. He first explained the various sources of energy and then categorised them into renewable and non-renewable and explained the meaning of renewable and non-renewable and wrote on the chalkboard. He then wrote some of the source of energy on the chalkboard for the students' to categorised into renewable and non-renewable sources. However, the 2012 JHS Integrated Science syllabus prescribed that Demonstration, Discussion and Project work methods be used to teach the topic *Sources of Energy*, as follows:

i. *Brainstorm students to bring out the meaning of the term energy and assign its unit.*

ii. *Brainstorm to come with the explanation for renewable and non-renewable sources of energy* (MoE, 2012, p.14).

Furthermore, it indicates students should be help in designing and construct:

i. *Biogas Digester*

ii. *Solar Heater*

iii. *Wind Mill for pumping water* (MoE, 2012, p14)

Therefore, the Expository Method used by Owusu to teach the topic did not reflect the ones prescribed by the syllabus for teaching the topic. It was therefore not surprising that students were passive in the lesson.

Students' participation

Participation in the lesson was mainly writing of points from the chalkboard into their notebook except at the introduction stage when a student was called to answer a question. An extract of students' participation was:

Owusu: what are the sources of energy?

No student put up a hand.

Owusu: yes, Chris say something.

Chris: sir, the sun

Owusu: good!

No question came from the students to the teacher and there was no student-student interaction throughout the development stage of the lesson.

After the lesson, I interacted with Owusu regarding the instructional method used to teach the lesson. From the interaction, Owusu knew the method used in the lesson observed (i.e. the expository). An extract of my interaction with Owusu was as follows:

Interviewer: What teaching method did you use to teach the lesson?

Owusu: ooh ... a normal lecture method. The topic did not demand any experiment... it is a straight forward topic but because the students are not good, I had to use the lecture method and also give them some notes on the chalkboard for them to copy.

Interviewer: then you must have been using this method for all your *lessons, is it not the case?*

Owusu: Sure! because, if I don't write the notes on the

chalkboard for them, they cannot write it on their own.

From the interaction the method used by Owusu did not resonates with his preferred teaching methods used to teach integrated science.

Focus-group interaction with some selected students from School D from Owusu's class confirmed that the expository method was used to teach integrated science. An except is follows:

Interviewer: did you enjoy today's science lesson?

Students: yes sir.

Interviewer: why?

Students: because of the way the lesson was taught.

Interviewer: Does he teach you the way he did today?

Students: yes, sir.... he always gives us notes to write after the lesson.

The Expository method used by Owusu was not consistent with the Activity and Demonstration methods he preferred to use to teach integrated science. From his preferred he was aware of the teaching method the syllabus required teachers to use.

Serwaa's integrated science lesson

The lesson was observed in JHS 2 class made up of 23 students, with 58.8% boys and 47.2 %girls. Serwaa was not a professionally trained teacher. She had taught Integrated Science for 6 years in the School. She possessed WASSCE with Agriculture Science as her area of concentration. Serwaa at the time of observing her lesson was pursuing further studies in Diploma in Basic Education. She indicated her teaching priority as to help students understand the science content and selected Demonstration and Activity methods as her preferred teaching methods. Serwaa's lesson on *Separation of Mixtures* taught on the 8th week of the second term of the school year is presented as follows.

Review of students' previous knowledge

The lesson started with a question to the students to define mixture, one student was called to respond orally. Serwaa then mentioned the topic for the day and asked the students to say it after her without writing it on the chalkboard. The topic taught according to the 2012 integrated science syllabus was prescribed for JHS 2. There was no Lesson Plan prepared for the lesson.

Instructional methods

Serwaa used the Expository or the "Chalk and Talk" Method to teach the lesson. She first explained what a mixture is, and wrote examples of mixture on the chalkboard and explained how they could be formed to the students. The methods of separating some mixtures into their components were also written on the chalkboard and students were asked to write them into their notebooks. However, to teach the topic *Separation of Mixtures* the syllabus requires that, the Discussion Method was used as follows:

i. *Discuss some methods for separating mixtures. For example, Filtration, Evaporation, Magnetization, and Distillation, Use of separation funnel* (MoE, 2012, p. 24).

Thus, the teaching method adopted by Serwaa (i.e. the Expository Method) to teach the lesson did not reflect what the syllabus proposed to be used to teach teach the concept. The method used had a tendency to make the students passive in the lesson, as was observed in the minimal participation in the lesson during the introduction stage.

Students' participation

Participation in the lesson was initiated by their response to the teacher's questions at the Introduction stage. For example, an extract of students' participation during the introduction stage was as follows:

> *Serwaa: what do you understand by a mixture?*
>
> *Student: madam, when two or more substance are put together.*
>
> *Serwaa: yes, mixture is the substance made when two or more substances are mixed together*
>
> *Serwaa:Ok our lesson for today is Separation of Mixtures.. say after me*

At the development stage of the lesson observed, students' participation was mainly by writing of points from the chalkboard given by the teacher into their notebooks. There were no questions from any of the students to the teacher and no student-student interaction was observed throughout the lesson. The passiveness of the student in the lesson could be due to the method Serwaa used to teach the topic

I interacted with Serwaa after her lesson on the method(s) used to teach the topic. From the interaction it seems to suggest that Serwaa knew she did not used the appropriate teaching method to teach the lesson. Again, the method used by Serwaa did not reflect her preferred methods of teaching integrated science. An excerpt of my interaction with Serwaa was as follows:

> *Interviewer: what teaching method did you use to teach this lesson?*
>
> *Serwaa: hmm... the method I used... it was more like a lecture*

method because there was practical activity but I had to write everything for them on the chalkboard.

Interviewer: so do you always teach science using the lecture method?

Serwaa: oh no... not always. I sometime do experiments with them... on topics which require the use of simple equipment. I must say that since we don't have a laboratory I cannot do all the experiments in the syllabus with the students.

Focus-grouped interaction with some selected students from School E of Serwaa's class confirmed the Expository Method was used to teach Integrated Science. An excerpt of my interaction with students were as follows:

Interviewer: did you enjoy today science lesson?

Students: yes sir.

Interviewer: why?

Students: it was not difficult... and the way our teacher teaches science.

Interviewer: Does she teach science to you like she did in today's lesson?

Students: Yes.. sir, it is the same.

The expository method used to teach the lesson observed did not resonant with the preferred methods Demonstration and Activity indicated by Serwaa. The preferred methods indicated by Serwaa echoes what syllabus has prescribed (MoE, 2012). This seems to suggest Serwaa was abreast of the requirement of the syllabus regarding the method that should be used to teach integrated science though she does not use it in her classroom instructional practice.

Malik's integrated science lesson

Malik's lesson was at JHS 2 class composed of 26 students, with 52.8% boys and 47.2% girls. Malik was a professionally trained teacher with a Postgraduate Diploma in Education. He had Bachelor of Science in Natural Resources as his first degree. Malik had taught science in the school for 6 years. Malik indicated his teaching priority as help students appreciate the importance of science was his teaching priority and selected Demonstration and Group work as his preferred Integrated Science instructional methods. Malik's lesson on *Magnetism* taught on the 8thweek of the second term of the school year is presented as follows.

Review of students' previous knowledge

The lesson began with a question to the students on whether they have seen magnets before which they responded orally in the positive. Malik then wrote the topic for the day on the chalkboard. There was no Lesson Plan prepared for the lesson. The topic *Magnetism* according to the 2012 integrated science syllabus was to be taught at JHS 3 (MoE, 2012). Teaching the topic *Magnetism* at JHS 2, agrees with the tenets of the curriculum which gives room for teachers to teach concepts at any level provided it would lead to better understanding of subsequent topics (MoE, 2012).

Instructional methods

The Expository Method was used to teach the topic. Malik first explained magnetism; magnetic and non-magnetic substances; and gave examples of magnetic and non-magnetic substance. He drew a bar of magnet questions from any of the students to the teacher and no student-student interaction was observed throughout the lesson. This may due to the method used to teach the lesson.

After the lesson, I had an interacted with Malik on the method used to teach the topic. From the interaction, Malik seems to have little knowledge about teaching methods. This is because though he was aware that the Expository 'Chalk and Talk" method was used to teach, his reference to chalkboard illustrations as a Demonstration Method was incorrect in spite of the fact that he was a professionally trained teacher. An extract of my interaction with the Malik was as follows:

Interviewer: what method did you use to teach this lesson?

Malik: I combined the methods because I had to be giving the students notes on the chalkboard....and also draw to explain how magnets work.

Interviewer: okay so which specific methods were these?

Malik: I will say lecture and demonstration.

Interviewer: why did you combined the methods

Malik: yes... so that the students will understand the lesson well.

The method used to teach the lesson did not match the preferred teaching methods Malik reported (i.e Demonstration and Group work). But his preferred teaching methods resonated with the activity-oriented methods recommended by Integrated Science Syllabus.

A focus-group interaction with students Malik's class from School F confirmed the Expository method was used to teach integrated science. An excerpt of my interaction with the students was as follows:

Interviewer: did you enjoy today's science lesson?

Students: yes, sir.

Interviewer: what made you enjoy it?

Students: the way the teacher taught.

Interviewer: oh ok. so does your teacher always teach science like he did today?

Students: yes sir.

Interviewer: so, do you want your science teacher to teach you like was done today?

Students: yes, sir ... and add some practical so that we can see how some of the things work.

Mawuli's integrated science lesson

The lesson was in JHS 2 class which comprised 21 students, with 54.8 % boys and 47.2% girls. Mawuli had taught integrated science in the school for 6 years. Mawuli possessed SSCE with science as his area of study. He had an intention to apply for further studies at the time of the lesson observations. Mawuli had to help students appreciate the importance of science as his teaching priority and selected Demonstration and Activity as his preferred teaching methods. Mawuli's lesson on *Methods of Heat Transfer* taught on the 9th week of the second term of the school year was as follows:

Review of students' previous knowledge

Mawuli started the lesson by mentioning the topic to the students and wrote it on the chalkboard. The topic *Methods of Heat Transfer* according to the 2012 syllabus is to be taught at JHS 3 (MoE, 2012). No Lesson Plan was prepared for the lesson.

Instructional methods

Mawuli used the Expository or "Chalk and Talk" Method to teach the lesson. He first mentioned three methods in which heat could be transferred and explained each of them and wrote it on the chalkboard for students' consideration. Mawuli drew a diagram which illustrated the convection method of heat transfer and explained the process to the students. The teaching syllabus however, recommends that to teach the topic *Methods of Heat Transfer* Demonstration and Discussion methods of teaching should be used as indicated:

i. *Brainstorm to bring out the meaning of temperature and heat. State the differences between them.*

ii. *Demonstrate conduction by putting one end of a piece of metal in fire and observe by holding the other end of the metal from time to time. Record and explain your observations.*

iii. *Demonstrate convection by dropping crystals of potassium permanganate in warm water and observe movement of coloured column.*

iv. *Demonstrate radiation by placing their hands close to a source of heat.*

v. *Discuss the application of conduction, convection and radiation as used in the Thermos Flask.* (MoE, 2012, p.45).

The Expository method used by Mawuli to teach the lesson was not in line with the ones prescribed by the syllabus for teaching the concept. The method used could result in students' passive participation in the lesson.

Students' participation

Students' participation in the lesson was characterised by writing of points from the chalkboard into their notebooks. There were no questions from any of the students to the teacher and no student-student interaction was observed throughout the lesson. This could be attributed to the method used by Mawuli to teach the topic.

After the lesson, my interaction with Mawuli suggests that he had little knowledge about the Demonstration method of teaching. This is because Mawuli referred to his chalkboard illustrations as one. An extract of my interaction with Mawuli was as follows:

Interviewer: what teaching method did you use to teach your lesson?

Mawuli: I used lecture and demonstration methods because I did a lot of talking by explaining everything to the students ...and then used the drawing to show how the process of conversion in heat transfer occurs.

Interviewer: where did you use the demonstration?

Mawuli: by indicating on the chalkboard for them.

Interviewer: so, do it you normally use the demonstration and the lecture methods to teach your lessons.

Mawuli: yes...mostly that is what I use

Focus-group interaction with selected students from School G confirms Mawuli's use of the Chalk and Talk Method to teach Integrated Science, an excerpt was as follows:

Interviewer: did you enjoy today's science lesson?

Students: yes, sir

Interviewer: why?

Students: because of the way our science teacher teach the subject.

Interviewer: does your teacher teach science the way he did today?

Students: sir.

Interviewer: so, do you want your science teacher to teach science to you the same way as he did today?

Students: not always... as was done today ... we need to do experiment so that it will help us to understand the subject very well.

Mawuli's preferred teaching method reflected the ones prescribed by the 2012 Integrated Science teaching syllabus. The preferred teaching methods of Mawuli was not what was used to teach in the lessons observed.

Aboagye's integrated science lesson

The lesson was at JHS 2 class which comprised 17 students, with 52.8 % boys and 47.2 % girls. Aboagye had a Diploma in Early Childhood and was in his 6th year of teaching integrated science in the school. To help students appreciate the importance of science was Aboagye's teaching priority Aboagye and selected Activity and Demonstration as his preferred teaching methods. Aboagye's lesson on *Germination* taught on the 9th week of second term of the school year was as follows:

Review of students' previous knowledge

Aboagye started the lesson by asking students to mention the stages in the life cycle of flowering plants and called one student to answer it orally. Aboagye then wrote the topic of the day on the chalkboard. The topic *Germination* according to the 2012 integrated science syllabus was to be treated in JHS 1 (MoE, 2012). No Lesson Plan was prepared for the lesson.

Instructional methods

Aboagye used the Expository Method to teach the lesson. He first explained germination, as well as conditions necessary for germination to occur and wrote it on the chalkboard for the students to follow. An experimental procedure to verify the conditions necessary for germination to occur was explained and further wrote it on the chalkboard. How to set-up apparatus to verify the conditions necessary germination was further drawn on the chalkboard for students' consideration. The syllabus recommends Discuss and Demonstration as instructional methods to teach Germination. These should be used as follows:

i. Brainstorm to list the stages flowering plants go through from pollination, through fertilization to seed germination.

ii. Arrange the stages in the life cycle of a flowering plant as they occur in nature.

iii. Set up an experiment to demonstrate the conditions for germination. (MoE, 2012, p.10).

The teaching method (i.e. the Expository "chalk and talk") adopted by Aboagye to teach the lesson was not inconsistent with the methods prescribed by the syllabus for teaching the of Germination. The method used to teach the lesson might have resulted in the passive participation of students" in the lesson.

Students' participation

Participation in the lesson was in response to teacher's questions at the introduction stage. This could be due to the method used by Aboagye to teach the lesson. Extract of student's participation was as follows:

Aboagye: mention the stages of the life cycle of flowering plants?

Students put up their hands

Aboagye: yes, Frank

Frank: seed, germination, growth, reproduction... it's ok Teacher

At the development stage of the lesson, students' participation was by writing of points from the chalkboard into their notebooks. No question came from any of the students to the teacher and no student-student interaction ensued throughout the lesson.

After the lesson, my interaction with Aboagye showed he had little knowledge of what the Demonstration method entails because he referred to his chalkboard illustrations as one. An excerpt of the interaction was as follows:

Interviewer: what teaching method did you use to teach?

Aboagye: demonstration... because I needed to show to them how germination occurs using the drawing since there is no laboratory in the school for us to do the real experiment.

Interviewer: so, do you always teach using the demonstration method?

Aboagye: yes, I thinking it is the best method to use when teaching science.

Interviewer: why is it the best method can you explain further?

Aboagye: the demonstration method .... helps students to understand the subject very well

Focus-group interaction with students from Aboagye's class of School G confirmed the expository method was used teach integrated science. An excerpt was as follows:

Interviewer: did you enjoy today's science lesson?

Students: yes, sir

Interviewer: why?

Students: because teacher explained the things for us to understand.

Interviewer: good, so do you want your science teacher to teach science to you the way he did today?

Students: yes sir.... but we don't have science equipment in our schools so we don't do any experiment here.

Aboagye's preferred methods of teaching integrated science reflect ones suggested by the 2012 JHS Integrated Science Syllabus. But Aboagye's classroom instructional practice differed from his preferred as well that which was prescribed by the syllabus.

Generally, the results from the integrated science lessons observed indicate that teachers sampled from both school-types taught the subject with the Expository Method. The method used by the teachers to teach the lessons observed resonates with behaviourism. Thus, confirm Mensah and Somuah, (2013); and Akyeampong, Pryor, and Ampiah, (2006) that the teaching of science in Ghanaian JHS was characterized with behaviourism. The expository method (such as Lecture, and "Chalk and Talk") used by the teachers sampled from both school-types to teach in the lessons observed do not reflect the student-centred instructional approach advocated in the 2012 JHS Integrated Science Syllabus and the preferred teaching method they indicated. This seems to suggest that there no synergy between the classroom instructional practices of the integrated science teachers whose lessons were observed in relation to what they say, do and what the curriculum document of the MoE and GES prescribes.

Ironically, two professional and three non-professional teachers from both school-types whose lessons were observed referred to chalkboard illustrations as Demonstration and Activity methods of teaching. This seems to suggest that some teachers from with either professional and non-professional backgrounds are not familiar with the tenants of Activity and Demonstration methods of teaching. Moreover, though all the teachers from the public schools whose lessons were observed were professional and had to help students understand the content of science as their most important teaching priority, the behaviourists teaching approach they employed to teach the lessons observed could contributed to poor understanding of the concepts taught the classroom. On the order hand, none of the teachers from the private schools both professional and non-profession had a lesson plan prepared for the lessons observed in spite having to help students appreciate the importance of science which called for the use of constructivist-based approach teaching approach prescribed by the syllabus not the behaviourists approached as seen in the lessons observed,

Classroom Assessment Practices of Integrated Science Teachers

Research question three was in three parts; the first part sought to explore what classroom assessment practices Integrated Science teachers from the schools sampled used and how they conform to what is suggested in the teaching syllabus. Results on classroom assessment practices used by teachers are presented in Figure 3.

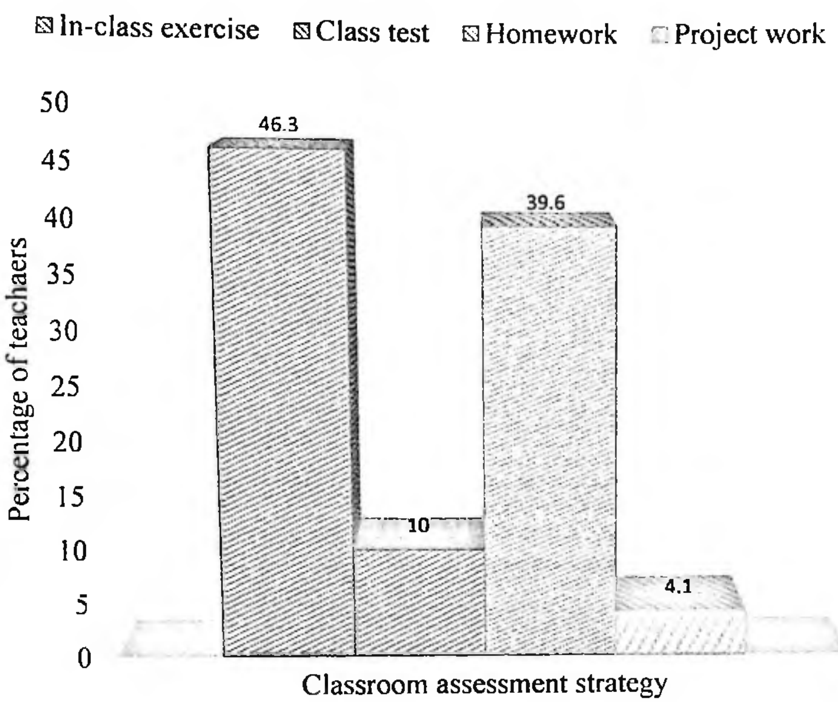

Figure 3: Types of Classroom Assessments used by Integrated Science teachers (N=246).

Source: Field Survey, Otami (2018)

The figure shows that Integrated Science teachers from junior high schools sampled used in-class exercises, homework, class test and project work, to assess students learning. However, in-class exercise and homework were the most used classroom assessment strategies by the teachers. The teachers rarely used project work as a form of classroom assessment.

To find how often in-class exercises were given to students by the teachers who taught Integrated Science in both school-types sampled, proportions of its usage are presented in Figure 4.

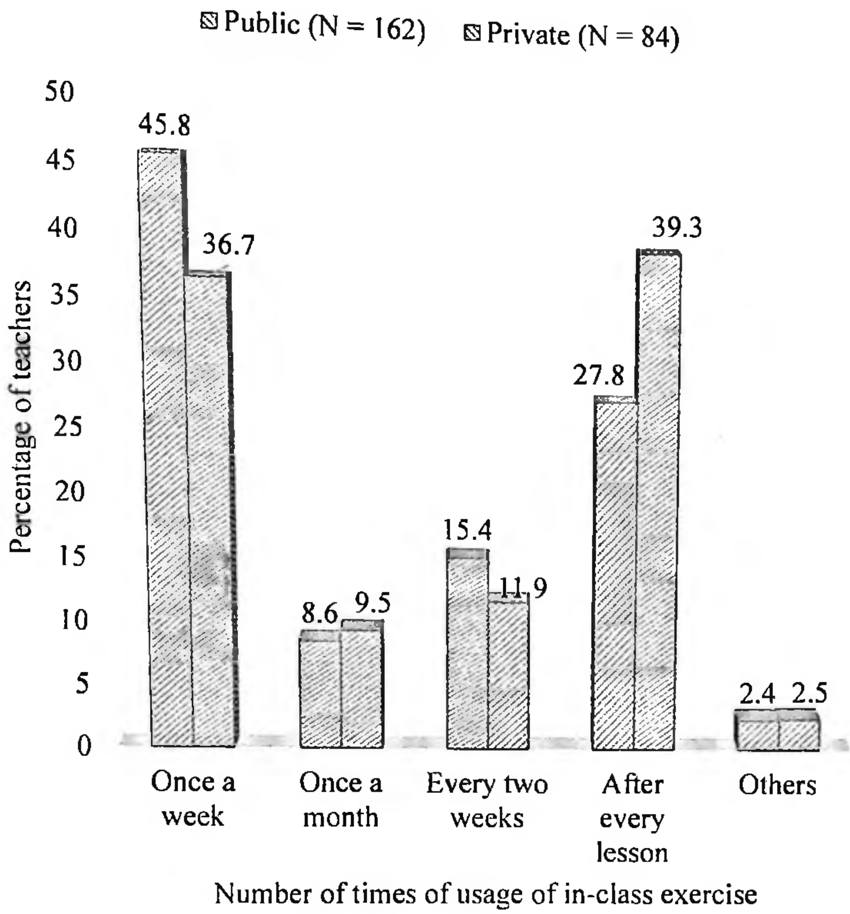

Figure 4: Bar graph showing how often teachers used in-class exercise

Source: Field Survey, Otami (2018)

The figure shows that majority (39.3%) of the teachers who taught integrated science in the private junior high schools sampled gave in-class exercises after every science lesson whereas 45.8% of those in the public schools did so once a week. However, 18.1% of integrated science teachers out of the total 246 sampled from both schools gave in-class exercises once a month. Also, (4.9 %) of the teachers use other forms of classroom assessment.

To further explore how often the integrated science teachers from the both school-types gave homework, proportions of its usage are presented in Figure 5.

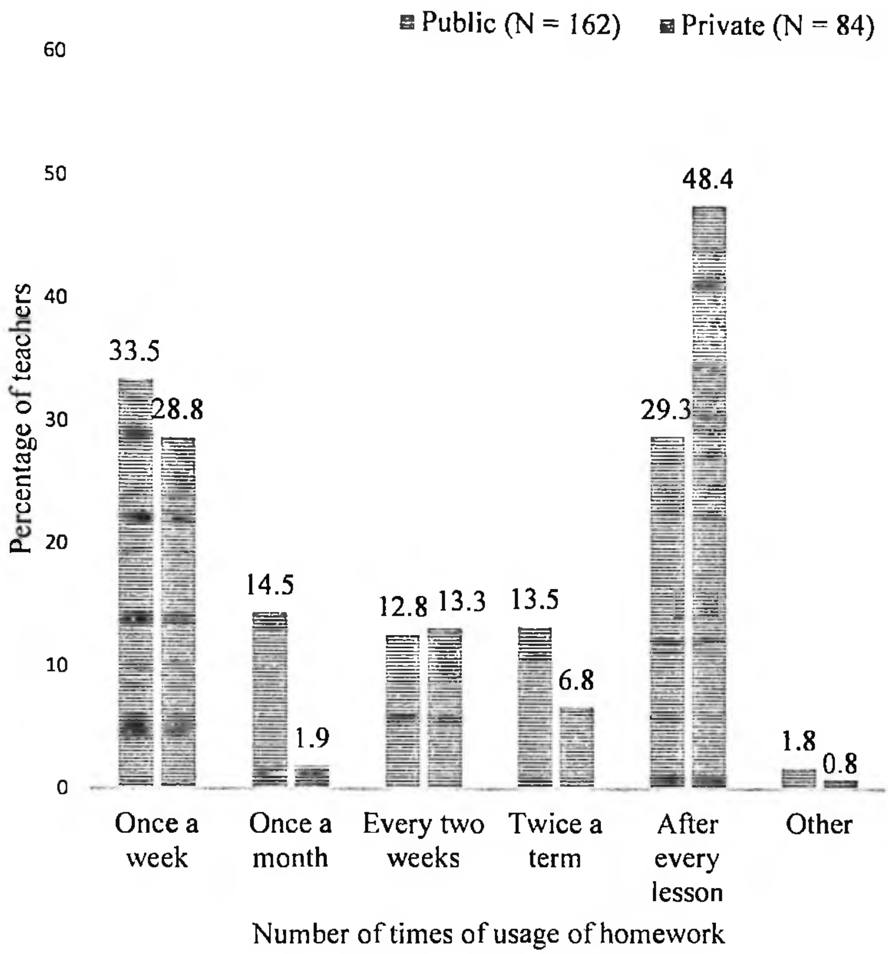

Figure 5: Bar graph showing how often Integrated Science teachers gave homework to students.

Source: Field Survey, Otami (2018)

The figure shows that majority (48.4%) of the teachers from the private junior high schools sampled gave homework after every science lesson as against (33.5%) of the teachers in the public schools sampled who did so once a week. Of the total 246 Integrated Science teachers in the schools sampled, 20.3% indicated that they gave homework twice a term.

To gain deeper insights into what classroom assessment integrated science teachers use and how it conformed to what is suggested in the Integrated Science syllabus, a documentary analysis of the eight teachers used in the case study were recorded from the first to the end of the 10^{th} week of second term of the 2017/2018 academic year with field notes. To do this, students' exercise books, lesson notes, and scheme of work of the teachers were observed. The purpose was to obtain information on the frequency with which classroom assessment strategies were used by teachers. The results are presented in Table 10.

Table 10: Frequency of classroom assessment strategies used by teachers whose lessons were observed (N=8)

Teacher	School-type	No of lessons done	In-class exercise	Class test	Homework	Project work
Mensah	Public	42	1	0	2	0
Adu	Public	31	0	0	1	0
Adam	Public	33	1	0	1	0
Owusu	Public	33	0	1	1	1
Serwaa	Private	27	2	1	12	0
Malik	Private	31	3	1	13	0
Mawuli	Private	27	3	1	13	0
Aboagye	Private	29	4	1	14	0

Source: Field Survey: Otami (2018)

Results in the Table 10 show that out of the mean of 32 integrated science lessons delivered by each teacher from both school-types, those in the private schools had given more homework and in-class exercises compared to those from the public schools. However, only one teacher from a public school out of the four teachers sampled from both school-types had given project work as a form of classroom assessment to students. Only the teachers in the private schools had conducted a class test. The results from the documentary analysis reflected the classroom assessment practices of Integrated Science teachers reported in the survey.

I interacted with the eight teachers and some selected students from their classes in the schools used for the case study on classroom assessment practices. Excerpt of their responses were as follows:

> *"Class exercises are to be used to find out whether or not students understand the lesson so once I get to know they understand it; I don't waste time giving any class exercise or homework"* (Teacher from Public School A)
>
> *"As a teacher, I have to give Class exercises and home to monitor students understanding of lessons to I see whether they have understood"* (Teacher from Public School B)

Focus-group interaction with some selected students from the classes of public schools A and B yielded response as such as:

> *"our teacher has given us homework before but we have not done any class exercise".*

The views of the teachers as well as the students of the public schools buttress why homework and in-class exercises were most often not given to students after every lesson.

However, the teachers from the private schools gave reasons as follows:

"I have to often give my students class exercises and homework after the lesson to make sure they really understand what is taught." (Teacher from Private School E)

"giving class exercise and homework to my students are the surest way to know my students understood what happened in the classroom" (Teacher from Private school F)

However, a focus-group interaction with students from Private School E revealed that:

"our science teacher gives us class exercises and homework anytime we do science"

Another focus-group interaction with students from Private School H revealed that:

"our science teacher gives us as a lot of homework after every topic"

Thus, views of teachers and students reflected the practice of giving in-class exercise and homework are after every lesson as observed in the private junior high schools.

Further interaction with a teacher in one of the case study schools on why he had given project work to students, an excerpt of his response is as follows:

"the *SBA system requires that students are given at least a project to work on to be submitted for marking before the term ends"* Teacher from Public School D

Excerpts of responses of teachers from public and private schools in the case study schools where no project work had been given to students were as follows:

"we don't have science laboratory to be doing some of these project works" (A teacher from a Public School B)

"I teach the things I have to be giving to the students as project work in class.... so I don't allow them to do it on their own" (A teacher from a Public School C)

"I don't really know if I have to give them a project work every term to be working on" (A teacher from a Private School F)

The responses provided suggest some of the teachers were not aware of the requirements regarding SBA regime current place in the schools. Also, some of the views of the teachers indicated that the practice of SBA in their classrooms depended on availability of science laboratories in the schools.

To explore how the classroom assessment strategies used by the teachers who taught integrated science were consistent with what was in the 2012 JHS integrated science syllabus. The classroom assessment practices of the teachers were compared with what the syllabus indicates. First, even though the syllabus indicate that class exercises and homework were essential to teaching and learning, it gave no specific timelines for teachers to follow. The teachers were only encouraged to use them regularly. This may have resulted in a situation where the integrated science teachers from the private junior high schools sampled had given more in-class exercise and homework after every science lesson to their students compared to the practice of teachers from the public schools who give homework and in-class exercises once a week. The practice of the private school integrated science teachers suggests they use classroom assessment to monitor their students learning. Again, only one out of the eight Integrated Science teachers from the schools sampled had given class tests at the end 10th week. The results from the case study buttress that of the survey because though none of the teaches in the public schools had conducted a class text, those in the private schools had only done one. This is in contrast with the expected two class tests that should have been conducted by the teachers as of the time data were gathered from the schools. From the Teachers' Handbook for SBA class tests are to be conducted on the fourth, eighth, and at end of the eleventh weeks (MoE, 2012) in schools by the teachers. Thus, from the documentary analysis the integrated science teachers sampled do not follow the dictates of the syllabus' regrading classroom assessment prescriptions as only one teacher had given a project per the term. (MoE, 2012). Hence, the classroom assessment practices of integrated science teachers from the schools sampled was consistent with the requirements of the 2012 JHS integrated science syllabus (MoE, 2012)

What informs classroom assessment practices of Integrated Science teachers

The second part of research question three sought to explore what informs classroom assessment practice in both public and private schools. Results on what informs the practice of classroom assessment in both school-types are presented in Table 11.

The results in Table 11 show that there were multiple reasons for conducting classroom assessment with majority (96.3%, M=1.7; SD=0.6) indicating that they almost always conduct classroom assessment to inform the teaching of integrated science whiles 81% (M=1.6; SD=0.8) reported that they almost always conduct classroom assessment for grading and filling of reports cards for parents. The results suggest that the focus of the conduct of classroom assessment by integrated science from the schools sampled was to inform classroom instructional practice rather for identification of students' learning difficulties.

Table 11: Percentage responses of Integrated Science teachers' reasons for conducting classroom assessment (N=246)

	Almost always		Most of the time		Very often		Often			
	N	%	N	%	N	%	N	%	Mean	SD
To inform teaching of integrated science	172	69.9	65	26.4	8	3.3	1	0.4	1.7	0.6
Feedback on students learning	155	63	78	31.7	12	4.9	1	0.4	1.4	0.6
Grading and Filling report cards for parents	151	61.4	49	19.9	43	17.5	3	1.2	1.6	0.8
Identification of students' learning difficulties	137	55.7	92	37.4	14	5.7	3	1.2	1.5	0.7

Source: Field Survey, Otami (2018)

To find out whether the teachers from public and private junior high schools sampled differed in their reasons for the conduct of classroom assessment. One-way Multivariate Analysis of Variance (MANOVA) was used. The reasons were to grade and fill report cards for parents, give students feedback on their learning, identify students learning difficulties, and inform the teaching of integrated science. The reasons served as the dependent variable. The independent variable used was school-type. Preliminary assumption tests were conducted to check for normality, linearity, univariate and multivariate outliers, and homogeneity of variance-covariance matrices, with violations noted. The results of the MANOVA test is presented in Table 12.

Since the assumption for equal variance was violated, a more conservative alpha for determining significance was set at 0.01 to 'give students feedback on their learning' (Tabachnick & Fidel, 2007).

Table 12: One-way MANOVA on reasons for conducting classroom assessment in public and private schools

Effects	Value	F	Hypothesis df	Error Df	Significance
school type	0.95	2.94	4.00	241.00	0.061

Not Significant p>0.05; N= (Public 162, Private 84)

Source: Field Survey, Otami (2018)

Wilks' Lambda (λ) value of 0.95 was not statistically significant F (4,241) =2.94, p<0.061; partial eta squared=0.046, indicating that the population mean scores on the four reasons on which teachers from the school-types conducting classroom assessment is the same. Hence, there was no statistically significant difference in the reasons for conducting classroom assessment by the teachers from the schools sampled with respect school-types. This is not surprising because majority (96.3%) of the teachers from the schools sampled indicated their main reason for conducting classroom assessment was 'to inform the teaching of integrated science'. The results give an indication that the reasons for conducting classroom assessment by the teachers lies in the four domains.

Interactions with teachers whose reasons for conduct of classroom assessment are 'to inform teaching of Integrated Science' and for grading and filling of report cards for parents as the teachers' yielded responses as follows:

> *"...I am able to know what my students have understood and what they have not .... this enables me to decide on what action to take... either to re-teach the topic otherwise. Again, it will help me to complete my continuous assessments score for students which I will use it to fill their terminal report cards".* (Mensah from a Public School A)

"Without conducting classroom assessment, I will not be able know of what I taught had be understood or not and, again, I cannot fill my report cards for the students" (Mawuli from a Public School F)

However, the only teacher from a private school whose reason for conducting classroom assessment was too identify students learning difficulties gave a response as follows to buttress his point:

"it helps me to know the problems my students have regarding a particular topic...so that I help in correcting them". (Aboagye from a private school H)

From the results most of the teachers' reason for conducting classroom assessment in both school-types was to inform their teaching of integrated science followed by grading and filling report cards for parents. The reasons for conducting classroom assessment practice as indicated by the Integrated Science teachers seem to means that the teachers want use the classroom assessment of their students to improve their teaching in order to scale up their students' performance in Integrated Science considering the fact that this study was conducted in low performing educational districts.

Questions used by Integrated Science teachers for classroom assessment

The third part of research question three sought to investigate the type of questions integrated science teachers used for their classroom assessment. To do this, questions used by the integrated science teachers for their classroom assessment in the schools sampled were classified based on Anderson and Krathwohl's (2001) table for classification of question. The results are presented in Figure 6.

"Without conducting classroom assessment, I will not be able know of what I taught had be understood or not and, again, I cannot fill my report cards for the students" (Mawuli from a Public School F)

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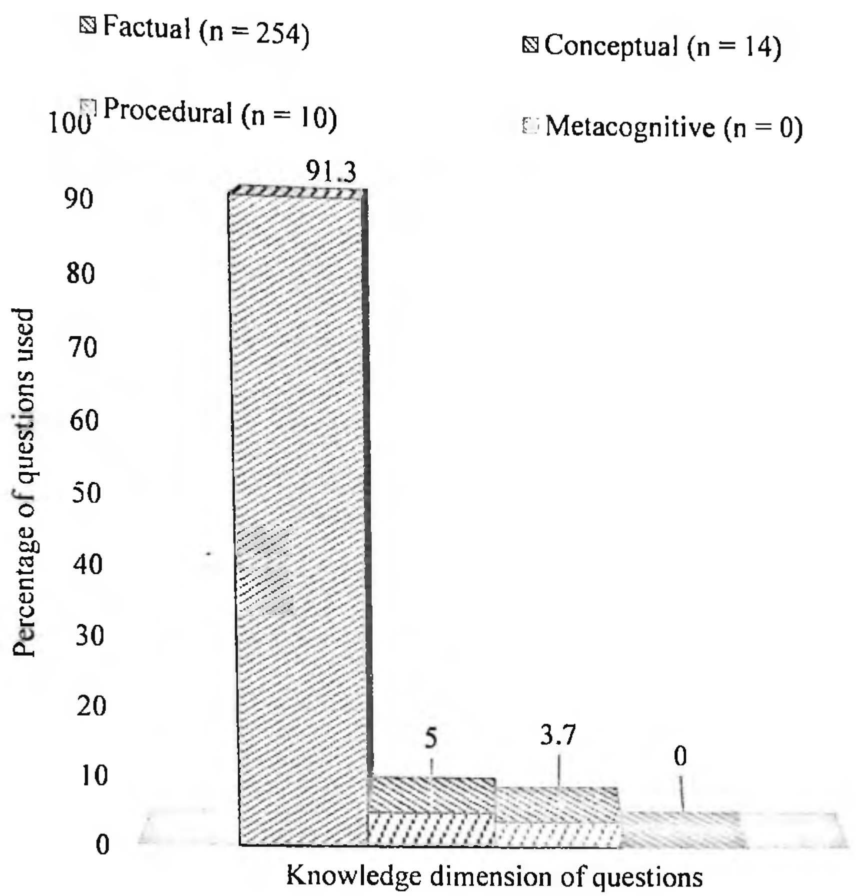

Figure 6: Bar graph showing knowledge dimensions of questions used by teachers (N = 278).

Source: Field Survey, Otami (2018)

Out of the total 278 questions used by the teachers for their classroom assessment in the sampled schools obtained, 91.3% assessed factual knowledge which essentially looked at Remembering and Understand. Only 8.7% assessed both conceptual understanding and procedural knowledge. Besides, no question elicited factual knowledge questions that fell in the cognitive dimensions of; Apply, Analyze, Evaluation and Create. The results on knowledge dimensions are presented in Figure 7.

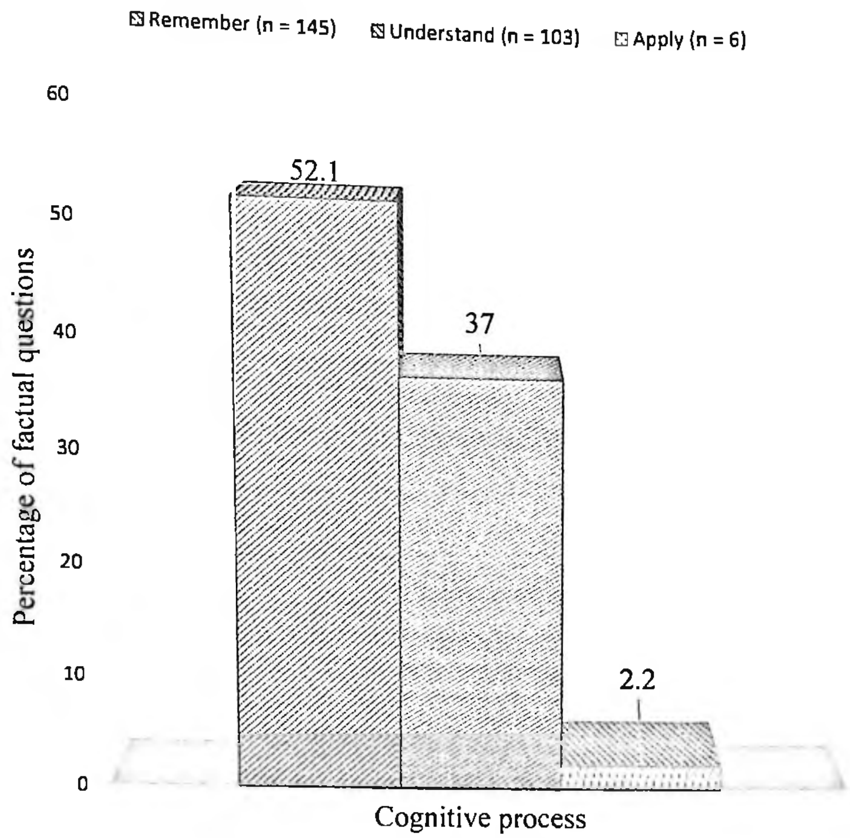

Figure 7: Bar graph showing cognitive process of factual questions used by teachers (N = 254).

Source: Field Survey, Otami (2018)

The results in Figure 7 show that of the 91.3% teacher questions identified to assessed factual knowledge only 2.2% assessed the process skills. This is an indication that most of the questions used by the integrated science teachers for classroom assessment assessed lower-order process of 'remember'. This is not surprising because an evaluation of objectives of the topics in the 2012 JHS Integrated Science Syllabus on which most of the teachers had based their questions for classroom assessment indicate that they were not those which demanded higher order questions. Hence, the type of questions used by the teachers seem to resonate with objectives of the topics in the 2012 JHS integrated science syllabus which the teachers taught. Furthermore, an appraisal of questions set by WAEC for the integrated science paper in the BECE indicated practically little or no higher order thinking questions.

The findings seem to suggest that integrated science teachers from the schools sampled used lower order questions for their classroom assessment because the BECE integrated science paper which the students take at the end of JHS 3 hardly use higher order questions. This is in support of the views of Mertler (2009); Akyeampong, Pryor and Ampiah (2006); and Wragg and Brown, (2001) that teachers at the elementary level (Basic Education in Ghana) are inadequately exposed to issues in assessment in their development which might influence their views, understanding and use of questions for classroom assessment. The results showing that integrated science teachers the schools sample used questions which largely elicited factual knowledge (lower order) could be influenced by the objectives of the topics in the 2012 Integrated Science Curriculum that they use in teaching. Also, the teachers may be using lower order questions because the standard of the questions set by WAEC for the BECE. The integrated science teachers from the schools sampled might also perceive their students to be weak hence they use the lower order questions for their classroom assessment to create enabling environment for students learning (Wagg & Brown, 2001).

Coverage of Topics in the 2012 JHS Integrated Science Curriculum

The fourth research question explored the extent to which the teachers teaching integrated science in the schools sampled cover integrated science curriculum. To answer this research question, the teachers from the schools sampled were made to indicate which of the topics amongst all the 43 topics (16 each for JHS 1 & 2, and 11 in JHS 3) in the syllabus that they treated. Results on the percentage coverage of the topics in the syllabus in relation to all the three levels of JHS are presented in Figure 8.

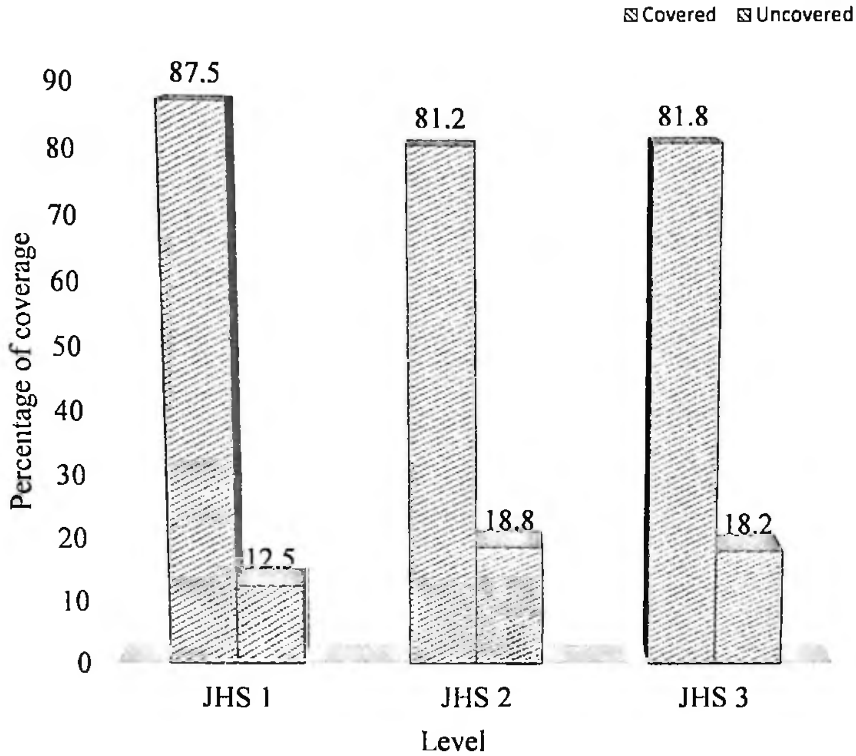

Figure 8: Bar graph showing the extent of coverage of topics in the Integrated Science syllabus by teachers (N = 246).

Source: Field Survey; Otami (2018)

Figure 8 indicates that the integrated science teachers covered more than 80% of the 43 topics in the 2012 JHS Integrated Science syllabus from JHS1 to JHS 3. Of these, the teachers covered over 85.0% of the 16 topics indicated to be treated in JHS 1 compared to around 80.2% of the 16 topics for JHS 2 and over 80.0% of 11 topics for JHS 3.

To further explore the percentage coverage of the topics at each level by the teachers from the different school-type, the results are indicated in Figure 9

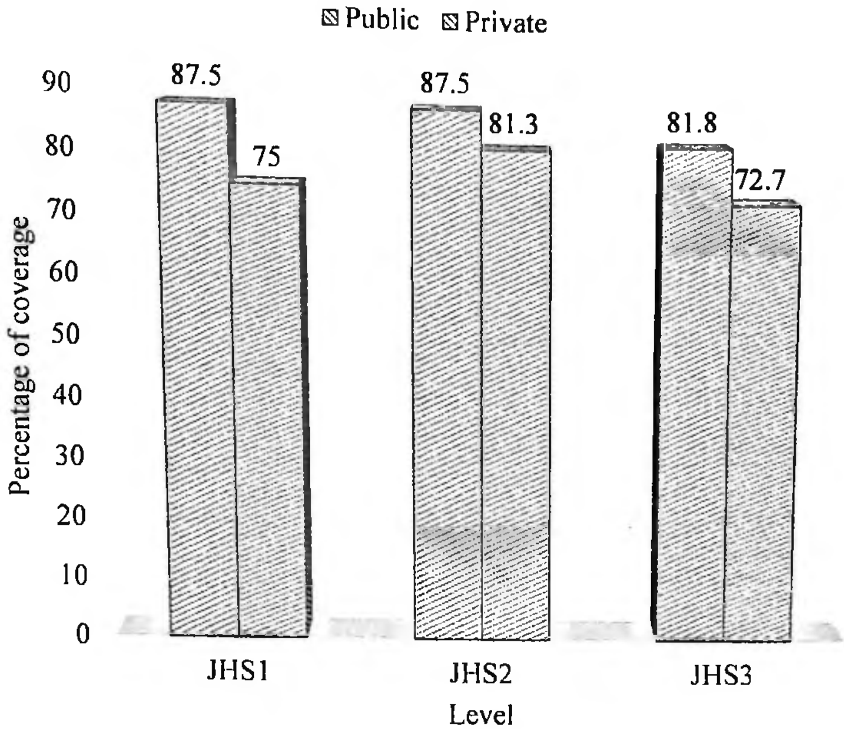

Figure 9: Bar graph showing the extent of coverage of topics in the Integrated Science syllabus in the school type (N = 246).

Source: Field Survey; Otami (2018)

The figure shows that Integrated Science teachers from the public schools sampled covered 85.5% of the 43 topics in the 2012 JHS Integrated Science teaching syllabus (i.e. JHS1 to JHS 3) compared to 76.3 % by those in the private schools. Furthermore, the teachers from the private junior high schools covered many of the topics assigned to be treated in JHS2 by the syllabus compared to JHS1 and JHS 2. Hence, graph seem to suggest that integrated science teachers in the public schools sampled covered many of the topics in the integrated science curriculum compared to those in the private.

To further explore how many of the topics in the curriculum were not covered as indicated on the TQCAP, proportions of integrated science teachers who did not cover them are shown in Figure 10.

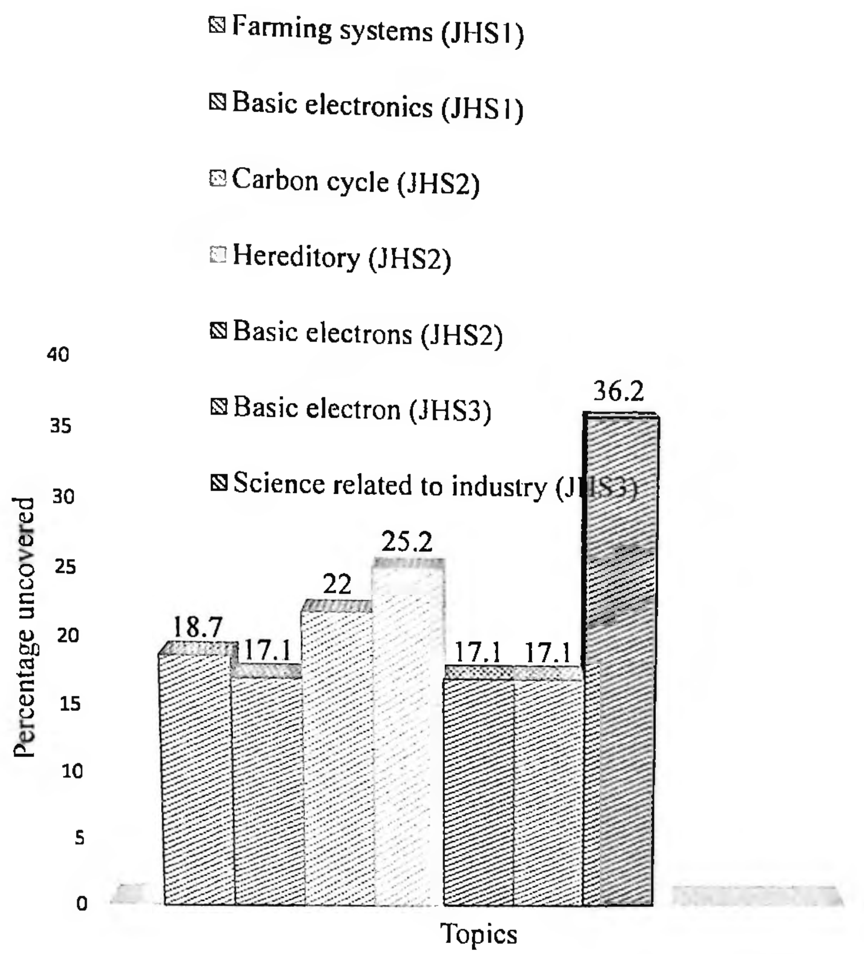

Figure 10: Bar graph showing the extent of uncovered topics in the integrated science syllabus by teachers (N = 246).

Source: Field Survey; Otami (2018)

The figure indicates that generally about 17 % integrated science teachers from the junior high schools sampled did not teach Basic Electronics, a topic prescribed for all the three levels (i.e. JHS 1 to JHS 3) by the syllabus. Also, over a quarter of the teachers from the schools sampled did not cover Science Related to Industry, a topic according to the 2012 JHS integrated science syllabus was to be taught at JHS 3. Furthermore, 25% of the teachers indicate they did not teach Heredity, a topic for JHS 2. Thus, not all the topics in the integrated science curriculum were covered by the teachers in the schools.

To further explore how many of the topics in the integrated science curriculum were covered by teachers in the different school-types, the results are presented in Table 13.

Table 13: Number of teachers who did not cover some topics in the 2012 Integrated Science syllabus

		Public (N=162)		Private (N=84)	
Year group	Topics	N	%	N	%
JHS 1					
	Farming systems	28	11.4	18	7.3
	Basic Electronics	19	7.7	23	9.4
JHS 2					
	Carbon Cycle	16	6.5	38	15.5
	Heredity	39	15.9	23	9.4
	Basic Electronics	19	7.7	23	9.4
JHS 3					
	Basic Electronics	19	7.7	23	9.4
	Science Related to Industry	58	23.6	31	12.6

Source: Field Survey; Otami (2018)

The table shows that Basic Electronic and Science Related to Industry which are new topics introduced into the current 2012 Integrated Science syllabus are not receiving adequate attention from the teachers. With respect to the topic, Science related to Industry, 36.2% of the teachers indicated that they do not cover it in the third year of the 2012 Integrated Science syllabus.

To triangulate the information given by the teachers, 48 students selected (24 from each school-type) were made to identify topics in the syllabus that their teachers did not cover and the responses provided were similar to those of the teachers. They indicated Farming Systems and Basic Electronics for JHS 1; Carbon Cycles, Heredity and Basic Electronics at JHS 2 as well as Basic Electronics and Science Related to Industry at JHS 3.

The reasons for the teachers' inability to cover all the topics in the syllabus were also investigated, eight teachers (four from each school-type) who had indicated that they were unable to cover some topics in the syllabus were interviewed. For instance, an individual interview with James, a teacher from a public school, who did indicate that Basic Electronics was not covered, said:

> "*the school has no apparatus which can be used to teach a topic like Basic Electronics*"

An extract from an interaction with Michael, a teacher from a public school, who did not cover Basic Electronics is:

> *Interviewer: you indicated you did not cover Basic Electronics, why?*
>
> *Michael: the school has no money to buy the things I need to teach Basic Electrons, so I do not teach it.*
>
> *Interviewer: what if it comes in their BECE?*
>
> *Michael: When it comes in their exams (BECE), they can skip questions on it... after all they have options to choose from so it is not a big problem."*

An extract from an interaction with Glover a teacher from a public school who also indicated Basic Electronics was not covered was as follows:

> *Glover: Basic Electronic is very difficult to teach without*

practicals ...and in our school, there is not laboratory and equipment

Interviewer: can't you improvise to teach it?

Glover: hmmm... improvising electronic materials? I don't think it is possible. That is why, I do not teach it.

Interviewer: what if it comes in their BECE?

Glover: they can answer questions on other topics and still pass their exams and get a good grade in science, ... so it is not a big deal".

Techers from private schools, who did indicate they were unable to cover Basic Electronics in the Integrated Science Syllabus, were also interviewed to ascertain reasons for their inability to cover topic. An extract from an individual interview with Chris, a teacher from a private school, was as follows:

Interviewer: you indicated you did not cover Basic Electronics, why?

Chris: Basic Electronics is very difficult. So, I have decided not to teach it

Interviewer: but there could be Basic Electronics questions in their BECE.

Chris: yes, but I do not think not answering a question on basic electronics will let you get a bad grade in science... there is always a chance for them to answer questions from other areas.

Another teacher from a private school, Grace who was not able to cover the Basic Electronics, said:

"you do not need to answer questions from all the topics in the syllabus to pass".

Maxwell, a private school teacher who did not Basic Electronics in an interaction said:

Maxwell: It is a topic that.... sincerely I do not have control over. So, in order not to put my students in trouble, I teach the other topics which they can answer questions on and still get one in science.

Francis, also from a private school who did not cover Basic Electronics said:

I do not really understand the topic... so I cannot teach what I do not understand myself.

The responses from the interactions with the selected Integrated Science teachers, seem to suggest that the teachers do not have adequate knowledge in the topic Basic Electronic to enable them teach it. Consequently, the teachers believe without teaching Basic Electronics students could still pass with a good grade in Integrated Science.

However, all the eight teachers from the different school-types who had indicated they were not able to cover Basic Electronics did indicate they did cover Farming System as well. Reasons gave by the teachers for their inability to cover the Faming Systems were as follows:

"the current JHS Integrated Science syllabus has no topic called Farming *Systems"; "Farming Systems is not part of the topics in the Integrated Science syllabus";* and *"when was this topic (Farming System) added to the syllabus?"*

The results from the interactions seem to suggest that coverage of topics in the integrated science syllabus by teachers was influenced by the teachers having *"you do not need to answer questions from all the topics in the syllabus to pass".*

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The results from the interactions seem to suggest that coverage of topics in the integrated science syllabus by teachers was influenced by the teachers having adequate knowledge about the topic and availability of resources to support its teaching. Additionally, the results further suggest that the 2012 Integrated Science syllabus was not what was being implemented in the schools. This is because, on the contrary, the topic Farming Systems is in the 2012 Integrated Science Syllabus (MoE, 2012, p.12).

Furthermore, the eight teachers (four from each school-type) who indicated Heredity and Carbon Cycle were not covered were interviewed to ascertain their reasons. For instance, in an interview with John, a teacher from a public school gave:

> *"these topics do not come in their exams (BECE) and so I don't teach them"*

Andrews, another teacher from a public school who had indicated he did not cover Heredity and Carbon Cycle, said:

> *"WAEC does not ask full questions on these topics in their exams (BECE).... why should we waste time on them?"*

Teachers from private schools who were not able to cover the topics Heredity and Carbon Cycle gave reasons similar to their counterparts from public schools. An individual interview with Nelly, a teacher from a private school, said:

> *"I don't see them as serious topics because WAEC hardly sets questions on them in the BECE.*

Akwasi, another teacher from a private school, also said:

> *"there have not been questions on it that I have seen in the BECE... so I will not waste time to teach it"*

To appreciate claims by teachers about some topics not being important, a document analysis of past Integrated Science questions set for the BECE by WAEC was conducted. The results show that since 1990, only six objective and three essay type questions have been set on Heredity. The objective type questions are:

> *"The shape of a child's nose may resemble that of her mother due to... Qu.27 [WAEC,1990]".*
>
> *"Which of the following features of a parent would __not__ be inherited by the children? Qu.30 [WAEC, 2007]"*
>
> *"In humans, features of parents are passed on to offspring through... Qu.18 [WAEC, 2008]".*
>
> *"Which of the following characters is __not__ acquired through heredity? Qu.37 [WAEC, 2011]".*
>
> *"The heredity material that is passes on from parents to offspring is known as.... Qu.7[WAEC, 2013]"* and *"An example of inheritable characteristics in humans is... Qu.22. [WAEC,2017]".*

With respect to the essay type questions set on Heredity by WAEC for the BECE, are:

> *"Give __two__ features which can be passed on from parents to children. Qu. 3e (ii)[WAEC,1994]".*
>
> *i. Explain heredity*
>
> *ii. Give two examples of heredity characters"* and
>
> *Qu.4a [WAEC,2009]"*

"State __four__ heredity features in humans. Qu.2b [WAEC, 2013]".

Further documentary analysis of questions on Carbon Cycle show that since 1990, only three objective type questions and two essay type question have been set by WAEC for the BECE. The first objective question are;

> *"Which of the following human activities maintains the carbon cycle? Qu.38 [WAEC, 2013,]"; "Global warming is caused by the…Qu.30. [WAEC, 2016]"*, and *"Which of the following gases supports combustion? Qu.38 [WAEC, 2016]"*

The two essay type questions were in 2011 and 2015. They are:

- *i. Mention **two** ways in which the carbon cycle can be maintained*
- *ii. State **one** environmental effect which the carbon cycle is disrupted? Qu.2c [WAEC, 2011]*

and

- *i. State **two** human activities that disrupt the carbon cycle*
- *ii. State **two** effects of the disruption of the carbon cycle on the environment. Qu. 4c [BECE,2015, WAEC]*

The results from the document analysis of questions on Heredity and Carbon Cycle support the reasons that the topics were not important for WAEC examinations for BECE. It seems to suggest that coverage of topics in the Integrated Science Syllabus by teachers appeared to be influenced by the extent to which questions were set on concepts in the BECE by WAEC. The reasons given by teachers do not reflect those espoused by (Adu-Gyamfi, 2014; Adu-Gyamfi, 2016: Somuah & Agyenim-Boateng 2014; Mensah & Somuah, 2013; Parker, Osei-Himah, Asare, & Ackah, 2018; Somuah & Orodho, 2016) that the overload nature of the Integrated Science curriculum hindered its coverage by the teachers in JHS.

To explore reasons Science Related to Industry did not received much attention, teachers from the different school-types indicated it was not part of the syllabus and made comments like:

> *"Science Related to Industry is not a topic in the syllabus";* *"the topic is Entrepreneurship and not Science Related to Industry*"'; and, *"may be a topic like that is been considered but for now, there is no topic like that in the science syllabus"*

Further, on the topic Science Related to Industry not being in the integrated science syllabus is incorrect. This is because Science Related to Industry is a topic in the 2012 integrated science syllabus (MoE, 2012, p.48).

In summary, not all the topics in the integrated science curriculum were covered by teachers in both public and private JHS. Reasons given were varied, ranging from non-availability of equipment to the topics with some saying it was not part of the integrated science syllabus. Nonetheless, all the topics indicated for the teachers to indicate the ones they do not teach were in the 2012 Integrated Science Curriculum (MoE, 2012). The suggestion that some topics not covered were not in the 2012 integrated science syllabus was incorrect. This seem to suggest that some of the teachers in the schools sampled were not aware of the topics in the 2012 integrated science curriculum which teachers are supposed to be implementing in the classrooms currently.

Availability of Resources for Teaching and Learning of Integrated Science

Research question five elicited information on teaching and learning resources available in the schools and the extent to which they were used to teach integrated science. To do this, the teachers were made to indicate the availability or otherwise of science laboratory, science equipment, integrated science textbooks, the 2012 JHS Integrated Science Syllabus for and Computers in their schools. Furthermore, the adequate or otherwise of the resources were investigated using a Checklist. Results on the availability or non-availability of the resources in the schools sampled are presented in Table14.

Table 14: Teachers' responses on availability of resources for teaching Integrated Science

	Public (N =162)				Private (N = 84)			
	Available		Non-available		Available		Non-available	
Resource	N	%	N	%	N	%	N	%
Science laboratory	0	0	162	100	2	2.4	82	97.6
Science equipment	3	1.9	159	98.1	6	7.1	78	92.9
Science textbooks	14	8.6	148	91.4	84	100	0	0
2012 Integrated Science Syllabus	158	97.5	4	2.4	80	95.2	4	4.8
Computer for science teaching	3	1.9	159	98.1	57	67.9	27	32.1

Source: Field Survey; Otami (2018)

The table shows that generally science equipment, integrated science textbooks, integrated science syllabus, and computers were available for the teaching and learning of integrated science in the schools sampled. Of the resources, the 2012 JHS Integrated science syllabus and integrated science textbooks appear to be most available resources in the schools. However, teachers two private junior high schools indicated they had science laboratory.

To find out teaching and learning resources indicated to be available in the schools were adequate or not, the results are presented in Table 15.

Table 15: Teachers' responses on adequacy of resources for teaching Integrated Science

	Public (N=162)				Private (84)			
	Adequate		Inadequate		Adequate		Inadequate	
Resource	N	%	N	%	N	%	N	%
Science laboratory	0	0	0	0	0	0	2	2.4
Science equipment	3	1.9	3	1.9	0	0	6	7.1
Science textbooks	5	3.1	9	5.6	84	100	0	0
2012 Integrated Science Syllabus	158	97.5	9	5.6	78	92.9	2	2.4
Computer for science teaching	0	0	3	1.9	0	0	57	67.9

Source: Field Survey; Otami (2018)

The table shows that most of the resources indicated by the teachers to be available in their schools were inadequate. Of these resources indicated by the teachers to be adequate in the schools like Science textbooks, and the 2012 Integrated Science syllabus, they were more in the public schools compare to the private schools. This is not surprising as the Ministry of Education through GES supply teaching syllabus to all public schools. However, the private schools had adequate numbers of science textbooks compared to the public schools. This finding may be due to the fact that the private schools rely on open market for textbooks supply which their students are required acquire them.

To explore the extent to which the resources available in the schools were used by the teachers to teach Integrated Science, four teachers each from the different school-types were selected and interviewed. An extract of an interview with Eugene, a teacher from private school who indicated his school had a science laboratory, an excerpt was as follows:

> *Interviewer: you indicated you have a science laboratory in your school, where is it?*
>
> *Teacher Eugene: "the science laboratory is the building standing alone there,*
>
> *Interviewer: Do you use it to teach integrated science?*
>
> *Teacher Eugene: Yes, we occasionally go there to have let students have a feel of how the theory they are taught relate to live.*

Focus group interview with some selected students from Eugene's class suggested that the science laboratory was used to teach Integrated Science. An extract of the interview was:

> *''we have not gone the science laboratory for practicals"*

Further checks in the science laboratory show that it was labelled as one but was inadequately equipped.

To find extent of availability of science textbooks through interaction with some private school teachers, an in-classroom observation of integrated science lessons as well as focus-grouped discussion with some select students revealed that every student had a copy of integrated science textbook. An excerpt of focus-group interview with select students yielded response as follows:

> *"we all have copies of the integrated science textbook. We bought it from the school."*

Regarding availability of the 2012 integrated science syllabus in the schools, my checks with the schools whose teachers had indicated they have adequate numbers revealed that indeed they had extra copies of the syllabus aside the ones the teachers were using. However, in some of the private schools sampled, it was revealed that the teachers were using the 2007 integrated science syllabus.

On how the teachers used the computers they have indicated were available in their schools to teach Integrated Science, an interaction with some teachers from both public and private junior high schools yielded responses as follows:

> *"I use the computers to show videos about concepts I feel students will find it difficult to understand in class".* (Teacher from a Public School A)
>
> *"we use the computers to learn science and it makes my students like science"* (Teacher from Public school C)
>
> *"Watching some of the things with computers make the teaching and learning of science easier"* (Teacher from Private School F).

Focus-group interviews with some selected students from the schools where computers were available yielded responses as follows:

> *"We have not used the computer to learn science before though our teacher has said one day we will watch some of the things we*

learn in class on it".

(students from Public School A)

"our teacher has not used the computer to teacher us science before…… he says will use it more when we get to Form 3

(Students from Private School F)

With respect to non-availability of science laboratory as indicated by some private school teachers, an interaction yielded responses such as:

"Some of the topics can be taught with simple materials which is easy to come-by without a laboratory so I use them and do simple activities in science with the students in the classroom" (A teacher from Private School E)

An example of such lessons on test of food substances was done by a teacher in a public school.

However, a focus-group interviews with some selected students in schools with no science laboratory said:

"our teacher performs some science experiments with us in class by not many" (Students from Public School A)

"At times we are shown pictures of how some science experiments is performed in our textbooks or sometime the teachers draw it on the chalkboard for us to copy" (Students from Private School E)

The information seems to suggest that teachers from the school-types rarely use resources available to them to enhance the teaching and learning of Integrated Science.

Generally, there were some resources available to teachers who taught Integrated Science in the junior high schools sampled for teaching and learning of the subject though they were inadequate. Despite it being inadequate, the private junior high schools sampled appeared better resourced compared to public schools. This study broadens the scope of teaching and learning resources aside science laboratory which had been the focus of previous studies by including computers for teaching integrated science as well as the 2012 JHS integrated science syllabus. Furthermore, it appears the teachers do not use the little resources available to them for teaching and learning of integrated science in the schools. The extent of inadequate resources available in the schools to be driving the teachers to use the expository method to teach integrated science instead of the constructivist approached advocated in the 2012 JHS integrated science syllabus (MoE, 2012). Furthermore, on the extent to which teaching and learning resources available to the Integrated Science teachers in the junior high schools were used to teach, accounts of the teachers on their usage were not in agreement with that of their students. Thus, making one doubt what they teachers said.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In this concluding chapter, summary, conclusions and recommendations are presented. The summary highlights the key findings, the conclusions and recommendations made based on the key findings. Suggested area for future research is also pointed out.

Summary

Overview of the study

This study explored the teaching and classroom assessment practices of integrated science teachers in JHS in educational districts overserved with teachers yet produce low students' performance in Integrated Science in the Central Region of Ghana. Five research questions were formulated to guide the study. The study followed the convergent parallel mixed methods design in which both qualitative and quantitative data were obtained concurrently with Teachers' questionnaire on Teaching and Classroom Assessment Practices, Interview Protocols and Lesson Observations. Multiphase sampling technique, stratified, convenience, simple random and purposive, was used to select teachers who taught integrated science and some students for the study. The quantitative data were gathered through responses the teachers provided on the questionnaire in the areas of their academic and professional qualifications, the priorities that informed their teaching and classroom assessment practices, coverage of the topics in the Integrated Science curriculum, and resources and facilities available to the teacher for the teaching and learning of integrated science in the JHS. The quantitative data were analysed with frequencies and percentages, Kendell's Coefficient of Concordance, and one-way Multivariate

Analysis of Variance (MANOVA). Qualitative data were obtained from lesson observations, interviews with the selected teachers and students, recordings of inspection of teachers' lesson notebooks, and students' integrated science exercise books through field notes. The qualitative data were analyzed using themes generated from the views expressed by the teachers and students on the teaching and classroom assessment practices, coverage of the Integrated Science curriculum and the resources and facilities available for teaching and learning of Integrated science in both school-types.

Key findings

1. Majority (72%) of teachers who taught Integrated Science possessed at least a Diploma academic qualification. With respect to school-type, 54.1% of teachers teaching Integrated Science in private schools had (SSCE/WASSCE) compared to 6.2% from public schools.

   Overall, one-half of teachers who taught Integrated Science possessed no professional certificate. Of this, majority (88.1%) came from private schools with 11.9% from public schools. Teachers who taught with no professional certificate but had background in at least senior high school level science. Majority of the teachers (74.4%) came from public schools compared to 25.6% from private schools. High number of teachers possessed Bachelor of Education (Basic Education) as professional qualification. Regarding teachers with professional certificates and had a background in science, majority (80.2%) were from public schools compared to 19.8% from private.

(2)(a)(i) The teaching of integrated science was mostly informed by 'developing students' conceptual understanding of concepts'. Teachers

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(2)(a)(i) The teaching of integrated science was mostly informed by 'developing students' conceptual understanding of concepts'. Teachers ranking of priorities informing their teaching from the highest to the least was as:

i.help students understand the content,

ii. motivate students to have interest in science,

iii. help students appreciate the importance of science

iv. prepare students to pass their exams

v. complete the syllabus.

The first three are most beneficial for nurturing conceptual understanding of integrated science concepts.

(ii) The study found that priorities that informed the teaching of integrated science by professional and non-professional teachers differed with Kendall's Coefficient of Concordance (w=0.588; p=0.001). The priority of the professional teachers in teaching integrated science was to help develop students' conceptual understanding of integrated science concepts. Their top three ranked priorities were to:

i. help students to understand integrated science content

ii. motivate students to have an interest in science

iii. help students appreciate the importance of science

However, non-professional teachers ranking were to:

i. prepare students to pass their exams,

ii. complete the syllabus,

iii. help students appreciate the importance of science.

(b) Integrated science teachers used mostly the expository method to teach. This was confirmed through observation of integrated science lessons.

3.(a) Generally, classroom assessment practices of integrated science teachers did not conform to what was suggested in the teaching syllabus. Integrated science teachers used in-class exercises, homework, class test and project work for classroom assessment. Of these, homework and in-class exercises were the most used with private school teachers using more of these compared to public school teachers. However, this did not conform to what was indicated in the teaching syllabus. Project work was normally ignored by teachers as a form of classroom assessment.

(b) Classroom assessment practices of integrated science teachers were more towards teaching rather than promoting students learning. Teachers ranked in the order of importance was to;

i. inform teaching of integrated science, and

ii. grade and fill report cards for parents

However, the study found no difference [F (4,241) =2.94, p<0.061; partial eta squared=0.046] in the reasons for conducting classroom assessment in both school-types.

(c) Integrated science teachers used mostly lower order questions for classroom assessment. Majority (91.3%) of the questions elicited factual knowledge with 50.0% of questions on remembering.

4. Integrated science teachers covered more than (80.0 %) of the 43 topics in the integrated science curriculum. Teachers in the public schools treated (85%) of the topics compared to (76.3%) by those in the private schools. Setting of questions on popular topics in BECE influenced its coverage by teachers. It was found that adequacy of teachers' knowledge about topics in the teaching syllabus as well as availability of teaching

and learning resources related to the topics in the schools influenced coverage by teachers.

5. Schools had some teaching and learning resources available. These were mostly Science textbooks and Integrated science syllabus, Computers, Science laboratories and Science equipment for Science teaching was rare. Private schools had more teaching resources compared to the public schools. Usage of the inadequate resources for teaching and learning of integrated science was doubtful. However, teachers' account on their use of resources for teaching was contradicted by their students.

Conclusions

The study explored teaching and classroom assessment practices of Integrated Science teachers in junior high schools in four educational districts overserved with teachers yet produced low students' performance integrated science in the Central Region of Ghana. The study has shown that Integrated Science teachers in junior high schools studied were mostly qualified academically but not professionally. This finding is consistent with Abe (2014) and Ampiah (2008) which showed that teachers teaching in basic schools possessed the required academic qualification. This current study found that one-half of teachers were not professionally qualified but had a background in SHS science. In addition, the selected Integrated Science teachers in public schools were more academically and professionally qualified compared to those in the private schools. This finding though consistent with Abe (2014); Ampiah (2008); Tooley, Dixon & Amuah (2007). This study found high number of teachers' possessed Bachelor of Education (Basic Education) as professional qualification in both school-types. This implies that the minimum professional qualification for teaching at the junior high school level is Bachelor of Education and this is what the MoE is aspiring to achieve for basic schools in country.

In this study, priorities that informed the teaching of Integrated Science in both school-types were explored. The study has shown that the order of priorities that informed the teaching of Integrated Science in both school-types ranked by the teachers as follows were to: help students understand the content of science, motivate students to have interest in science, help students appreciate the importance of science, prepare students to pass their exams, and complete the syllabus in that order. This seem to suggest that Integrated Science teachers have priority areas that informed their teaching and was informed mostly by development of students' conceptual understanding in science concepts. However, the priorities informing the teaching of Integrated Science by professional and non-professional teachers in the schools studied differed. Whereas professional integrated science teachers ranked to: 'help students understand integrated science content', and 'motivate students to have interest in science', as the first two most important priorities, the non-professional integrated science teachers ranked 'prepare students to pass their exams', and "complete the syllabus', as the highest. The non-professional teachers, therefore focused their teaching of Integrated Science on completing the syllabus and helping their students pass examinations. Given that schools in the educational districts were low performing, this seem to be a normal reaction to solving students' poor performance in the BECE. The difference in teachers 'priorities for teaching shows that professional teachers unlike non-professional teachers studied prioritized the development of students' conceptual understanding in science concepts. The study has shown that integrated science teachers in the junior high schools used the expository teaching approach which is teacher-centred and ignoring mostly the recommended approaches which were mostly activity- based and hence student-centred.

Despite the 2012 JHS Integrated Science syllabus (MoE, 2012) recommendation that class test should be given every fourth week of a term and a project work once a term the teachers from schools studied preferred the use of in-class exercises and homework and ignore project work contrarily to the recommendations of the syllabus. Consequently, the integrated science teachers do not implement the assessment strategies as recommended.

The study has also shown that teachers teaching Integrated Science in junior high schools studied use lower order questions which focus on lower cognitive skills for their classroom assessment. This finding agrees with Lustick, (2010); Chin (2007); and Hand, Vanghan & Carolyn, (2015) that questions used by teachers for classroom assessment are lower order. The Integrated Science teachers covered over three quarters of the topics in the integrated science curriculum. The Integrated Science teachers from the public schools covered nine percent (9.0%) more of the topics in the Integrated Science curriculum compared to private schools. The reasons for coverage of topics in the curriculum seem to be influenced more by how WAEC set question, and teachers conceptual understanding of the topics they teach. This does not agree to findings of Adu-Gyamfi (2014; 2016) and Mensah and Somuah (2013) that integrated science teachers' inability to cover some topics in the curriculum was due to its overloaded nature. The finding of this current study contributes to the debate in the literature on factors which influence the coverage of the topics in the integrated science curriculum by teachers in junior high schools.

Finally, the finding from the study has shown that science laboratory, science equipment, science textbooks, the 2012 JHS integrated science syllabus and computers were available in the schools studied though they were inadequate for the teaching and learning of Integrated Science. The private schools seem to be better resourced, but some followed the outdated Integrated Science syllabus to teach.

Recommendations

The following recommendations were made based on the findings:

1. As there were teachers teaching integrated science with no background in science, the MoE and GES should ensure teachers with required background in science teach integrated science in the junior high schools studied. Furthermore, since there were non-professional teachers teaching integrated science, it is therefore recommended that such teachers be encouraged by the MoE and GES to go for Postgraduate Diploma in Education, UTDBE, and Modular courses to upgrade their knowledge in the teaching of integrated science.
2. As the teachers mainly used the expository method in teaching, which is not in line with the recommendation of the 2012 integrated science teaching syllabus, it is recommended that the headteachers of the sampled schools should supervise the teaching of integrated science to ensure that teachers use the Activity-oriented methods in teaching integrated science. Also, used teaching methods not prescribed by the syllabus, it is recommended that in-service training and workshops are

organised for the teachers by the MoE and GES for the teachers on how to use the teaching method indicated in the Integrated Science syllabus.

3. Since the schools in the educational districts sampled had no science laboratories for effective teaching and learning of Integrated Science as prescribed in the syllabus, it is recommended that the MoE and the GES provide schools in the educational districts sampled with laboratories so that Integrated Science teachers teach using methods prescribed in the syllabus.
4. The MoE and GES should organise refresher courses, workshops and seminars on topics teachers have little or no knowledge about to help them teach the topics in the curriculum.
5. Since integrated science teachers in the schools studied rarely used the resources available in the schools in their teaching of integrated of integrated science. It is, therefore, recommended that Heads of the schools and the Circuit Supervisors encourage the teachers to use the resources available to them for teaching and learning of the subject. syllabus to teach the students.

Suggestions for Further Research

The study explored teaching and classroom assessment practices of integrated science teachers in junior high schools in educational districts overserved with teachers yet produced low students' performance in integrated science in the Central Region of Ghana. The study, however, did not look at how the teaching and classroom assessment practices of the teachers influenced students' achievement in integrated science. It is, therefore, recommended that future research should explore how teaching and classroom assessment practices of integrated science teachers in the over-served educational districts influenced students' achievement in integrated science.

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APPENDICES

APPENDIX A

TEACHERS' QUESTIONNAIRE TEACHING AND CLASSROOM ASSESSMENT PRACTICES (TQCAP)

Dear Teacher,

This is an anonymous questionnaire. Do not write your name, or any other comment that would identify you on the questionnaire. By completing this questionnaire you are consenting to take part in this study.

This questionnaire seeks your opinions and concerns about teaching and classroom assessment practices with respect to Integrated Science. There is no right or wrong answer to each question. Information from this questionnaire will be used to improve teaching and classroom assessment practices of Integrated Science teachers in Ghana. The information will be aggregated and summarized for inclusion in research reports. No person or school will be identified in any report.

Thank you for your participation.

Academic and Professional Background

This questionnaire is divided into sections. The first section is for eliciting information about background characteristics. The second is about your teaching priorities and classroom teaching strategies. Please, fill the questionnaire as honestly as you can.

Instruction: Write or Tick [ ] the appropriate response to each item.

SECTION A

PART I

Bio Data

1. Sex: M [ ] F [ ]
2. School type: Public [ ] Private [ ]
3. Age range:

   Below 20 years ☐ 21 25 years ☐ 26-30 years ☐ 31-35 years ☐

   36-40 years ☐ 41- 45 years ☐ 46-50 years ☐ 51 years and above ☐

4. What is your highest academic qualification?

   GCE O' LEVEL [ ] GCE A' LEVEL [ ] SSSCE/WASSCE [ ] CERT 'A' [ ]

   UTDBE [ ] Diploma [ ] HND [ ] B. Sc [ ] B.Ed. [ ] M. Phil [ ]

   Others (Specify)..

5. What programmed did you offer at the Senior Secondary School Level: If application Science [ ] Agric Science [ ] Business [ ] General Arts [ ] Other (Specify) ....
6. Did you attend a Teacher Training Institution? YES [ ] NO [ ]
7. If ***YES*** what qualification were you awarded DBE [ ] Cert 'A' [ ] UTDBE [ ] B.Ed [ ]

8. What was your area of specialisation? ....

9. What programme did you read for degree programme if you now have a first degree OR a Masters degree? Please indicate your area of specialisation ....

10. Which of these professional Certificates do you have?

Certificate 'A'	[ ]
Bachelor of Education	[ ]
Post Graduate Diploma in Education	[ ]
Post Graduate Certificate in Education	[ ]
Untrained Teachers' Diploma in Basic Education	[ ]
Certificate in Education	[ ]
None	[ ]

11. Are you currently pursing any programme to upgrade yourself in any academic institution?

YES [ ] NO [ ]

12. If **YES,** what subject area are you pursing the further studies in? ....

13. How many years have you been teaching ....

14. How many years have you being teaching Integrated Science ....

SECTION B

Priorities that inform the Teaching Integrated Science

The following are priorities for teaching Integrated Science in your school

(Put them in order of importance, 1 being most important and 5 being the least Important of the priorities)

Priorities	Rank
To help students to understand the content	
To motivate students to have an interest in science	
To help students appreciate the importance of science	
To prepare students to pass their exams	
To Complete the syllabus	

15. Why do you consider priority ranked ONE as being the most important?

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

SECTION C

TEACHING METHODS

16. Which of the following teaching strategies do you use to teaching Integrated Science (**1 being the most often and 5 being the least use teaching strategy)**

Teaching strategy	**Rank**
Activity Method	
Demonstrator Method	
Discovery Method	
Discussion Method	
Expository method	
Group Work	

17. Why do you consider the teaching strategy ranked first and second as your most preferred teaching strategy for teaching Integrated Science?

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

SECTION D

CLASSROOM ASSESSMENT PRACTICES

Indicate the extent to which your classroom assessment of students learning of Integrated Science is based on the following

NO	Statements	Almost Always	Most Of the time	Very Often	Often
1	Grading and fill reporting to their parents				
2	Feedback on students learning				
3	Identifying students' learning difficulties				
4	To inform the teaching of integrated science				

18. Which of the following classroom Assessment strategies do you use to assesses your students **(Put them in order of importance, 1 being the most often used teaching Integrated Science)**

b) **How do you assess**	**Rank**
a) Homework	
b) In-class exercise	
c) Class test	
d) Projectwork	
Other Special	

19. What inform your choice of using your most preferred assessment procedure?

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

20. When in the term do you organise your assessments in Integrated Science

Start of the term [ ] Weekly [ ] Monthly [ ] Midway through the term [ ] End of them [ ]

21. Do you discuss outcome of students' assessments results help in class?
....
....
....

22. Why do you discuss assessment results with your students?

....

....

....

....

Please indicate by ticking the topics under each JHS level which you were NOT able to cover before the end of the academic year

Topic under JHS 1	**Tick**	**Topics under JHS 2**	**Tick**	**Topic under JHS 3**	**Tick**
Introduction to Integrated Science		Elements, Compounds and Mixtures		Acids and Bases	
Measurement		Metals and non-Metals		Soil and water	
Matter		Chemical Componds		Conversation	
Nature of Soil		Mixtures and Water		Life cycle of a Mosquito	
Hazards		Carbon Cycle		The Solar System	
Life Cycle of Flowering plants		Weather, Seasons and Climate		Dentition in Humans	
Vegetable Crop Production		Reproduction in Humans		Digestion in Animals	
Farming systems		Heredity		Heat Energy	
Respiratory System of Humans		Diffusion and Osmosis		Basic Education	
Sources and Forms of Energy		Circulatory System in Humans		Magnetism	
Conversation and Conservation of Energy		Photosynthesis		Science Related to Industry	

Light Energy		Food and Nutrition			
Basic Electronics		Electrical Energy			
Ecosystems		Basic Electronic			
Air pollution		Infections and Diseases of humans and plants			
Physical and Chemical change		Pests and Parasites			
		Force and Pressure Machines			

24. Please give reason(s) why you could not cover the topics you have ticked

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

....

25. Suggest ways that would enable you cover the entire topic that you could not cover.

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

SECTION E

Availability of Resources and Facilities for Teaching and Learning Integrated Science in your School

Please indicate if the following resources are available in your school and if they are available indicate whether they are adequate or inadequate in your school.

Resources and Facilities	Available	Adequate	Inadequate	Not Available
Science laboratory				
Equipment for experiments				
Science Textbooks				
The 2012 Integrated Science Syllabus				

Computers to support the teaching and learning of Integrated Science				

23. How do you teach in the absence of these resources/ facilities?

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

APPENDIX B

TEACHERS' INTERVIEW PROTOCOLS ON TEACHING AND CLASSROOM ASSESSMENT PRACTICES (TIPCAP)

School-type...

Date of interview..

Interview starts time:...

Interview duration:..

Priorities that inform teaching of Integrated Science

1. What are your main priorities when teaching Integrated science and why?

Teaching methods used by their teachers

2. What method(s) do you normally use in your teaching?
3. Why do you normally use this /these method(s)?
4. Do you normally use a variety of the methods mentioned in question 4? Why?
5. How do you promote students' participation in your lessons?
6. How do you think is /are the best way(s) of teaching Integrated Science?

Classroom assessment

7. What classroom assessment strategies do you use to assess your

   Students learning of Integrated Science and why?

8. How often do you use the(es) assessment strategies and why?

Coverage of the Topics in the Integrated science Syllabus

9. Do you treat all the topics in the Integrated Science syllabus assigned for each of the levels (i.e JHS1, JHS 2 and JHS 3) within each academic year? if No, why?

Resources Available for Integrated Science Teaching in the schools

10. Do you have any of the following in your school?

    i.science laboratory,

    ii.science equipment,

    iii. integrated science textbooks,

    iv Integrated science syllabus and

    iv Computers for teaching integrated science

11. Do you use them in teaching integrated science during your school? If No, why?

APPENDIX C

STUDENTS' INTERVIEW PROTOCOLS ON TEACHING AND CLASSROOM ASSESSMENT PRACTICES (SIPTCAP)

School type……………………………………………………………………………

Date of interview………………………………………………………………………

Interview starts time:…………………………………………………………………

Interview duration:……………………………………………………………………

Teaching methods used by their teachers

1. Do you enjoy your Integrated Science lessons and why?
2. Does your teacher normally teach Integrated Science as was done today?
3. Do you want him/her to continue to teach Integrated science using the approach normally and why?

Classroom assessment

4. Do you have separated Integrated Science exercise book?
5. Do you solve questions during integrated science lessons?
6. Does your teacher give you homework? class test? project work?

Resources available in the schools

7. Do you have any of the following in your school?
   i.science laboratory,
   ii.science equipment,
   iii. integrated science textbooks, and
   iv Computers
8. Are they used for teaching integrated science by your teacher?

APPENDIX D

CHECKLIST ON AVAILABILITY OF RESOURCES FOR TEACHING OF INTEGRATED SCIENCE (CARTIS)

Resources	Available	Not available	Adequate	Inadequate
Science laboratory				
Science equipment				
Integrated science textbooks				
Integrated science syllabus				
Computers for teaching integrated science				

Other observations...
....
....
....
....

APPENDIX E

INTEGRATED SCIENCE LESSON OBSERVATION PROTOCOL

Background information

Name of teacher..

Name of School..

Topic.. Date ....

Class.. Number of Students......................

Date of Observation...

Lesson Starts... Lesson Ends....................

Lesson design		**Description of events**
Students Prior Knowledge was reviewed	Yes No	
The teaching strategy used was?	Activity Method Demonstration Method Discussion method Discovery method Expository method Group Work	
The lesson was designed to develop students understanding of a particular concept.	Yes No	
The lesson focus and direction were determined by ideas from students	Yes To some extent Never occurred	
The lesson engaged students	Yes To some extent Never occurred	
The teacher used prescribed textbook for the lesson	Yes Sometimes Never occurred	

Students participation		Description of events
Students played active role in the teaching and learning process	Yes Sometimes Never occurred	
Students were allowed to discuss their ideas with their colleagues	Yes Sometimes Never occurred	
Students were given the chance to find ways of solving problems on their own	Yes Sometimes Never occurred	
Students were encouraged to use variety of methods to solve problems	Yes Sometimes Never occurred	
Students were encouraged to make predictions and discuss their mistakes	Yes Sometimes Never occurred	
Students were given the chance to ask questions	Yes Sometimes Never occurred	
Students' questions were given the needed attention	Yes Sometimes Never occurred	
Students were given the chance to perform investigations to develop their own understanding	Yes Sometimes Never occurred	
There was a high proportion of students' talk	Yes Sometimes Never occurred	

APPENDIX F

LIST OF METRO, MUNICIPAL AND DISTRICT EDUCATION OFFICES IN THE CENTRAL REGION

1. CAPE COAST METRO	CAPE COAST
2. ABURA-ASEBU-KWAMANKESE DISTRICT	ABURA DUNKWA
3. MFANTSEMAN MUNICIPAL	SALTPOND
4. KOMENDA-EDINA-EGUAFO MUNICIPAL	ELMINA
5. ASSIN SOUTH DISTRICT	ASSIN DARMANG/KYEKYEWERE
6. ASSIN NORTH MUNICIPAL	ASSIN FOSO
7. TWIFO HEMAN LOWER DENKYIRA DISTRICT	TWIFO HEMANG
8. TWIFO ATTI-MORKWA DISTRICT	TWIFO PRASO
9. UPPER DENKYIRA EAST MUNICIPAL	DUNKWA-ON-OFFIN
10. UPPER DENKYIRA WEST DISTRICT	DIASO
11. AJUMAKO-ENYAN-ESSIAM DISTRICT	AJUMAKO
12. EKUMFI DISTRICT	EKUMFI ESSARKYIR
13. GOMOA WEST DISTRICT	APAM
14. GOMOA EAST DISTRICT	GOMOA AFRANSI
15. AGONA WEST MUNICIPAL	AGONA SWEDRU
16. AGONA EAST DISTRICT	AGONA NSABA
17. ASIKUMA-ODOBEN-BRAKWA DISTRICT	BREMAN ASIKUMA
18. AWUTU SENYA DISTRICT	SENYA BEREKU
19. AWUTU SENYA EAST MUNICIPAL	KASOA
20. EFFUTU MUNICIPAL	WINNEBA