Challenges face by Science Teachers in the Teaching of Integrated Science in Ghanaian Junior High Schools

Kenneth Adu-Gyamfi
Mampong Technical College of Education
Ghana
dondonsinco@yahoo.com

Abstract

Notwithstanding the quantum of research works in the literature relating to school science, there are still issues for science educators and researchers to consider and read around. Even at higher platforms such as UNESCO, research works on science education are presented and discussed in order to clear the way for quality science education. In this paper, an investigation into challenges science teachers face in teaching Integrated Science at the Junior High School level was conducted. Qualitative approach such as open-ended interviews and observations of science syllabus, standard examination questions, and students' textbooks were deployed to investigate the challenges of science teaching with 10 science teachers in a developing country. The challenges so identified included loaded science examination papers, attitude of students towards school science, the concept of improvisation, and students' preparedness towards new science lessons. These challenges in one way or the other affect the teaching methodology selection by teachers for quality science education. It was therefore recommended in addition to other things that experts in improvisation should take a second look at the concept in order to incorporate the current edition of scientific concepts which have been added to the Basic School Science.

Keywords: Challenges; Integrated Science; Junior High School; school science; teachers

Introduction

The state of science education has been of interest to many governments and researchers over the years in the world's school education system. Most governments in one way or the other focus on improving science education in order to affect the economy. For this and other reasons, many research works in science education have been conducted at all levels of school education using different variables and methodology given revelation to many things. Anderman, Sinatra, and Gray (2012) pointed out that issues such as availability of appropriate science textbooks and classroom resources, preparation and training of pre-service and in-service science teachers, political and religious oppositions to the cutting-edge of science are some of the enormous issues confronted with science education. The rest are the need to meet standards and to effectively train science students for standardised examinations and the challenge of the web as a source of information.

Pryor and Ampiah (2003) explained that in Africa, teaching in a village school is not an easy task. This is because the poor results obtained by students from the final examinations conducted by International Institutions such as West African Examination Council (WAEC) make it difficult for teachers to maintain any sense of professionalism and pride. Teachers usually attribute village school students' poor performance to the students' lack of interest in

schoolwork and indiscipline. Part of the blame is also attributed to parents/guardians' neglect towards students' learning. Thus the difficulty teachers face in teaching students from village junior high schools (JHS) in Africa in general and Ghana in particular is the poor attitude of students and other community members towards schooling (Pryor & Ampiah, 2003).

Students' poor attitude and interest towards school science is an issue identified across the world (Adu-Gyamfi, 2013; Fensham, 2008; Hallack & Poisson, 2001; UNESCO, 2010). In some instances, students' lack of interest in science is associated with the use of science to select a small fraction of elite students at the early ages to become science specialists and in Malaysia, students' lack of interest in science is associated with scarcity of well-paid jobs for science professionals (Hallack & Poisson, 2001). In Ghana the study of Adu-Gyamfi (2013) added that students' lack of interest in science is anchored on the time consuming and less practical nature of learning school science as well as the learning of science which is basically knowledge transfer from science teachers and textbooks. Science teachers' decisions about instructional practices such as procedures for assessment, grouping of students, and the types of rewards and punishments are crucial to influence students' interest and attitude in pursuing any science-related subject or course in the future (Anderman et al., 2012). It is therefore recommended that teachers should inculcate in students the interest in and adequate knowledge of the contribution of school science to the development and technological advancement of the society they live in (Fensham, 2008).

From Hewson (1992, p. 10), "accepting that students hold different conceptions that might need to change is one thing: concluding that it is the teacher's responsibility to engage in teaching practices that might facilitate conceptual change to occur is a separate matter." It is therefore the responsibility of teachers to identify students' conceptions and to instruct them in ways that will facilitate conceptual change. Consequently, Hewson asserted that teachers should not compel students to surrender their alternative conceptions but adopt appropriate instructional strategies that will offer students' alternative conceptions the opportunity to equally compete with teachers' or scientific conceptions for acceptance (Hewson, 1992). This can be achieved when science teachers encourage students to challenge any information presented to them and to discuss the information with respect to its personal merits (Dass & Yager, 2009).

In addition, to make science education effective teachers need to transform how students think to assist them to make meaning and apply scientific knowledge as scientists do. This transformation can be done if and only if science teachers can instruct science like a science (Wieman, 2008). It must further be noted that students' pre-representations, which are assembly of ideas and images students use to solve problems can be more or less accurate. It is expected of science teachers to discover and confront such representations to confirm or contradict them. This will help teachers to build new scientific knowledge in class (Kozan-Naumescu & Pasca, 2009).

Handelsman et al. (2004) reported that some teachers are intimidated by the challenge of learning new instructional strategies and therefore resist any change in their respective instructions. Wieman (2008) in his presentation revealed that the issue with science education is for teachers to develop a mindset that their instruction should be deployed in a similar way with all the rigor and standard as scientists conduct scientific research. Consequently, science teachers are expected to create an environment conducive for students' active questioning and identification of issues and answers by employing appropriate instructional strategies (Dass & Yager, 2009).

Further in Africa the problem of teachers teaching at the JHS level in Sub-Saharan African villages is the inability of teachers to use student-centered instructional strategies instead of teacher-centered ones (Pryor & Ampiah, 2003) and in San Francisco Bay Area, teachers in K-5 schools taught science using basically lecture methods based on textbooks (Thomberg, 2009). The teacher-centered instruction is reported to have become necessary as most students in African villages find it difficult to make any meaningful verbal interactions in English Language (L_2) or even Ghanaian Language (L_1) for the case of Ghana with respect to topics in the curriculum.

The study of Pryor and Ampiah (2003) revealed that most teachers were cautions with language policy adopted by Ghanaian Basic Schools, where the medium of instruction for the lower primary is L_1. JHS teachers including science teachers were of the view that the use of L_1 affect students' performance as the transition is poor and most students are left in the state of confusion. This is because all materials except those in Ghanaian Language are written in L_2 and students found it difficult to understand exercises written in L_2.

Dass and Yager (2009) reported that the nature of science teaching in schools and colleges has changed over the last 50 years and there is therefore a need for new perspective of school science education. For teachers to meet the changing nature of school science and the changing notions of what desirable science education is, they are expected to undergo effective professional development that can address such changes. Thomberg (2009) identified staff development as what teachers need to transform science studies into an inquiry-driven project-based learning. This staff development should be structured in such a way that it will take regular forms. Kozan-Naumescu and Pasca (2009) found that teachers within the bracket of pre-university education are involved in continuous education. This places two main challenges at the door steps of such teachers. That is teachers are partly required to raise the level of scientific knowledge of their respective areas of teaching and to raise the level of psycho-educational and methodical preparations in their lessons with respect to current trends of education.

Fensham (2008) identified that it is better to have less quality time of science learning to learning science aided by an under-equipped teacher. Fensham therefore recommended that members of Science Teacher Associations who are much experienced in the problems embedded in the teaching and learning of science should equip their colleagues who are under-equipped in order to offer the needed assistance to students. This is an indication that even at higher platforms such as that of UNESCO, science educators and other interest groups appreciated that science is bedeviled with some problems and if not identified and removed could still hinder the heights science education could attain in the 21st Century. This is because school science has been identified as tool that could help to delight society in and share in the scientific enterprise (Fensham, 2008).

In this paper there was the need to report on the investigation into the teaching and learning of school science at the Basic Education (herein Junior High School [JHS]) level in a developing country using qualitative methodology. Osborne and Collins (2001) explained that the use of qualitative methods in investigating complexity of an issue provides new insights into the nature and quality of school science. The purpose of the study therefore was to investigate the challenges face by teachers in teaching Integrated Science at the JHS level. Through this investigation, how the challenges so identified affected science education was determined. The study was guided by the following research question which helped to achieve the purpose of the study:

What challenges do science teachers face in teaching Integrated Science and how do these challenges affect the quality of science teaching at the JHS level?

Participants and Methods

The report in this paper was based upon a study conducted in one of the district assemblies of Ashanti Region of Ghana. The district so selected as it was noted for its interest in school education. All levels of school education were present in the district as compared to the other districts of the Ashanti Region. At one of the Districts' Teacher Association Meeting held at the district capital, I made contact with some of the science teachers present at the meeting; explaining the purpose and benefits of the study I intended to conduct with science teachers in the district. Out of the number of science teachers I spoke to, 10 of them agreed to participate in the study. All the 10 teachers were professional teachers with six of them holding degree in education and the other four holding diploma in education. Out of the four diplomas, two of them were pursuing degree in education through the distance education mode to upgrade themselves. The teachers could be referred to as experienced teachers as on the average each has taught the JHS Integrated Science for 5 years.

I made arrangement with the teachers to visit them in their respective schools for interviews. The interview with the teachers and the accompanied observation of science materials and equipment elapsed for 14 school days. This is because each teacher was given a day for the interview and where necessary a follow-up interview was carried out. It could be seen that few number of science teachers at the JHS level were involved in the study and the reason being the use of individual interviews. The individual interviews with the teachers provided the study with rich and extensive data though it was time consuming (Osborne & Collins, 2001).

The interview schedule was that of open-ended one where the 10 teachers had opportunities to demonstrate their unique way of looking at the challenges they face in the teaching and learning of science at the JHS level. All the teachers were asked the following basic questions in the order in which they occur:

1. How do you see the teaching and learning of science at the JHS level?
2. Explain why you consider science teaching and learning at the JHS level as an interesting one.
3. What kind of challenges do you usually face in teaching science at this level?
4. Explain how the challenges you have identified affect the teaching and learning of science at this level.

Such an approach of using the same basic questions for all the teachers could be said to have reduce any form of biasness and could have increased the spectrum of comparison of the teachers' views on the challenges of science teaching at the JHS level. However, from one teacher to another, new issues that evolved were further investigated in the next interview session with another teacher.

To ensure convergent validity of the views of the teachers interviewed, I observed and compared the past examination questions which were standardised test items set by the West African Examination Council (WAEC) for students at the JHS level in the Basic School Certificate Examination (BECE) to the outcomes of the interviews. The WAEC Science 2 test items for the period 2009 to 2013 were used for the study (WAEC, 2009; 2010; 2011; 2012; 2013). I further observed and read the Integrated Science Teaching Syllabus for JHS and this further helped to ensure the validity of the data from the instruments for the study. The data collected from the multiple sources helped to explain more fully, the quality and complexity of

the views of science teachers on the challenges of Integrated Science teaching at the JHS level (Cohen, Manion, & Morrison, 2007).

Findings

After the interviews and the observations, the views of the teachers were transcribed. I then constructed meanings from the explanations given by the teachers. From such meanings I made from the 10 science teachers' explanations as well as the observations of WAEC standardised test items and the JHS Integrated Science Syllabus, the findings were summarised under four main themes as:

1. Nature of JHS Integrated Science teaching;
2. Science materials and equipment;
3. Nature of WAEC test items for BECE candidates; and
4. Students' attitude towards learning science.

Nature of JHS Integrated Science Teaching

The Ghanaian JHS Integrated Science Syllabus had a goal of inculcating scientific literacy and culture in high school students to enable them make informed choices in their personal lives. It was further aimed at producing competent professionals in various scientific disciplines at other levels of education (Ministry of Education [MOE], 2012; Ministry of Education, Science and Sports [MOESS], 2007). The syllabus has been organised into five sections as diversity of matter, cycles, systems, energy, and interactions of matter. All the five sections were carefully structured for the three-year programme to help achieve the two main goals of teaching Integrated Science at the JHS level. Under each section for each year group, there were general objectives from which specific objectives and corresponding content were outlined. Teachers teaching the JHS Integrated Science were expected to devote 20%, 40%, and 40% respectively to Knowledge and Comprehension, Application of Knowledge, and Experimental and Process Skills in their teaching, learning and testing (MOE, 2012; MOESS, 2007). This is an indication that the planners of the syllabus require teachers to emphasize much on teaching, learning, and testing in the dimensions of application, experiment and process skills which could help to attain the goals of the syllabus.

The topics in the syllabus were carefully selected and developed to meet the aims and objectives of the syllabus. Almost all the teachers were of the view that the topics in the syllabus which seemed difficult and lengthy were broken down to meet students' growth and maturity. Matter was a perfect example here as aspects of it were treated every year for the three-year period. However, topics such as introduction to Integrated Science, hazards, measurement, acid, base and salt, machines, and water are treated and completed in only the respective year selected for such topics. Notwithstanding these observations made by the teachers from the syllabus, the teachers were unanimous in saying that the teaching the syllabus depends largely on the characteristics of the students. Erica sad:

> *When the students are good and you're sure of taking them the following year you can even teach all the aspects of a break-down topic. And if they are weak, then you need to work even extra for the selected aspect of the topic for that year.*

The teaching of Integrated Science at the JHS level was considered generally as an interesting thing to do by the teachers. Reasons given by the teachers as to why it was interesting

to teach science at the JHS level included the opportunities given to the teachers to train students at this level; teachers' interactions with students on some scientific concepts which students have prior knowledge and experience of, students sharing of scientific knowledge and experience with colleague students as well as their teacher; students' interactions with materials in learning the scientific concepts; and students' reactions after sitting for their final examinations. For instance, Mensa said:

> *My students naturally complain about the science content as compare to other subjects but they always come out of the examination room happy; saying it was cool. This usually makes me happy and motivates me as I prepare for the year ahead.*

Another area which is interesting when it comes to teaching science at the JHS level is the students' readiness or preparedness for the science lessons. Adiyia amongst the 10 science teachers added:

> *I don't know if it is only in my school or class, but my students are always well prepared and ready for my lessons. Whenever I'm absent from school the students will tell me the following day that they miss me. You see for such students I feel like being with them all the time.*

However, all the 10 teachers overwhelmingly indicated that notwithstanding the interesting nature of teaching science at the JHS level, it could at times be challenging. At this point of the interviews with the teachers, I began to look for answers to the questions of how and why teaching of science could be challenging. The next three sections are the presentation of the challenges and how these challenges identified affected the teaching of science.

Science Materials and Equipment

The syllabus which is the main science curriculum material for teaching Integrated Science was quite loaded and there were too much to teach at a particular time. Some of the topics should have been left in the domain of senior high school (SHS) science, where the students continue their learning after JHS. Addo said:

> *I remember some of my past students said that what they were learning currently at the SHS in Integrated Science were almost the same as what they met at the JHS…you see I myself appreciate this and think some of the topics should be pushed to the SHS to minimise the content burden on students and teachers.*

Agriculture was one of the areas of integration under Integrated Science and the teachers were of the firm view that Agriculture should not have been integrated with the sciences. This in one way could have helped reduce the load as teachers hardly teach the Agriculture aspects such as vegetable crop production, animal production, and fish culture as required by the Integrated Science Syllabus. Erica for instance said: "*teachers hardly take students to the field to experience the practical nature of Agriculture aspects due to time constraints*."

Amongst all the teachers there was general indication that science teaching at the JHS level was challenged in the area of science materials and equipment. The science materials and equipment were said to be unavailable and where they were available, they were insufficient for effective and efficient science teaching and learning. With respect to students' textbooks recommended for the teaching of Integrated Science at the JHS level, the textbook were

identified as being of low quality and currently not good enough for meeting the current expectation of the JHS Integrated Science Syllabus (MOE, 2012). Mensa said: "*student's textbooks' content are old and were not prepared in agreement with the current syllabus. I must say they are of no relevance in terms of the practical test*." Teachers use other books though not recommended by the Ghana Education Service (GES) but they are of relevance as they supplement what we have in the schools. This came in as I made known to Mensa that the science teacher has to be resourceful. Where students' textbooks were not sufficient and hardly do students have individual copies, teachers were prevented from using reading assignments as a means of engaging students during their out of school hours.

My checks as the author of this paper on some curriculum materials to ascertain the gravity of the challenge of textbooks being alluded to by the teachers; I came into contact with the students' textbooks by Kom-Zuta, which were some of the recommended textbooks for teaching Integrated Science at the JHS level. Indeed they were available in the schools. The students' textbooks of Kom-Zuta have been in the system since 2008; revised in the years 2009 and 2012. The students' textbooks of Kom-Zuta were written with respect to the Integrated Science Syllabus. For instance, under the topic: life cycle of flowering plants, Kom-Zuta (2012a, p. 68) outlined the learning objectives as "*describe the life cycle of flowering plants; demonstrate the conditions necessary for germination of a seed; and explain how knowledge about life cycle of flowering plants is important in vegetable crop production.*" Further under the topic: diffusion and osmosis, Kom-Zuta (2012b, p. 105) outlined the learning objectives as "*explain the terms diffusion and osmosis; demonstrate the processes of diffusion and osmosis; and distinguished between diffusion and osmosis*." With respect to the topic: acids and bases, Kom-Zuta (2012c, p. 3) outlined the learning objectives as: "*explain the terms acid and base; distinguish between an acid and a base; classify substances as acids or bases; and predict the product formed when an acid reacts with a base*." These learning objectives were similar to the learning objectives stated in the JHS Integrated Science Syllabus (MOE, 2012). The books of Kom-Zuta (2012a; 2012b; 2012c) seemed to be enriched with diagrams, pictures, and practical activities which were in line with the content and activities of the science teaching syllabus (MOE, 2012).

Another major challenge in the area of science materials and equipment was the absence of science laboratories for Ghanaian schools at the JHS level. Meanwhile, there was a requirement for JHS students to have laboratory practical experience. When asked: How do you teach the practical aspects of the subject in the wake of the absence of science laboratory in your school? Most of the teachers indicated they try to manage with the classroom environment for some of the practicals. However, Addo said: "*I have arranged with the Senior High School near my school to have some of the practicals there*." Most practical lessons on the classrooms were demonstration base as it was the general view that schools were ill equipped with science equipment to have the students interact with in groups or individually. I then enquired: you were trained from the Colleges of Education to practice improvisation; why not improvised? It was common to most of the teachers that not all science equipment can be improvised. For instance, in the words of Atatwum:

> *you can't improvise microscope, thermometer, and diode to mention but a few and all these are needed to teach science at this level… and the rate of student understanding in certain topics such as Basic Electronics is affected by the absence of some materials and equipment; and it makes teaching a challenging one.*

Nature of WAEC Test Items for BECE Candidates

The Science 2 Paper which was one of the papers leading to the award of the Basic Education Certificate Examination to JHS students by WAEC consisted of two parts: Part I and Part II. The total score for the Part I was 40 marks and Part II was 60 marks; all summing up to 100 marks. Students were required to answer Test Item 1 in Part I, which was the test of students' practical knowledge and four other test items from Part II, which were the test of students' theoretical knowledge in Integrated Science. The structure of the science paper from the view of students was lengthy to be answered within 1.25 hours. In response to my question: Is it true that students complain about the structure of the Science 2 Paper? Boatemaa shared her view as:

> *Students year-in and year-out usually complain about the structure of the Integrated Science Paper in relation to other WAEC papers. I have cross-check this and I think the students' observations are true when the paper is compared to Social Studies Paper, which is in three parts; answer one question from each part.*

Part of the challenge encountered by the teachers with the Science 2 Paper was that the paper seemed to be above standard. This is because when the practical test items were compared with the syllabus and other recommended curriculum materials, they seemed to be overboard. Osei said:

> *WAEC seems to have a different syllabus from the one that the schools use… in 2012 BECE practicals, the detail external features of flowering plant were asked but this is not treated in the government syllabus as the syllabus only looked for the major part of a flowering plant. I have to add this next time in order to meet the demands of the examination council which also broadens the content.*

Other teachers were positive about the WAEC Science 2 Paper as they alluded to the fact that it was not necessarily that WAEC uses a different syllabus but it all boiled down to the science teacher and his or her used of the recommended curriculum materials. Erica said: "*I don't know the syllabus the colleague teacher is using as all questions are from the government syllabus… all 2012 practical tests were from the syllabus*." Mensa's view on this same subject was unequivocal. He said:

> *Is not true that WAEC Science Practical Test is not in the Basic School Syllabus. Teachers who have problems with the content of WAEC practical test are those who hardly expand the syllabus but rather use it as the actual lesson plan.*

The teachers acknowledged that WAEC observed the concept of profile dimension to the letter in setting the Science 2 Paper for the BECE candidates as:
Knowledge and Comprehension = 20%
Application of Knowledge = 40%
Experimental and Process Skills = 40% (MOE, 2012; MOESS, 2007).
However, some teachers could only use knowledge-based questions for their students for the purposes of large class size and easy scoring which intend affect the performance of students in Integrated Science.

My observations of the WAEC Science 2 Paper, as the author of this paper, from the year 2009 to 2013 have shown that there were indeed two sections of the paper; Part I and Part II with a total score of 100 marks except the year 2009 where the total score was 75 marks (WAEC, 2009). The score of 75 arose as a result of the requirement for candidates to answer any other three questions from Part II for the year 2009 instead of four questions from 2010 to date (WAEC, 2010; 2011; 2012; 2013) in addition to the Part I question. The Part I question which was the test of practical knowledge comprised test items on Physics, Chemistry, Biology, and Agriculture for all the years mentioned in this paper except 2009. In 2009, the Physics item was on heat transmission through conduction, the Chemistry item was on rusting of nails, and the Biology item was on test of starch in green leaves. The items on Physics, Chemistry, Biology, and Agriculture for 2010 respectively were circuit diagrams; use of indicators on acids and bases; digestion in human digestive system; and simple farm tools. In 2011 the test of practical knowledge was in the area of transmission of light energy; hazards and symbols in everyday life; human dentition; and simple farm tools. Further in 2012, the test items under the practicals were as in Physics, determination of volume of irregular solid objects; Chemistry, the identification and uses of some samples of chemical laboratory equipment; Biology, identification of external features of flowering plants; and Agriculture, identification and uses of part of a small farm animal. In 2013, the Biology item was on demonstration of osmosis in a living tissue; the Chemistry item was on reactivity of metals; the Physics item was on modes of heat transmission; and the Agriculture item was on water holding capacity of soil samples. All these scientific concepts being assessed by the WAEC Chief Examiner for Science 2 seemed to be present and clearly outlined in the Integrated Science Syllabus (MOE, 2012; MOESS, 2007).

Students' Attitude towards Learning Science

The teachers acknowledged that one of the challenges of teaching science at the JHS level was the students' attitude toward science. It was common that one of the students' attitudes towards learning science was that they perceived Integrated Science as a difficult subject with respect to the other subjects they study at the JHS level. "*It at times becomes frustrating in trying to demystify science*." Kwakye made this known as he tried to point out why students' attitude toward science can be a challenge to the teaching of science. The students' perceived difficult nature of science stems from the fact that the language of science was at times uncommon in everyday life and the other subjects they learn in school; the content of science was too broad as compared to other subjects; students spent a lot of time to cover science content in preparation towards examinations; and science questions were loaded compared to other subjects from examination council.

Students most of the times fail to revise their previous lessons in preparation towards new lessons. In such cases students found it difficult to respond to revision exercises and hardly asked questions but could only answer when they make reference to their science materials. This made teaching more of teacher-centered to that of student-centered. However, Adiyia differed from this perceived attitude of students as I asked him: how well do your students actively contribute in your lessons? Adiyia said: "*as I indicated earlier my students are always ready for my new lessons and their contributions are encouraging*."

It was a general feeling among the teachers that notwithstanding how much teachers put in teaching science, students still feel they will need extra contact hours outside the regular instructional hours to make it in science. Boatemaa said: "*I at times had to meet my students after school to teach them whenever they asked for*" and Mensa added that "*I meet my students every*

Saturday for science lessons". Erica However did not agree that she has to give her students extra hours after the school hours even if they call for. She said:

> *It is true that students always call for extra classes for teaching science and you know this attitude is not good for a teacher maximizing time and doing his or her best… I usually don't meet my students for extra classes but assign students with study mates as they learn better from their own friends.*

Erica further added that the use of study mate was necessary as over the years students have confessed that their mates assisted them in understanding some topics they thought were difficulty. This revelation came in as I probed further to find out why the use of study mates instead of the teacher being there in person to help his or her students who are in need.

Another attitude of students which the teachers identified as quite disturbing and not good for science education was students' preference for teachers to teach those topics that are likely to come in the final examination. This was particularly common with final year students. The students perceived that the content for Integrated Science was broad and that learning everything for final examination was a difficult task. Atatwum explained that

> *the final year students are usually exam driven. They learn with the aim of obtaining good grades in science exams but not to acquire knowledge. The students only preferred me teaching those topics which WAEC will likely ask questions on in the final exams.*

The teachers generally agreed that in such situations they only assured the students that all the topics in the syllabus are important for their personal lives and the communities they live in. The teachers further assured that students that a good basic knowledge in science will help them to learn and perform better in Integrated Science and other science related courses at the senior high school level.

Discussion

The finding that science teaching is interesting at the JHS level shows that teachers teaching science are happy with their jobs though there seem to be some challenges. This could imply that is not all that 'bad' at all teaching science as there is something to cheer about. If students' interactions with teachers is something pleasant to teachers whenever students bring to bear on the new lesson their previous knowledge and experience, then science teachers could be encouraged to always take advantage of students' previous knowledge and experience with direct bearing on their new lessons. This is because they influence students learning (The Association for Science Education, 2006). In addition, if students' interactions with teaching and learning materials in learning scientific concepts are pleasant scenes for teachers, then science teachers should create the enabling environment for students learning.

One of the challenges teachers face in teaching Integrated Science is the loaded nature of the content of the subject. Teachers have to teach so much within the three year period. Could science educators begin to look at the content of school science studied at each level of school education? This is because there are suggestions that the Agriculture aspects of Integrated Science curriculum should be separated and treated as a subject on its own as it was the case in Ghana some years back where trained Agricultural Educationists handled the Agriculture as a subject at both basic and high schools.

The findings from the study have shown that science teaching materials and equipment are not available in schools and where they are, they are inadequate. The availability of science materials such as textbooks has been one of the issues confronting school science (Anderman et al., 2012). Government agencies and private organisations which are the direct or indirect beneficiaries of science professionals from schools and colleges should therefore help academic institution to procure science materials for quality science education.

The assertion that the recommended students' science textbooks being old and currently not good enough for teaching science, especially science practicals at the JHS level could be said to be factually incorrect as my observation revealed otherwise. For instance, the Kom-Zuta Integrated Science textbooks used by the schools are current and revised to meet the demands of science syllabus. The third edition books (Kom-Zuta, 2012a; 2012b; 2012c) are the most current which are prepared in line with 2012 Integrated Science syllabus (MOE, 2012). Science teachers are therefore encouraged to be resourceful in all their endeavours.

It was also found in the area of science materials and equipment that the schools at the JHS level are without science laboratories but science teachers are expected to train their students to acquire practical knowledge in science (MOE, 2012). This is because the teaching of science cannot go on without practical lessons (Millar, 2001). There is therefore the need for MOE and GES to provide the basic schools with science laboratories; now that students' practical knowledge is being assessed by the examination council.

Though from the findings of the study, science teachers adapt to the use of demonstration method as a means of making the best out of the insufficient science equipment they have (Dass & Yager, 2009) but that still denies most students' hands-on experience in the subject (Pryor & Ampiah, 2003). Hence, the concept of improvisation was supposed to be adopted for teaching Basic School Science in developing countries such as Kenya (Ndirangu, Kathuri, & Mungai, 2003) where materials which are readily available in the environment are used in place of the original ones which are not available (Bhukuvhani, Kusure, Munodawafa, Sana, & Gwizangwe, 2010). Improvised materials equally enhance students' understanding in scientific concepts as it was when the original materials are used in teaching and learning of scientific concepts (Bhukuvhani et al., 2010). However, the science teachers are of the conviction that not all science equipment can be improvised. I therefore admonish science educators in developing countries who are the expert in the concept of improvisation to have a second look at the concept.

Another finding from the study is the loaded nature of science examination questions for assessing students' scientific knowledge in Integrated Science by the examination council compared to other subjects studied at the JHS level. It is loaded because within 1.25 hours students are required to answer five questions whereas under Social Studies, which is one of the basic school subjects, students are required to answer only three questions. This could affect the performance of students in Integrated Science Final Examinations which intend could lower science teachers self-esteem (Pryor & Ampiah, 2003).

The finding that practical test is used to assess students' knowledge in science at the JHS level disconfirm the revelation of Osborne (2001) that there is no need of practical assessment as written assessment correlates positively with the practicals. And that the use of only written test to assess students' knowledge in scientific concepts is fair enough. This current finding of practical test being used in addition to written test to assess students' knowledge in science is a wakeup call for science educators and researchers to look once again at the impact of practical work on students' performance in school science.

The challenge of science teachers with respect to the examination questions set by the examination council is how to translate what is outlined in the science curriculum into practice. This is because some science teachers use the syllabus as the actual lesson plan instead of expanding it. This seems to be an unprofessional attitude of a science teacher. Furthermore, some science teachers find it difficult to implement the JHS Integrated Science profile dimension (MOE, 2012) to the letter thereby using only knowledge-based questions; which fall short of what the examination council is using and therefore placing pressure on such teachers and their students. I therefore agree with Fensham (2008) that experienced science teachers should assist the less experienced ones to practice classroom assessment which are in consonance with the prescribed profile dimension at their teacher association conferences. Also, science educators from teacher education institutions should also adopt teaching methodologies that could help teacher-trainees to learn and use curriculum materials in the most appropriate way possible.

One of the challenges teachers face in teaching science at the JHS level is students' perception of Integrated Science as a difficult subject. School science as a difficult subject or course has been identified over the years by researchers (Adu-Gyamfi, 2013; Osborne & Collins, 2001). The difficulty is in the areas of language of science, content of science curriculum, and time spent to prepare for school science examinations. This shows that the difficulty associated with school science is becoming clearer as a result of this current study and others such as (Osborne & Collins, 2001). Further research work in the area of students' difficulty in school science could reveal other things for science educators to work around the clock to assist students to overcome the difficulty.

Another students' attitude which is seen as a challenge to teachers teaching Basic School Science is students' lack of preparedness or readiness towards a new lesson. This affects students' participation in science lessons as literature supports the fact that students' academic and social skills brought to the classroom have effects on the learning outcomes (Canadian Council on Learning, 2008). Hence, rendering science teaching and learning process teacher-centered to the preferred student-centered at the basic schools as they (students) barely participate in a lesson they are not ready for.

Conclusion

There are number of challenges facing teachers teaching Integrated Science at the JHS level. The challenges are associated with the nature of JHS Integrated Science teaching, science materials and equipment, nature of examination council's test items, and students' attitude towards science. The specifics of these challenges include loaded content of science curriculum, inadequate science teaching materials and equipment, lack of science laboratories for Basic Schools, the concept of improvisation of science teaching materials and equipment where they are not available, and translation of curriculum requirements into practice. The rest of the challenges science teachers face are loaded science examination paper for assessing student knowledge, the use of profile dimension to assess students' scientific knowledge, students' perceived difficult nature of science, final year students interest in knowing and learning examination oriented topics only, and students' lack of preparedness towards science lessons. These challenges in one way or the other affect the selection of appropriate teaching methods, students' performance in school science, the interest of students in school science, and students' participation in science lessons. In the wake of these challenges and their effects on Basic School Science which is crucial to the success of science education in general, the MOE, GES, and Non-

governmental organisations interested in science education should go to the aid of Basic School Science Teachers to help overcome these challenges they face.

References

Adu-Gyamfi, K. (2013). Lack of interest in school science among non-science students at the senior high school level. *Problems of Education in the 21st Century*, *53*(53), 7-21.

Anderman, E. M., Sinatra, G. M., & Gray, D. L. (2012). The challenges of teaching and learning about science in the twenty-first century: Exploring the abilities and constraints of adolescent learners. *Studies in Science Education*, *48*(1), 89-117.

Bhukuvhani, C., Kusure, L., Munodawafa, V., Sana, A., & Gwizangwe, I. (2010). Pre-service teachers' use of improvised and virtual laboratory experimentation in science teaching. *International Journal of Education and Development using Information and Communication Technology*, *6*(4), 27-38.

Canadian Council on Learning. (2008). *Ready to learn? A look at school readiness in young children.* Retrieved September 16, 2013, from www.ccl-cca.ca/pdfs/LessonsInLearning/Sep-18-08-Ready-to-learn.pdf

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London: Routledge.

Dass, P. M., & Yager, R. E. (2009). Professional development of science teachers: History of reform and contributions of the STS-Based Iowa Chautauqua programme. *Science Education Review*, *8*(3), 99-111.

Fensham, P. J. (2008). *Science education policy-making: Eleven emerging issues.* Paris: UNESCO.

Hallack, J., & Poisson, M. (2001). The challenges to be faced in order to progress towards a greater coherence and relevance of science and technology education. In M. Poisson (Ed.), *Final report of the international workshop on the reform in the teaching of science and technology at primary and secondary level in Asia: Comparative references to Europe*, (pp. 127-134). Geneva: International Bureau of Education.

Handelsman, J., Ebert-May, D., Beichner, R., Bruns, P., Chang, A., DeHaan, R., Gentile, J., Lauffer, S., Stewart, J., Tilghman, S. M., & Wood, W. B. (2004). Scientific teaching. *Science, New Series*, *304*(5670), 521-522.

Kom-Zuta, T. E. T. (2012a). *New integrated science for junior high schools: Book 1* (3rd ed.). Accra: Sedco Publishing Ltd.

Kom-Zuta, T. E. T. (2012b). *New integrated science for junior high schools: Book 2* (3rd ed.). Accra: Sedco Publishing Ltd.

Kom-Zuta, T. E. T. (2012c). *New integrated science for junior high schools: Book 3* (3rd ed.). Accra: Sedco Publishing Ltd.

Kozan-Naumescu, A., & Pasca, R-D. (2009). Teaching science: New trends in pre-universitary learning. *ACTA Didactica Napocensia*, *2*(2), 57-64.

Millar, R. (2001). *Teaching and learning science through practical work*. Outline of talk given at Nordlab-DK seminar, Copenhagen.

Ministry of Education. [MOE]. (2012). *National syllabus for integrated science for junior high school*. Accra: Curriculum Research and Development Division.

Ministry of Education, Science and Sports. [MOESS]. (2007). *Teaching syllabus for integrated science for junior high school*. Accra: Curriculum Research and Development Division.

Ndirangu, M., Kathuri, N. J., & Mungai, C. (2003). Improvisation as a strategy for providing science teaching resources: An experience from Kenya. *International Journal of Educational Development, 23*(1), 75-84.

Osborne, J. (2001). Science education for contemporary society: Problems, issues and dilemmas. In M. Poisson (Ed.), *Final report of the international workshop on the reform in the teaching of science and technology at primary and secondary level in Asia: Comparative references to Europe*, (pp. 7-14). Geneva: International Bureau of Education.

Osborne, J., & Collins, S. (2001). Pupils' views of the role and value of the science curriculum: A focus-group study. *International Journal of Science Education, 23*(5), 441-467.

Pryor, J., & Ampiah, J. G. (2003). *Understandings of education in an African village*: *The impact of information and communication technologies*. Retrieved May 22, 2014, from r4d.dfid.gov.uk/PDF/Outputs/TechDist Learn/papers52.pdf

The Association for Science Education. (2006). *Science education in schools*. *Issues, evidence and proposals*: *A commentary by the teaching and learning research programme*. Retrieved August 26, 2013, from www.tlrp.org/pub/documents/TLRP_Science_Commentary_FINAL.pdf

The West African Examination Council. [WAEC]. (2009). *Basic education certificate examination*. *Science 2*. Accra: WAEC.

The West African Examination Council. [WAEC]. (2010). *Basic education certificate examination*. *Science 2*. Accra: WAEC.

The West African Examination Council. [WAEC]. (2011). *Basic education certificate examination*. *Science 2*. Accra: WAEC.

The West African Examination Council. [WAEC]. (2012). *Basic education certificate examination*. *Science 2*. Accra: WAEC.

The West African Examination Council. [WAEC]. (2013). *Basic education certificate examination*. *Science 2*. Accra: WAEC.

Thomberg, D. D. (2009). *Five challenges in science education*. Retrieved May 20, 2014, from www.tcse-k12.org/pages/science.pdf

UNESCO. (2010). *Current challenges in basic science education*. Retrieved June 20, 2012, from unesdoc.unesco.org/images/0019/001914/191425e.pdf

Wieman, C. (2008). *Science education in the 21st century using the tools of science to teach science*. A summary of paper presented at the Forum's 2007 Aspen Symposium, British Columbia.