UNIVERSITY OF EDUCATION, WINNEBA

FACULTY OF SCIENCE EDUCATION

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SENIOR HIGH SCHOOL SCIENCE TEACHERS IN-SERVICE NEEDS IN SCIENCE INSTRUCTION: A COMPARISON ACROSS GENDER, SCHOOL LOCATION AND AREA OF SPECIALIZATION IN THE CENTRAL REGION OF GHANA

JOHN EKOW MBIR AMOAH

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B.ED SCIENCE EDUCATION

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NOVEMBER, 2011

CANDIDATE'S DECLARATION

I, John Ekow Mbir Amoah, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: .... **DATE:** 9/08/2013

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 Education, Winneba.

SUPERVISORS' SIGNATURE: .... **DATE:** 09/8/2013

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(DR. I. K. ANDERSON)

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DEDICATION

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ABSTRACT

The research design employed in this study was a survey research design using a questionnaire as the instrument. This study was descriptive in nature. This had been designed to identify and establish Ghanaian Senior High School Science Teachers' In-service Needs' across Gender, School location and Area of Specialisation. The instrument used to collect data was a questionnaire on Science Teachers Inventory of Needs (STIN) which was adapted to suite the Ghanaian context. The target population was made up of all Senior High School science teachers in Ghana. Teachers in certain parts of the Central Region of Ghana which comprised of the Komenda Edina Eguafo Abrem , Cape Coast , Abura Asebu Kwamankese, Assin South and Assin North districts, municipal and metropolitan assemblies (MMDA'S). The reliability of the science teachers' needs assessment instrument was ascertained using the internal consistency approach. This was to reduce costly mistakes and prevent threat to validity of the research through the use of Cronbach alpha. Data was collected from 29th November, 2010 to 11th March, 2011.It was also realised from the data that the topmost priority of science teachers' in-service needs was the integration of multimedia technology into science instruction. Based on the findings, it was recommended among others that frequent in-service training should be organised for Senior High School science teachers to update and refresh their knowledge in science. This study therefore provides meaningful empirical evidences of effective in-service programmes in the process of upgrading science teachers' professionalism in Ghana. These recommendations when put into action will assist Senior High School science teachers in their lessons and career as a whole.

CHAPTER ONE

INTRODUCTION

1.0 OVERVIEW

This chapter takes a look at the background to the study, leading to the statement of the problem, the purpose of the study and research objectives. It continues with the research questions and the significance of the study it further captures delimitation of the study which ends the chapter of this study.

1.1 BACKGROUND TO THE STUDY

The issue of improving the quality of science teachers is fast becoming a key concern in the search for ways to improve science education at all levels especially at the Senior High Schools (MOEYS, 2003).Within the framework of the Free Compulsory Universal Basic Education (FCUBE) reform programme, new teacher education policy has been put forward in an attempt to improve the quality of trained science teachers to effect positive changes in the school system (MOEYS, 2003). There is the belief that recently trained teachers often lack important skills and qualities that would make them better prepared to handle the new directions of curriculum reform and practice (MOE, 1994).

In fact, some heads of Senior High Schools have questioned the calibre of science teachers recently produced from the country's teacher training colleges and universities, arguing that they lack the commitment and skills that would otherwise make them successful science teachers (Awuku, 2000). In order to improve professional development, learning communities need to be established between schools and tertiary education institutions and also between experienced mentor teachers (in-service teachers) as well as between teacher educators and in-service teachers (Agbo, 2003). Agbo (2003) argues that collaboration within professional development communities and learning communities alike could be seen as "learning about teaching and teaching about learning". This learning from one another could only be possible when one of the parties/participants is an experienced teacher/mentor or teacher educator. This symbiotic collaboration also provides solutions for concurrent effective teacher education and therefore the improvement of the preparation of teachers.

Underpinning all the concern and remarks about teacher quality in Ghana is perhaps the important question: "What kind of science teacher does the school system produce''? International evidence suggests that the "quality of secondary education, especially in maths and science, has a stronger impact on economic growth than years of schooling. Equitable access to secondary education for poor students, and especially girls is an additional factor enhancing countries' economic growth performance" (World Bank, 2002). But this also depends on an adequate supply of qualified teachers who can generate interest in science and mathematics through innovative teaching. Ghana's progress against these international benchmarks reveals that developments in secondary education still have a long way to go. Of all approximately 14,000 secondary teachers in public schools, about a fifth are not professionally qualified, and for science and mathematics subjects this is even less - 19 percent and 13 percent approximately (NPT/GHA PRACTICAL project, 2007) cited by Akyeampong, Djangmah, Oduro, Seidu, & Hunt (2007). The general science stream in secondary schools currently stands between 13 to 15 percent of all students, although elective science and mathematics subjects can be selected in other more practical streams. Overall participation in physics has declined to 18 percent of examination candidates, in chemistry to

21 percent, 24 percent in biology and in elective mathematics to 28 percent. Education in general, and science education, for that matter, is a battle to contend with for all Ghanaians.

Analysis of the historical panorama of Science education in Ghana leads to the conclusion that science curriculum innovation is continuously in the state of flux. The lessons of 1987, 1997 and 2007 education reforms in Ghana are particularly important at a time when the international community is pressing and supporting African states to improve access to basic education as a strategy for poverty alleviation (World Bank, 2002). To date, continuous modification of Science curriculum innovation in Ghana has been planned and hence implemented to suit the nation due to changes in globalisation. More to that, all the educational reforms implemented in Ghana since September 1975, (the beginning of the implementation of the Dzobo Education Reforms of 1974), were aimed at providing well trained citizens (Dzobo, 1975) as cited by MOE (1974). This involved the acquisition of the requisite skills and knowledge needed to meet the needs of the nation. At secondary level, the emphasis in science teaching will be on innovation and problem-solving. There had been problems with the implementation of all these reforms. The current reform, the Anamuah-Mensah Reforms, is facing certain challenges that need to be surmounted. According to the new educational reforms, Continuous teacher development will be undertaken to upgrade and update the competencies and skills of serving teachers. Also Open universities and distance learning colleges shall be established to train and retrain teachers with regards to the reforms. These needs are to be addressed urgently to make the reforms succeed which augments this research.

Curriculum development is the process of creating new or alternate curricula or modifying existing ones. It is also defined by Adentwi (2000) as ‘‘the developmental stages through which an incipient curriculum, and also an existing curriculum passes through until it is ready for wide scale use in classrooms''. Craft (1996), Day (1999) & Parkinson (2004) concur by negotiating that the first step in designing a curriculum for continuous professional development is revelation and assessment of science teachers' needs. Although it is well-known that teachers play a crucial role in efforts to implement curriculum innovations, teachers' role can be examined from different perspectives. Recent work on teacher change and curriculum innovation suggested a bottom-up approach instead of the traditional top-down innovation model (Drier *et.al.,* 2001; Fincher &Teneberg, 2007; Richards, Gallo, & Renandya, 1999). In the traditional top-down innovation model, teachers are usually blamed for the failure of an innovation, where change is viewed as the transmission of ideas from curriculum developers or researchers to teachers (Fincher & Teneberg, 2007; Levy & Ben-Ari, 2007). In contrast, the bottom-up or more teacher-oriented approach suggests that the role of teachers in curriculum innovation is not merely executing the innovative ideas of others.

Lee (1992) argues that such innovation is triggered by the interface between internal affairs and external global factors, which leads to the production of a local made science curriculum; Ghana is not an exception to this assertion. Ghana's school curriculum is not only recognized in Ghana, but is also accepted in the international arena. Compared to the other subjects in the school curriculum, changes in the science curriculum appear to occur at a much faster pace. This might be due to significant impact created by science and technology on the advancement of human civilization. As a result, to keep abreast with the changes in globalisation, science teachers must be well-equipped with the necessary knowledge and skills so that what is outlined in the curriculum is realized in the classroom. In other words, science teachers must deliver their lessons effectively as envisaged in the curriculum.

As a facilitator of knowledge, skills and values to the mass population, science teachers in many other parts of the world, are always considered their nation's greatest asset (Kamisah, 1999). In Ghana, the situation does not only call for the need to equip science teachers with the necessary knowledge and skills per se, but includes tackling issues pertaining to the quality of teaching and learning Science.

Arguably, Ghana, like many other countries in the world is confronted with the problem of inadequate trained science teachers especially in the teaching of Physics, Chemistry, Biology and Integrated Science. As a result, teachers with various subject majors' or backgrounds are often required to teach science subjects which they were not trained for. Though these teachers might use various kinds of coping strategies in their teaching, they may be in dire need for in-service training courses in order to teach science meaningfully and effectively whilst filling the gaps in content knowledge and pedagogical content knowledge in the subject that they are required to teach (Subahan, Lilia, Khalijah & Ruhizan, 2001).

Effective in-service training programme should include programme development and orientation geared towards meeting the stated needs of the teachers' concern (Amir, 1993). In this regard, a study conducted by Kamariah (1984) on the perceived needs of secondary school science teachers in Malaysia concluded that the most prevalent need of science teachers then was providing for students' safety in the science laboratory. It could therefore be argued that science teachers' perceived in-service needs, is in contrast to the current accepted view of priority needs which lead to effective science teaching, namely developing students' understanding and creating meaningful learning (Harlen, 1997). Ghana is no exception since organisers of in-service training programme do not consider the priority of the curriculum implementers thus the needs of teachers. The approach in Ghana, for the organisation of in-service training can be likened to a top-bottom approach where the aim of the training is not realised because the specific and immediate needs of teachers are not met.

In a similar vein, Baird & Rowsey (1989), based on their survey of Senior High School science teachers needs concluded that without accurate data on teachers' needs, planning is not only difficult, but results generated are likely to be disappointing to both teachers and those who offer in-service courses. Baird and Rowsey (1989) also highlighted teachers' complaints that much time spent during in-service programme and activities had been wasted where such programme were not applicable in meeting their respective classroom needs. Thus, it is timely that another comprehensive assessment of the perception of the professional needs of Senior High School science teacher's be conducted here in Ghana.

Many countries report that teachers express a strong preference for urban postings. In Ghana, for example, over 80% of teachers said they preferred to teach in urban schools (Akyeampong & Lewin, 2002). There are a number of rational reasons why teachers may prefer urban postings. One of the concerns about working in rural areas is that the quality of life may not be as good. Teachers have expressed concerns about the quality of accommodation (Akyeampong & Stephens, 2000), the classroom facilities, the school resources and the access to leisure activities (Towse *et al*, 2002).

Health concerns are a second major issue. Teachers may perceive that living in rural areas involves a greater risk of disease (Akyeampong & Stephens, 2002), and less access to healthcare (Towse *et al*, 2002). Hedges (2002) describes teachers reluctance to accept a rural position .There is a profound fear among newly trained teachers with a modern individualistic outlook that if you spend too much time in an isolated village without access to further education, you become ‘a village man’, a term which strongly conveys the perceived ignorance of rural dwellers in the eyes of some urban educated Ghanaians.

Female teachers may be even less willing to accept a rural posting than their male counterparts, and rural areas may have fewer female teachers than urban areas (Gottelmann-Duret *et al*, 1998). In some cases posting single women to unfamiliar areas may cause cultural difficulties, and may even be unsafe (Rust & Dalin, 1990; VSO, 2002). For unmarried women, posting to an isolated rural area may also be seen to limit marriage prospects (Hedges, 2000). In some countries, like Ghana, teachers are not posted to rural areas as a matter of policy (Hedges, 2002). For married women, a rural posting may mean separation from her family, as the husband may not move for cultural or economic reasons (Gaynor, 1998). Where women have been posted to rural areas they may come to see themselves as having been treated unfairly by the system and thus seek early transfers (Hedges, 2002).

Teachers may also see rural areas as offering fewer opportunities for professional advancement. Urban areas offer easier access to further education (Hedges, 2000). In addition, teachers in rural areas are less likely to have opportunities to engage other developmental activities, or in national consultation or representative organisations. Teachers in rural areas may even find it more difficult to secure their entitlements from regional educational administrations, sometimes to the extent of having to put up with obstacles or corruption by officials.

The factor of gender disparity which is also significant in teacher recruitment needs to be considered. Female teachers make up 84%, 33%, 23% and 20% of pre-primary, primary, lower secondary (Junior Secondary School) and upper secondary (Senior High School) teachers respectively United Nations Educational Scientific and Cultural Organisation (UNESCO, 2010).

Misconceptions of females' participation in science and technology related subjects and careers are well documented in STME reports and other sources (Anamuah-Mensah, 1995). The studies have revealed that negative misconceptions and stereotyped attitudes are the major factors contributing to the negative attitudes on the part of girls towards the study of science.

Gender studies have shown that society in general and girls in particular, consider science as a male domain - that science is either too mechanical or too technical for girls. Girls are also considered as not being able to think or work scientifically (Agholor, 1993, Jegede & Okebukula 1993, Nkani, 1992, Eshun 1991) as cited by Quasie (1999). Technical subjects are considered suitable for boys only and girls who study them are considered un-ladylike.

Boys who study the so called 'feminine subjects' like secretaryship and cookery are laughed at by their friends and considered weak, lazy and poor achievers (Ellis, 1984). Over the years those who attempt to cross the gender barrier, do so against several odds and only a few bold ones manage to succeed (Ellis, 1984). In the new educational reforms currently going on in Ghana, where both boys and girls are expected to study all subjects at basic educational level, reports reaching us indicate that the few boys who eventually decide to study the so called feminine subjects like cookery at secondary schools are given names such as "Mr. Apron". Girls who choose to do technical subjects are called "Mrs. Hammer" (Ellis, 1984). The resultant effect of this problem is the apparent vast areas of job opportunities which seem to be available for men and very limited opportunities for women.

Gender related issues are now being incorporated into in-service and pre-service training for teachers. Ways of presenting the sciences to make girls feel comfortable with them are focused on teachers' language and teacher-student classroom interaction should be devoid of gender bias. Gender balanced curriculum materials call for curriculum developers and text book writers to be sensitised on the use of examples, (particularly tools and machines) charts and equipment which emphasize the male image of science.

Another significant point is that those who teach science at the Senior High School level are from diverse groups and thus require different needs. High quality in-service programme designed to meet those perceived needs of science teachers are necessary if teachers are to respond and benefit from staff development programme.

The researcher intends to compare the in-service needs of Senior High School science teachers across gender, geographic location and area of subject specialisation in the Central Regional of Ghana.

1.2 STATEMENT OF THE PROBLEM

The level of teachers' knowledge of a subject is crucial and has been shown to be a good predictor of student achievement (Darling-Hammond, 1999). According to Kofi (2007), a teacher who is competent and knowledgeable in his or her subject can teach it well and is more likely to establish a good rapport with students, create a democratic classroom climate, maintain an orderly and learning-focused environment, motivate learners, and provide co-operative interaction that can maximize learning. He further states that, to be competent and knowledgeable, the teacher must undergo comprehensive training and continue to learn throughout his or her teaching career.

In many developing countries, like Ghana, there are teacher shortages and as such in some places science subjects teaching are taken up by unqualified teachers. This can affect the quality of science teaching and learning as well as student achievement. A teacher is required to possess a requisite professional qualification to teach a particular subject. A teacher who has not completed a prescribed programme of study in science education including practicum is not considered professionally qualified, but is nonetheless offered teaching positions due to the shortage of science teachers. Ghana, like many other countries in the world is confronted with the problem of inadequate trained science teachers especially in the teaching of Physics, Chemistry, Biology and Integrated Science. This is problematic because these educators have limited knowledge of science content. Subahan *et al.* (2001) found that 60% to 68% of non-option physics teachers believed they needed to increase their understanding of physics content.

Therefore, teachers with various subject majors' or background are often required to teach science subjects which they were not trained for. Though these teachers might use various kinds of coping strategies in their teaching, they are in dire need for in-service training programme in order to teach meaningfully and effectively. This in-service training will help to fill the gaps of content knowledge as well as pedagogical content knowledge in the subjects that they are required to teach (Subahan, Lilia, Khalijah & Ruhizan, 2001).

It also appears that, for quite some time now, schools and colleges have been places of individuals not professionally fit to undertake teaching. So often, the problem or fear of unemployment has pushed even non-education graduates into the teaching sector. Such people come from various fields of specialisation inter alia engineering, agriculture, sociology, forestry, and home economics. A study in Malaysia by Berenson *et al.* (1991) found that 58%

of the teachers felt unqualified to teach science and only 8% would elect to teach science. Additionally, 37% of these teachers requested more in-service courses dealing with science content. The organisers of in-service training in Ghana fail to meet the specific needs of teachers in such programmes. It is essential to re-train science teachers in order for them to keep the best interest of their students and maintain that lifelong learning at the heart of teacher development.

In this study the researchers' aim is to investigate Senior High School science teachers perceived needs across gender, school location and areas of specialisation, in terms of undergoing in-service training programmes to enhance teaching and learning science. Often the experiences and views of those who are the direct beneficiaries of science are seldomly given voice in the consideration of programme restructuring or reform. The intention of the study is to use such findings to reflect on the current ways, of improving science education in Senior High Schools in Ghana.

1.3 PURPOSE OF THIS STUDY

The purpose of this study was to identify Senior High School science teachers' perceived needs and to compare those needs across gender, school location and area of subject specialisation.

1.4 RESEARCH OBJECTIVES

An objective describes an intended result of a research (Mager, 1984). Hence for this research to have a direction the objectives of the study were to;

- Identify the most prevalent in-service needs of senior high school science teachers for science instruction.

Specifically, the study looked at;

- In-service needs of Senior High School science teachers across gender.
- How school location influences Senior High Schools science teachers' in-service needs.
- Senior High School science teachers' in-service needs with respect to area of subject specialization.

1.5 RESEARCH QUESTIONS

The research questions that guided the study included the following;

1. What are the most prevalent in-service needs of Senior High School science teachers?
2. What are the gender differences in Senior High School science teachers' in-service needs?
3. What are the in-service needs of Senior High School science teachers with regards to school location?
4. What are the in-service needs of Senior High School science teachers with regards to their areas of subject specialisation?

1.6 SIGNIFICANCE OF THE STUDY

It is anticipated that the findings of this study are likely to reveal some information on science teachers' in-service needs in order to improve science instructional activities. This is essential so that appropriate measures can be taken in order to prepare teachers confronted with some of the local challenges as well as issues of globalization during classroom delivery. The information obtained may add to knowledge and documentation on the development of supportive programmes of the Ghana Education Service to enhance the teaching and learning of science. It is also likely that the Centre for School and Community Science and Technology Studies (SACOST), Institutions of Science Education may use the findings to improve their methodologies to enhance effective teaching and learning. Science curriculum designers and other stakeholders of education may also benefit from the study.

1.7 DELIMITATIONS OF THE STUDY

As this is human endeavour, it is envisaged that there might be some limits such as financial constraints some of which include the cost of printing the questionnaire, transportation to the various schools, the time frame to finish distribution and collection of the questionnaires of the study. The study is delimited to Senior High Schools in Komenda Edina Eguafo Abrem district, Cape Coast Metropolis, Abura Asebu Kwamankese district, Assin North and South districts of the Central region of Ghana. It is also likely that, schools chosen may not have all the characteristics of the targeted population. However the intervention and results can be replicated or adapted for use in other regions of the country.

CHAPTER TWO

LITERATURE REVIEW

2.0 OVERVIEW

This chapter deals with the review of literature that relates to this study. Under this chapter, Theoretical framework is covered. It continues with concepts such as Needs assessment model and Dimensions of Science Teacher Inventory of Needs (STIN).Other topics include Gender issues and In-service training programmes in Ghana. The chapter ends by focussing on the Influence of geographic location on the in-service needs of science teachers' and Area of subject specialisation.

THEORETICAL FRAMEWORK

In this ever changing globalized world, the disciplines in science (Biology, Physics, Chemistry, Integrated Science and other science related subjects) are continuously evolving. Similarly, instructional techniques used to teach these subjects are also developing at the same pace, both as a result of new developments in Information and Communication Technology (ICT) and research in science teaching and learning (Kamisah, Lilia & Subahan, 2006). Consequently, practicing science teachers need to update their knowledge in both content and pedagogy. It is a well-known phenomenon that, in some countries, specialists of some subject areas are often made to teach science subjects that they are not trained for. The need to continuously develop professional science teachers is critical in science teaching. Even though these teachers might have used various kinds of coping strategies and safety net in their teaching, they still need in-service training courses to teach science meaningfully and effectively.

For science teaching professionals, to continue functioning efficiently, productively and contribute meaningfully towards quality science education, they must be given training opportunities to keep them up-to-date. This will enable them to be able to face new professional, academic, and global society challenges. In this regard, quality teacher professional development programmes are meant to empower teachers in line with changes taking place in the world. The late Julius Kambarage Nyerere (an education icon of the philosophy and policy of Education—*Education for Self-Reliance*—in Tanzania) once said that any educational policy needs well-trained professional cadres who are continually updated for the educational policy to succeed (Nyerere, 1988). Consequently, teacher professional development programmes must be geared towards keeping teachers in all capacities abreast of new professional, academic, pedagogical and global society challenges.

Quality teachers in schools, colleges or universities are products of quality teacher education and re-education programme. With regards to this study, developing quality teacher professionals is about empowering them in affective, cognitive and psychomotor domains. These domains are reflected in science teachers' inventory of needs identified by Kamariah, Rubba, Tomera and Zurub (1988) as: generic pedagogical knowledge and skills, knowledge and skills in science subjects, managing and delivering science instruction, diagnosing and evaluating students, planning science instruction, administering science instructional facilities and equipment and integration of multimedia technology.

The essence of successful instruction and good schools comes from the thoughts and actions of the professionals in the schools who are mainly teachers. So, if one is to look for success in education, the best thing to do is to provide continuous education for the educator that is through professional development.

Those who would like to improve their teaching methods must find suitable training as well as those who would like to get a deeper knowledge of their teaching subjects. There must also be possibilities for science teachers to broaden their skills and knowledge in order to be qualified for teaching positions in other levels in the education system. Lee (2004) further stated that the lack of motivation for staff development might be due to the fact that in-service programmes are typically designed to cater to the masses in the district rather than appealing to the specific needs of teachers. Therefore, accurate data should be gathered and used in planning a successful programme.

There should be different kinds of in-service training offered to science teachers due to their various areas of specialisation. In-service training should be organized within working hours, with the possibility for the teacher to have reduced class contact hours while following a course. Effective professional development programmes should be designed to help teachers build new understandings of teaching and learning through direct experiences that introduce new strategies, which help students learn in new ways (Lee, 2001). The development of in-service programmes should be directed towards meeting the stated needs of teachers.

To make a profession attractive it is essential to offer a good education to those who will work in the profession. Teachers' must be involved in the planning, implementation and diffusion of curricula, since they are the implementers. The teacher herself/himself knows best her/his needs. The teacher should be given a large amount of freedom to choose the kind of training that he/she thinks is most appropriate. In-service training must be considered a fundamental right for teachers. If the importance of in-service training is to be properly recognized it cannot leave out the teacher during its organization.

Teacher retention, attraction and motivation packages should be enhanced especially for all science teachers as well as incentive packages for rural science teachers. Apart from the national and local awards currently running institutional heads in rural areas can also motivate their teachers in order to bridge the gap between the rural-urban divide. It is significant to note that, there exists a sharp contrast between the rural and urban areas in all the focal areas covered by this study.

The needs of rural science teachers are not being met as those of their urban colleagues (Lyons, 2008). Some of which include getting access to science equipment, chemicals just to mention but a few. Also, those who teach science at the Senior High School level are diverse and thus have very different needs (Kamisah, Lilia & Subahan, 2006).

In sum, the concept of quality teacher professional development is therefore about the process that entails empowering teachers with the potential or professional qualities enough to undertake teaching. It is a course of action destined to make teachers professionally (cognitively, affectively, pedagogically, andragogically, etc) alive. The prime aim of this study is to ascertain the in-service needs of Senior High School science teachers characterized by gender, school location, and area of specialization in the Central Region of Ghana.

2.1 NEEDS ASSESSMENT MODEL

Needs are defined, for example, as "the necessity of the organism to gain or, if need be, loose something" (Hartl, 1994). An unsatisfied need is sometimes reasoned by the lack of equilibrium, possibly accompanied by emotions: tension, dissatisfaction, fear, anxiety, uncertainty, anger, etc. Needs are not necessarily comprehended, so they can remain unsaturated for a long time. The same can happen with teachers educational needs.

According to Encarta (2007) a ‘need’ is to require something in order to have success or achieve a goal or to indicate that a course of action is desirable or necessary. Needs assessment is a process for determining and addressing needs, or "gaps" between current conditions and desired conditions, often used for improvement in individuals, education/training, organizations, or communities. The need can be a desire to improve current performance or to correct a deficiency. The idea of needs assessment, as part of the planning process, has been used under different names for a long time. In the past 50 years, it has been an essential element of educational planning. Over the past four decades, there has been a proliferation of models for needs assessment with dozens of models to choose from.

Considered the "father of needs assessment," Roger Kaufman first developed a model for determining needs defined as a gap in results This particular emphasis in results focuses on the outcomes (or ends) that result from an organization's products, processes, or inputs (the means to the ends). Kaufman argues that an actual need can only be identified independent of premature selection of a solution (wherein processes are defined as means to an end, not an end unto themselves). To conduct a quality needs assessment according to Kaufman, you first determine the current results, articulate the desired results, and the distance between results is the actual need. Once a need is identified, then a solution can be selected that is targeted to closing the gap. Kaufman's model in particular identifies gaps in needs at the societal level, what Kaufman calls "Mega" planning, along with gaps at the Macro (or organizational) and Micro level.

Analytical scrutiny of needs assessment model used in educational research indicates the availability of a variety of models such as Discrepancy Model (Sweigert & Kase, 1971), System Model and Organizational Needs Model (Kaufman, 1972), and Marketing Model (Kotler (1982). Based on his conception of training needs as "…a discrepancy between an educational goal and trainees performance in relation to this goal", Borich (1980; p.40) proposes another needs assessment model known as the Borich Needs Assessment Model. This model primarily focuses on (i) underlining the competencies, (ii) surveying the in-service teachers, (iii) ranking competencies, and (iv) comparing high priority competencies with training programme content.

Although Borich's (1980) model is widely used in determining the science teachers' needs. Witkins (1984) contends that there is no "best" or single universally accepted model of needs assessment in the educational field since its choices, procedures as well as instrument used to gauge the needs will depend on the purpose and context of the assessment study.

Reviews on empirical studies on science teachers' needs and the development of procedures for identifying and categorizing science teachers' needs have been a major educational agenda since the 1970s. The evolution of science teachers' needs instrument inaugurated with the development of Moore Assessment Profile (MAP) was further refined by Blakenship & Moore (1977) & Rubba (1981). Eleven years later, Kamariah, Rubba, Tomera & Zurub (1988) established the Science Teacher Inventory of Needs (STIN) which classifies the science teachers' needs into eight categories. The STIN was widely used primarily in Jordan and in Malaysia. It was further used and contextually refined by Baird & Rowsey (1989) by comprehensively administering the instrument to 1,870 science teachers across Alabama. In 1993, once again STIN was used by Zurub and Rubba in identifying the needs of

1,507 rural science teachers in Arkansas, Illinois, Oklahoma, Kansas, Tennessee and Texas. Until recently,the needs of the science teachers is still a major national agenda as evidenced in Dillon, Osborne, Fairbrother and Kurina (2000) and State of Delaware study (2002).It could be synthesized that from all the needs assessment study highlighted, the STIN's major outcome is the identification of contextualized science teachers' needs.

In Malaysia, a needs analysis study was initiated in an effort to establish empirical evidence of the science teachers' needs in meeting the challenges of science education. Kamariah (1984) first undertook a national needs assessment study to ascertain the needs of Malaysian science teachers five years after the implementation of the New Integrated Science Curriculum for Secondary Schools. At the primary level, currently there is only one comprehensive study conducted by Mohamad (2002). This literature served as a focal point to be used for this study, which specifically focuses on Senior High School science teachers' in-service needs a comparison across gender, school location and area of specialisation in the Central Region of Ghana using the Science Teachers Inventory of Needs (STIN).

2.2 DIMENSIONS OF SCIENCE TEACHERS INVENTORY OF NEEDS (STIN)

A 'dimension' is a psychological unit for describing a particular learning behaviour. More than one dimension constitutes a profile of dimensions(Integrated Science Teaching Syllabus,2007).Since the evolution of science teachers needs model, the STIN have continuously been refined to assess science teachers in-service needs in some developed and developing countries to establish empirical evidence and to improve science education (Zurub & Rubba, 1983). The refined STIN used to assess in-service needs of science teachers in some developed and developing countries showed different needs. This served as a direction for this study.

Strengthened pedagogical research based on these premises could be an important step in improving educational quality, by addressing science teachers' needs. The assumption underlying the needs model is that the science teacher can best judge his/her own performance and, when explicitly asked to do so can make an objective judgement.

Some of the dimensions in this study thus include management and delivery of science instruction, diagnosing and evaluating students for science instruction and generic pedagogical knowledge and skills. It further captures knowledge and skills in science subjects, administering science instructional facilities and equipment, as well as planning activities in science instruction. The last dimension is the integration of multimedia technology in science instruction.

2.2.1 Management and Delivery of Science Instruction

Management according to Encarta (2007) dictionary is the act of controlling or handling something successfully. Also it could be described as the skilful handling or use of resource. Management of science instruction is basically the skilful and experience in handling science instruction. According to Marsh (2000), effective instruction is not possible without effective management and as most of the science teachers have shown their lack in management skills, consequently, there will be ineffectiveness in delivering science instruction. Sometimes, the role of the science teacher is unique in comparison with that of other teachers in other subjects. Science teachers are required to perform many additional management tasks due to the large laboratory component of science lessons. Osborne and

Freyberg (1985) indicate that this is due to considerations such as safety, which can come into direct conflict with the instinctive desires of an excited student. Doyle, as cited by Conrath (1986) suggests that laboratory activities are more difficult than traditional classroom activities for securing cooperation from a large number of students. It is further suggested by Conrath (1986) that ineffective classroom managers will be reluctant to undertake laboratory activities. Consequently, ineffective management shown by the studied science teachers may lead to their reluctance in undertaking laboratory activities.

Classroom management skills are considered by Lang P. J. Van Goozen, S., Van de Poll, N. E. & Sergeant, J. A. (1994) as by far the most important aspect of a teacher's training and they state that effective classroom management starts with effective lesson preparation. Classroom management is largely concerned with discipline strategies, but other aspects are also of vital importance. The definition developed by Conrath (1986) for classroom management includes the organization and planning of students' space, time and materials so that instruction and learning activities can take place effectively. Alternatively, effective classroom management was divided into four main categories in the studies of Evertson & Emmer (1982) and Sanford (1984). These four categories are: classroom procedures and rules, student work procedures, managing student behaviour and organizing instruction. It is clear from these examples that classroom management is much more than a collection of strategies for discipline and involves many aspects of a teacher's professional expertise.

Teachers' varying approaches to classroom management are reflected in differing levels of effectiveness. For example, a well-prepared teacher has a much greater chance of achieving effective lesson management than an unprepared teacher. From the discussion of Lang *et al.* (1994), different approaches to discipline are said to range from intimidation to total permissiveness. They advised that such extremes should be avoided and in forming these individual approaches, teachers should include monitoring and enforcing reasonable classroom rules, procedures and routines. Effective teaching is more than discipline alone and classroom management has been closely linked to the achievement and engagement of high school science students (McGarity & Butts, 1984). The Ghanaian Senior High School science teacher in relation to the discussion of Lang *et al*. (1994) indicate that teachers' should be equipped and motivated to develop effective classroom management techniques which will have a significant impact on their educational effectiveness. This can be achieved through continuous professional training programme such as in-service training. The focus of this study is to identify the in-service needs of Senior High School science teachers to form a database for future in-service programme.

Classroom management can take up a considerable amount of a teacher's time. This time is generally focused on keeping the students on task and ensuring that the task is effective. One reason why these things do not happen naturally is because students' motivations do not match those of the teacher (McGarity & Butts, 1984). A study by Allen, as cited by Lang *et al*., (1994) indicated that students tend to have two major classroom goals, to "socialize" and "pass the course". From this it is evident that a student's desire to socialize may lead to disruptive and off task behaviour. The findings of Lang *et al*. (1994) indicate that students will learn best from teachers that combine positive reinforcement with preventative discipline, effective management, and interesting instruction. In light of this, effective management and instruction must allow students to socialize whilst learning interesting content. The amount of time spent on discipline may therefore be minimized with an appropriate form of classroom management.

The use of effective classroom management will be most effective when applied consistently throughout a pupil's schooling and should therefore be implemented school wide, if not system wide. At Balmain High School there has been a school wide approach to classroom management for some time. This approach was implemented through the adoption of the Glasser system. As discussed by Lang *et al*. (1994), this system is based on the ideas of Dr. William Glasser's "reality therapy". This approach focuses on the present behaviour and changing it for the better. Misbehaviour is viewed as a result of a bad choice on the part of the student, the teacher provides consequences (positive and negative) to help promote good decision making on the student's part and over time, the student comes to accept responsibility for his/her own behaviour. This system has been studied by Englehardt (1983) and proved effective over previous and competing models when implemented school wide. Not only does it address the behavioural aspects of classroom management, it also provides a general framework for the classroom environment and instructional techniques.

Since classroom management is clearly such a pivotal component of effective instruction it was chosen as one of the dimensions of this study. Due to the practical activities undertaken by the science teacher, more skill is required in some aspects of classroom management and therefore it is of great importance. This is to meet the goals of the dimensions emphasised in the teaching syllabi. This research also explored the role of classroom management in the teaching practice of the science teacher.

Effective teachers command a wide range of generic instructional techniques and use them appropriately. They manage efficiently both the students and the learning environment. Thus, instruction is organized and implemented to allow the schools' goals for students to be met. Educators are able to set the norms for social interaction among students and between students and teachers. Moreover, they understand how to motivate students to learn and how to maintain their interest even when facing temporary failure.

Accomplished teachers can assess the progress of individual students as well as that of the class as a whole. They employ multiple methods for measuring student growth and understanding and can clearly explain student performance to parents.

Science instruction management should reflect the way that science is practiced in the real world. While it isn't always practical or effective to use inquiry as the sole teaching method, inquiry should have a prominent place in every science classroom. When students are active participants in asking questions, designing procedures, carrying out investigations, and analyzing data, they take responsibility for their own learning, and begin to think like scientists. The issue of class management is one of the most challenging aspects of teaching and science teachers have to endeavour to learn as much as possible in order to improve. It is likely that organisers of in-service programmes consider this profile of dimension as a need for the Senior High School Science teacher.

2.2.2 Diagnosing and Evaluating Students for Science Instruction

Assessment means a broad area of monitoring or taking stock of the performance of students or the impact of programme. The teacher makes total assessment which includes a variety of procedures both quantitative and qualitative. The types of assessment usually considered in teaching are diagnostic, formative and summative.

Diagnostic assessment normally precedes instruction but may be used under special circumstances to discover students learning problems during instruction. It can also provide information to teachers about knowledge, attitudes and skills of students entering a course and can be used as a basis for individual remediation or special instruction.

Formative assessment is carried out during the instructional period to provide feedback to students and teachers on how well the material is being taught and how much of the subject matter the students have mastered in order to help them learn more or help the teacher to improve ongoing instruction. Since teaching is a dynamic process formative assessment can provide useful information that can be used to modify instruction and to improve teaching effectiveness for individuals and groups.

Summative assessment is the kind that is used most often by teachers and is primarily aimed toward providing students grades and reports of achievement and/or overall instructional method effectiveness. It is most frequently based upon cognitive gains and rarely takes into consideration other areas of the intellect.

The Ghana Education Service (GES) has evolved various models of evaluating the performance of pupils and students of all levels of education in the country. At the basic and second cycle levels, there is a system of continuous assessments by which the actual classroom performance of the student is assessed and computed at the end of every school term. This system of assessment has been replaced by the school based assessment (SBA).

It must be emphasised that both instruction and assessment be based on the profile dimensions of the subject. In developing assessment procedures, the teacher is to select specific objectives in such a way that he/she will be able to assess a representative sample of the syllabi objectives. Each specific objective in the syllabi is considered a criterion to be achieved by the student. When teachers develop a test that consists of items or questions that are based on a representative sample of the specific objectives taught, the test is referred to as 'Criterion- Referenced Test'. In many cases, a teacher cannot test all the objectives taught in a term, academic year etc. The assessment mode used that is class test, homework, projects etc must be developed in such a way that it will consist of a representative sample of the important objectives taught over a period.

The end of term examination is a summative assessment and should consist of a sample of knowledge and skills students have acquired in the term. For instance the end of term test for third term should be composed of items/questions based on the specific objectives studied over the three terms, using a different weighting system such as to reflect the importance of the work done in each term in appropriate proportions. It is important to link knowledge and skills gained in each term to the various end of term test. This will make students realise that they cannot learn something in the first term and forget about it. Knowledge is always continuous. Linking the end of term tests across the objectives studied in the various terms will bring this important concept home to pupils.

The new School Based Assessment (SBA) system is important for raising students' school performance. For this reason, the SBA marks will be scaled to the score of 50 in schools. The total marks for the end of term test will also be scaled to a score of 50 before adding the SBA marks and end of term examination marks to determine students end of term results. The SBA and end of term results/ will then be combined in equal proportions of 50:50. The equal proportions will affect only assessment in the school system. It will not affect the SBA mark proportion of 30% used by the West African Examinations Council (WAEC) for determining examination results at the end of Senior High School. Most science teachers are not conversant with the School Based mode of Assessment, in spite of this there is an utmost need to organise in-service programme in this regard for science teachers.

2.2.3 Knowledge and Skills in Science Subjects

Teachers are responsible to help students make sense of the science they are teaching. This is not a new idea, but one shared by scientists, researchers and science educators (Bybee, 2003: Bransford, Brown, & Cockling, 2000: Farber, 2000; Jackson & Davis, 2000; Rutherford, & Ahlgren, 1990; Smith, Wiser, Anderson, Krajick, & Coppola, 2004; Wilson, 1998). Coherence in science can be described as a set of ideas that are related to each other and represent a coherent structure with unifying concepts. These include energy transfer, diversity and evolution of living organisms that are hierarchically specified from elementary to high school (Bybee, 2003; NRC, 1996; Rutherford, 1964.).

Bybee further clarifies this by stating that "coherence occurs when small number of basic components are defined in a system, organized in conceptual relationship to each other, and other components are based on or derived from those basic components" (p.350). If this is the understanding of experts, do science teachers have this same understanding of science? If not, the expectation of the Curriculum may never be reached as teachers will not be able to help students understand science as a coherent discipline as outlined by the Curriculum (Bybee, 2003; NRC, 1996; Rutherford, 1964).

Research on teacher effectiveness has focused primarily on how much science a teacher knows rather than how teachers understand the science they teach in relationship to other ideas in science (Banilower, Smith, Weiss, & Pasley, 2003). So many well intentioned science reform efforts focus on improving content knowledge of teachers, however the objectives ends up not achieving its purpose. This situation handicaps the classroom teachers in helping students make conceptual connections in science (Banilower, Smith, Weiss, & Pasley, 2003). Literature about teacher knowledge and beliefs indicate that their knowledge and beliefs play a central role in those decisions about what content and how they teach that content (Abd-El-Khalick, Bell, & Lederman, 1998). Beginning teachers are characterized by having weaker content preparations and therefore demonstrating a lower quality of classroom discourse between the teacher and student (Bell and Gilbert, 1996), communicating alternative conceptions in science to their students (Klaassen & Lujnse, 1996; Lee, 1992), and lacking confidence in their subject area knowledge leading to fragmented and disjointed content (Abd-El-Khalick, Bell & Lederman, 1998; Lederman, GessNewsome, & Lantz, 1994). Bell & Gilbert (1996) stated that "Teachers' knowledge and beliefs about the content, their role as teachers, how students learn, and the context of school are a part of a web of beliefs that influence one another". Consideration of this evidence as it is related to the selection and interpretation of the content by teachers for their instruction is often neglected in reform efforts. If teachers do not think about accomplishing their learning goals through the selection of appropriate ideas that build to larger concepts, they will contribute to the fragmented, disconnected and incoherent learning experiences by students (Schmidt, McKnight, & Raizen, 1997; Apple, 1995). A coherent curriculum is one that has a sense of unity, connectedness, relevance and pertinence. Therefore the ideas have a sense of a larger purpose (Beane, 1995). Providing instructional experiences that make connections among science ideas within science may offer teachers new ways to help students learn science as stated in the National Science Education Standards (NRC, 1996). Understanding science requires students to integrate a complex structure of many types of knowledge, including the ideas of science, relationships between ideas, and reason for these relationships (NRC, 1996).

The depth of knowledge in a science skill is dependent on the era in which it is learned. Trying to apply a science skill to a more advanced era will result in severe penalties due to inadequate knowledge of tools, antiquated theories, and spurious notions. Many of these science skills are interdisciplinary, giving the science teacher and learner some skill in the related sciences. It also appears that knowledge and a skill in science subjects is a perceived need of science teachers. Hence in-service programmes in this regard should focus on this need of science teachers.

2.2.4 Generic Pedagogical Knowledge and Skills

The concept of pedagogical content knowledge is not new. The term gained renewed emphasis with Shulman (1986), a teacher education researcher who was interested in expanding and improving knowledge on teaching and teacher preparation that, in his view, ignored questions dealing with the content of the lessons taught. He argued that developing general pedagogical skills was insufficient for preparing content teachers as was education that stressed only content knowledge (Shulman, 1986).

Shulman (1987) defined pedagogical content knowledge as teachers' interpretations and transformations of subject-matter knowledge in the context of facilitating student learning. He further proposed several key elements of pedagogical content knowledge: (1) knowledge of representations of subject matter (content knowledge); (2) understanding of students' conceptions of the subject and the learning and teaching implications that were associated with the specific subject matter; and (3) general pedagogical knowledge (or teaching strategies). To complete what he called the knowledge base for teaching, he included other elements: (4) curriculum knowledge; (5) knowledge of educational contexts; and (6) knowledge of the purposes of education (Shulman, 1987). To this conception of pedagogical content knowledge, others have contributed valuable insights on the importance and relevance of the linguistic and cultural characteristics of a diverse student population (Shulman, 1987).

Pedagogical content knowledge is also known as craft knowledge. It comprises integrated knowledge representing teachers' accumulated wisdom with respect to their teaching practice: pedagogy, students, subject matter, and the curriculum. Pedagogical content knowledge is deeply rooted in a teacher's everyday work. However, it is not opposite to theoretical knowledge. It encompasses both theory learned during teacher preparation as well as experiences gained from ongoing schooling activities. Therefore the development of pedagogical content knowledge is influenced by factors related to the teacher's personal background and by the context in which he or she works. It is also deeply rooted in the experiences and assets of students, their families and communities. It therefore implies that when teaching subject matter, teachers' actions will be determined to a large extent by the depth of their pedagogical content knowledge, making this an essential component of their ongoing learning.

"Teachers' poor grasp of the knowledge structure of science acts as a major inhibition to teaching and learning". Strengthening science teachers' content knowledge should therefore be an essential component of any professional development programme. However, content knowledge is not enough, as indicated by Adler & Reed (2002), who write, "The issue is how to integrate further learning of the subject with learning about how students in school acquire subject knowledge". They suggest that teachers need to learn "subject knowledge for teaching", echoing the sentiments of veteran educator, Shulman (1986), who coined the term "pedagogical content knowledge''. Pedagogical content knowledge research links knowledge on teaching with knowledge about learning, a powerful knowledge base on which to build teaching expertise. Teachers think systematically about their practice and learn from experience.

Darling-Hammond (1999) refers to studies which have correlated teachers' courses in subject matter areas and scores on subject matter tests with student achievement. She concludes that the former show positive effects more frequently than the latter. Low variability in test scores is seen as the main reason for low and insignificant associations. Mastery of subject matter is seen as a basic requirement that is relatively uniformly addressed in initial teacher training. In this sense the explanation of the results in this area is the same as that for overall teacher education effects. Hawk, Coble & Swanson (1985) found that the relation between teachers' training in science and student achievement was greater in higher-level science courses.

Darling-Hammond (1999) lists some ten studies indicating that pedagogical training generally has a stronger effect than subject matter mastery. It should be noted that most of the studies referred to look at teaching methods related to subject matter.

As suggested by Byrne (1983), subject matter mastery is likely to interact positively with knowledge on how to teach the subject. The most frequently used analytical variables when attempting to explain why some teachers are more effective than others are mastery of subject matter and pedagogical knowledge. In the more recent research literature, an interactive construct, combining the two, namely "pedagogical content knowledge" appears to show promising results. The need for professional development in Pedagogical content knowledge is therefore advised.

2.2.5 Administering Science Instructional Facilities and Equipment

In 1995, the government of Ghana established the Science Resource Centres (SRC) project as part of the educational reforms of 1987. The SRCs were established in 110 senior secondary schools spread across Ghana one in each administrative districts. The idea behind this project was to bridge the gap between resourced schools and non-resourced schools within a forty kilometre (40km) radius. This project was initiated to help bridge the gap between schools with well resourced science laboratories (both human and material resources) and those with little or no resources. This was also to ensure equity in students learning across the rural-urban divide.

There are multiple, complex problems that contribute to learners' poor performance. These include poverty, resources, learning cultures, infrastructure of schools and low teacher qualifications which is very common in the rural areas. As a matter of fact some science teachers in the rural areas are non- professionals and ill resourced, this affects their lesson delivery. The non-professionally trained teachers find it challenging to teach the sciences' effectively with regards to administering science instructional facilities and equipment.

Inadequate science resource materials constitute an impediment to inquiry, hands-on and practical science activities in schools. Many classrooms reportedly lack appropriate science resource materials and supplies, which is often exacerbated by poor funding (Khale,Meece &Scatelbury,2000;Hewson et al., 2001; Ndiragu,Khathuri & Mungai,2003; Ogunkola,Olatoye & Erinosho 2005) as cited by Erinosho (2009). Consequently, teachers face great challenges to provide activity-based instruction (or science by doing) in the context of resource poor and ill-equipped classroom environment. Whilst a few resourceful teachers adopt innovative strategies to get materials to overcome the shortage, many others resort to 'blackboard practical' or 'chalk and talk' teaching that often leads to minimal learning.

There is no doubt that teaching science by 'doing' in a resource poor environment requires dedication and creativity on the part of the teacher. This is because of the heavy reliance of hands-on, inquiry-oriented instruction on supplies and equipment. Essential and sophisticated materials, especially those that require high precision in their design and/or use must be purchased. However, the commonly available materials could be sourced from the immediate locality and resources outside the classroom.

How well a teacher is able to identify and source for local substitute or design prototype depends on his/her ingenuity and ability to use the hands and brain. Teachers must develop skills and competencies to:

- Conceptualise – bring into focus the original idea underlying the material to be improvised
- Dismantle- separate into parts all the components
- Identify parts- separate parts in the system to establish the the relationship and interdependence of the parts
- Source of alternatives- identify substitute or replacement for the parts ; and
- Assemble/ Construct- fabricate or construct substitute of the different parts and assemble them carefully and appropriately.

2.2.6 Planning Activities in Science Instruction

Planning is a deliberate process that results in teachers being well-prepared prior to walking through the classroom door for the day (Wharton-McDonald *et al*., 1998). Organizing time and preparing materials in advance of instruction have been noted as important aspects of effective teaching. The amount of time students spend engaged in learning experiences, together with the quality of the instruction, is positively associated with student learning (Walberg, 1988). Both the organization of time and the preparation of materials are components of the broader practice of planning carefully for instruction. Once the plans are developed, evidence suggests that effective teachers follow the instructional or lesson plan while continuously adjusting it to fit the needs of different students (Wharton-McDonald *et al*., 1998).

Pre-assessments can help gauge students' prior knowledge of the material (Wharton-McDonald *et al*., 1998). Effective teachers take into account the abilities of their students and the students' strengths and weaknesses as well as their interest levels. A study of teacher expectations revealed that teachers who had high classroom standards also planned in response to individual student performance, which was then linked to student achievement (Wharton-McDonald *et al*., 1998). Teachers that plan instruction, based on student performance and interest levels meet both the affective and cognitive needs of students.

Novice teachers have more difficulty responding to individual student needs in their planning. They tend to develop a "one-size-fits-all" approach to planning, whereas more experienced teachers build in differentiation and contingencies at different points during the lesson (Good & Brophy, 1986; Borko, 2004).

Effective teachers maximize the instructional benefits of resources while minimizing time allocated to less relevant or unnecessary material. They also evaluate resources to use when teaching a unit or lesson. They use criteria such as appropriateness for grade level; alignment to national, state, or local standards; accuracy of information contained within the resource; the time allowed for the lesson or unit; and the learning benefits that come from using the resource (Puttam, 1996). For example, when showing a video on the causes of the illegal mining, the teacher may select only a poignant quote or section from the video, rather than showing the entire segment.

Teachers also recognize that other adults (resource persons) can be a resource for the learning process. They coordinate the participation of adults in order to promote student engagement (Pressley *et al*., 1998; Wharton-McDonald *et al.,* 1998). In summary, effective teachers through planning maximize the instructional benefits of resources while minimizing time allocated to less relevant or unnecessary material. Since students learn at different rates, effective teachers plan academic enrichment and remediation opportunities for students. Through the teacher's knowledge of the students, it is possible to offer alternatives to a student or a small group of students who have mastered the material faster than the rest of the class. These students can study the concept on a deeper level or apply the concept in a different way. Students who may lack the prerequisite knowledge or skills need the teacher to give them time to learn the foundational material on which to build the new piece. Providing meaningful experiences for all students to learn is a goal of planning.

By planning a unit, that takes into account the students' prior knowledge and prior performance as well as their learning styles, a teacher can implement effective models for instruction (Wharton-McDonald *et al.,* 1998). Whatever the unit, students benefit if the material can be connected to something they are already familiar with from prior school experiences or real-life situations. Also conscientious planning for student instruction and engagement is a key to connecting the classroom to future success for students.

Research indicates that instructional planning for effective teaching includes the following elements as cited by Wharton-McDonald *et al.,* (1998).

- Identifying clear lesson and learning objectives while carefully linking activities to them, which is essential for effectiveness (Cotton, 2000; Wang *et al*., 1993b; Wharton-McDonald *et al*., 1998).

- Creating quality assignments, which is positively associated with quality instruction and quality student work (Clare, 2000).

- Planning lessons that have clear goals, are logically structured, and progress through the content step-by-step (Rosenshine, 1986; Zahorik *et al*., 2003).

- Planning the instructional strategies to be deployed in the classroom and the timing of these strategies (Cotton, 2000; Johnson, 1997).

- Using advance organizers, graphic organizers, and outlines to plan for effective instructional delivery (Marzano, Norford, Paynter, Pickering, & Gaddy, 2001; Wang *et al.,* 1993b).

- Considering student attention spans and learning styles when designing lessons (Bain & Jacobs, 1990).

- Systematically developing objectives, questions, and activities that reflect higher-level and lower-level cognitive skills as appropriate for the content and the students (Brophy & Good, 1986; Porter & Brophy, 1988).

It therefore appears that these elements of planning activities in science instruction are needed for Senior High School science teachers' in-service programmes.

2.2.7 Integration of Multimedia Technology in Science Instruction

The rapid development in Information Communication and Technologies (ICTs) have made tremendous changes including education in the twenty-first century, as well as affected the demands of modern societies (Tomei,2005). Recognizing the impact of new technologies on the workplace and everyday life, today's educational institutions try to restructure their educational programmes and classroom facilities, in order to minimize the teaching and learning technology gap between developed and the developing countries. This restructuring process requires effective diffusion of technologies into existing context in order to provide learners with knowledge of specific subject areas, to promote meaningful learning and to enhance professional productivity (Tomei, 2005).The use of Information Communication Technology (ICTs) in Ghanaian schools and African countries is generally increasing and dramatically growing (Tella & Adeyinka, 2007). However, while there is a great deal of knowledge about how ICTs are being diffused and used in high schools in developed countries, there is not much information on how ICTs are being diffused and used by teachers in Ghanaian schools. There is also an assumption that there are wide gaps in the use of ICTs between rural and urban schools (Aduwa-Ogiegbaen & Iyamu, 2005).

The Government of Ghana has placed a strong emphasis on the role of ICT in contributing to the country's economy. The country's medium-term development plan captured in the Ghana Poverty Reduction Strategy Paper (GPRS I&II) and the Education Strategic Plan 2003-2015 all suggest the use of ICT as a means of reaching out to the poor in Ghana (Government of Ghana, 2002). In 2004 the Ghanaian Parliament passed into law Ghana's ICT for Accelerated Development (ICT4AD) policy bill, which is currently at various stages of implementation. Out of this policy the Ministry of Education produced an ICT in education framework document to integrate ICTs in schools.

ICT constitutes computers, internet, radio and television broadcast and telephony. Teachers should learn to integrate ICT in school science due to globalization and technological changes, global economy, powered by technology, fuelled by information and driven by knowledge.

The computer has witnessed a wide range of applications in virtually all human endeavours. It has also found its way into the classroom, and educators now look in its way as a panacea to prevalent pedagogical challenges. Researches have indicated that appropriate use of the computer for science instruction facilitates teaching and learning (Rubin, 1996).

Information Communication Technologies (ICT's) into science instruction must be accelerated at the different levels of education especially Senior High Schools. ICT can help extend educational opportunities just as the Ghana Television (GTV) series on the Presidential Special Initiative on learning science. The use of videos, television, multi-media computer software combining sound, text, moving images and colour increase motivation (Williams, Wilson, Richards, Tuson, & Coles, 1999). It also facilitates acquisition of basic skills such as the use of computer assisted instruction programmes – drill and practice, tutorials (Williams, Wilson, Richardson, Tuson, & Coles, 1999).

More to the point, ICT creates a learner centred environment by catalyzing a paradigmatic shift in both content and pedagogy thus:

- Promotes Active learning – learner engagement to activities, participation in real-life situations
- Promotes Collaborative learning – interaction and cooperation among learners
- Promotes Creative Learning – engaged in finding new solutions problems
- Promotes Evaluative Learning – learners explore and discover

Finally the benefits of integrating multimedia technology instruction in science teaching and learning entails;

- Strengthening the creation, processing, storing and sharing of information as a continuous communication cycle.
- Providing income generating opportunities (e.g. outsourcing).
- Improving governance.
- Making geographical, social, economic and political borders irrelevant at the macro level.

In the past few decades, science curriculum has changed to match the new aims of science education and it will continue to change (Osborne & Hennessy, 2003) as cited by Aduwa-Ogiegbaen & Iyamu, (2005). Osborne & Hennessy (2003) again stated that the latest move towards ‘ ‘teaching about science rather than teaching its content will require a significant change in its mode of teaching and improved knowledge and understanding in teachers’ ’ (p.4). They emphasised that along with the changes in views on the nature of science and the role of science education. Also the increase in the number of ICTs offers a challenge to science teaching and learning.

Potential benefits from the use of ICT for science learning have been reported in several research studies. One of these potential benefits is the encouragement of communication and collaboration in science research activities. According to Gillespie (2006), new technologies can be used in science education to enable students to collect science information and interact with resources, such as images and videos, and to encourage collaborative communication. Murphy (2002) reviewed the impact of ICT on teaching and learning of science in schools. She indicated that ‘ ‘the internet is used in science both as a reference source and a means of communication’ ’ (p.24). New technologies may also help to increase student motivation (Osborne & Collins, 2000) cited by Murphy (2002), facilitate clearer thinking, and develop interpretation skills with data.

Another benefit from using ICT in science education is to expand the pedagogical resources available to science teachers (Murphy, 2002). Pickersgill (2003) explored effective ways of utilising the internet when teaching science. He found that the ease of internet access allows teachers to help students to become experts in searching for information rather than reviewing facts. He claimed it could ‘ ‘increase students awareness of the importance of the world around them, of citizenship and of a scientifically literate community' ' (p.86).Kelleher (2000) as cited by Murphy (2002) reviewed recent developments in the use of ICT in science classrooms. He wrote that ICT cannot replace normal classroom teaching. The review indicated that ICTs could be positive forces in science classrooms for a deeper understanding of the principles and concepts of science and could be used to provide new, authentic, interesting, motivating and successful educational activities.

The new ICTs have other potential benefits as tools for enhancing science teaching and learning in schools (Tomei, 2005). These tools include those for data capture, multimedia software for simulation, publishing and presentation tools, digital recording equipment, computer projection technology and computer-controlled microscopes (Osborne & Hennessy, 2003) as cited by Aduwa-Ogiegbaen & Iyamu, (2005).

However, although the use of educational technologies in the classroom has many advantages, in-service programmes should pay attention to these needs of Senior High School science teachers.

2.3 GENDER ISSUES

Although literature is however silent on the needs of gender with regards to science teachers' needs; this study on Senior High School science teachers' in-service needs a comparison across gender, school location and area of specialisation in the Central Region of Ghana intends to touch on it.

2.4 IN-SERVICE TRAINING PROGRAMMES IN GHANA

Training can also be said to be the process of acquiring specific skills to perform a job better (Jucious, 1963). It helps people to become qualified and proficient in doing some jobs (Dahama, 1979). Usually an organization facilitates the employees' learning through training so that their modified behaviour contributes to the attainment of the organization's goals and objectives. Van Dorsal (1962) defined training as the process of teaching, informing, or educating people so that (1) they may become as well qualified as possible to do their job, and (2) they become qualified to perform in positions of greater difficulty and responsibility.

Flippo (1961) differentiated between education and training, locating these at the two ends of a continuum of personnel development ranging from a general education to specific training. While training is concerned with those activities which are designed to improve human performance on the job that employees are at present doing or are being hired to do, education is concerned with increasing general knowledge and understanding of the total environment. Education is the development of the human mind, and it increases the powers of observation, analysis, integration, understanding, decision making, and adjustment to new situations.

Training may broadly be categorized into two types: pre-service training and in-service training. Pre-service training is more academic in nature and is offered by formal institutions following definite curricula and syllabuses for a certain duration to offer a formal degree or diploma. In-service training, on the other hand, is offered by the organization from time to time for the development of skills and knowledge of the incumbents.

In-service training is a process of staff development for the purpose of improving the performance of an incumbent holding a position with assigned job responsibilities. It promotes the professional growth of individuals. "It is a program designed to strengthen the competencies of science teachers while they are on the job" (Malone, 1984). In-service training is a problem-centred, learner-oriented, and time-bound series of activities which provide the opportunity to develop a sense of purpose, broaden perception of the clientele, and increase capacity to gain knowledge and mastery of techniques.

Although teachers play a crucial role in the implementation of new/ innovative curricula they are not duly informed about the organisation of orientation or professional development courses. The traditional top-down approach is what the central staff of the Curriculum Research Development Division (CRDD) use, in which most often teachers are blamed for the failure of new educational reforms or curriculum innovations. In this regard change is viewed as transmission of ideas from curriculum developers/researchers to teachers. Professional development programmes should be designed to result in collaborative programme. This means that teachers, administrators, supervisors, non-teaching staff, students and lay persons should be involved. Such programmes should be grounded on the needs of the participants of the study, thus Senior High School science teachers'. That is, the plan should be developed from an assessment of the needs and interests of the persons to be served.

Once training needs have been identified and training activities have been decided as part of the solution, a needs analysis should be done. This is to determine knowledge, skills, and attitude requirements as well as performance deficiencies. The needs analysis procedure involves breaking down the "training problem" into its basic parts in different successive phases to identify and understand the important components in each phase. Ultimately it leads to identifying and understanding the training content. The training needs analysis process can be divided into three distinct analytical phases: job analysis, task analysis, and knowledge and skill-gap analysis.

Again, in-service teacher training has more and more been considered as "provision of services", or rather "saturation of needs" of teachers and head-teachers (Joyce *et al*. 1993). With regards to teachers educational (and some other kinds of) needs and expectations is one major precondition of a successful educational event, and studies have shown that many teachers call for more respect and more preference to their individual needs (Hustler, 2003). It is important to realize that any trainer needs two separate sets of skills and knowledge. First, they need to know the topic they are teaching (subject matter expertise). And second, they need to know how to transfer that information to the student (instructional expertise).

2.5 INFLUENCE OF SCHOOL LOCATION ON THE NEEDS OF THE SCIENCE TEACHER

As countries in Sub-Saharan Africa expand access to education, geographic location influences science teachers' needs especially in hard-to-reach rural areas. Provision of educational services for these areas presents a series of problems particularly, is the deployment of teachers to rural schools.

2.5.1 Deployment of Teachers to Rural Schools

In many countries, urban areas have qualified teachers who are unemployed, while rural areas have unfilled posts. This pattern of simultaneous surplus and shortage is strong evidence that the problem of finding teachers for rural schools will not be solved simply by producing more teachers. There are quite a few constraints on teacher deployment to rural schools.

The rural-urban disparity in living conditions is the major constraint on attracting teachers to rural areas. Many countries report that teachers express a strong preference for urban postings because living conditions in general are so much better in urban than in rural areas. Teachers often express concerns about the quality of accommodations; the working environment, including classroom facilities and school resources; and access to leisure activities and public facilities in rural areas.

Limited opportunities for professional advancement in rural areas also discourage teachers. Urban areas offer teachers easier access to further education and training, while rural areas offer limited opportunities to engage in developmental activities such as national consultations, including those with representative organizations. Teachers in rural areas may even find it more difficult to secure their entitlement to professional development from regional educational administrations and must overcome many obstacles, including corruption by officials.

Diversified local languages and ethnicities can also create barriers for teachers' immersion in rural communities. Deployment is further complicated by the presence of multiple ethnic or linguistic groups within a country. Teachers may be reluctant to locate in an area where the first language is different from their own. For example, in Malawi, student teachers come /from various ethnic groups with different first languages, which can pose problems for their deployment in areas with a different dominant language group. Similarly in Ghana, the first language is not a criterion for teacher posting but may be very relevant to the experience of teachers. Where a teacher is not fluent in the language spoken locally, he or she may feel isolated professionally and socially.

Socioeconomic background may also make teachers reluctant to be deployed to less-developed parts of the country. This is particularly the case when the overall access to tertiary education is limited and the majority of higher education students are from the better-off urban families.

There are also specific difficulties of placing female teachers in rural schools. Female teachers may be even less willing to accept a rural posting than their male counterparts, resulting in rural areas having fewer female teachers than urban areas. In some cases, posting single women to unfamiliar areas may cause cultural difficulties and even be unsafe. For an unmarried woman, posting to an isolated rural area may also be seen to limit her marriage prospects. In some countries, single women are not posted to rural areas as a matter of policy. For a married woman, a rural posting may mean separation from her family, as her husband may be unwilling or unable to move for cultural or economic reasons.

The gender distribution of teachers has important implications for gender equity in school enrolment. Across Sub-Saharan Africa, enrolment and retention are lower for girls than for boys. The underrepresentation of girls tends to be greatest in rural areas and the most disadvantaged communities. While a number of measures can be shown to have an impact on the retention of girls in school, one of the important factors is the presence of female teachers. Female teachers can help to make the school environment more supportive and nurturing for girls. Many girls in Africa are forced to drop out of school because school administrators are insensitive to gender issues. In addition, the presence of females in positions of responsibility and leadership in schools is an important factor in creating positive role models for girls.

Health and HIV/AIDS concerns also contribute to teachers' unwillingness to work in rural schools. Living in rural areas often involves poor access to health care. The prevalence of HIV in rural areas and the lack of medical facilities have made rural postings even less attractive to teachers. In some cases; teachers who are ill are posted to urban centres to allow them access to medical services. Although they do little to enhance the teaching in urban areas, their absence from rural areas further enhances the rural-urban divide. In Ghana, poor health is the most common reason given for early transfer from rural areas. When this happens the need for an experienced and professionally trained science teacher is lost to an urban area.

Stephens (2003) asserts that, quality is directly related to what occurs in two educational contexts: firstly in the more focused environment of the classroom; secondly in the wider context of the school system and social context in which the classroom is embedded. Stephens (2003) emphasizes that both environments have a reciprocal relationship with each other.

Paradoxically, 70% of Ghana's foreign exchange is derived from Gold, Cocoa and Non –Traditional Exports all of which are either found or produced in rural areas. But rural areas receive very little from the foreign exchange earnings of such export in terms of development and provision of quality social and economic infrastructure and services.

It is significant to note that, there exists a sharp contrast between the rural and urban areas in all the focal areas identified. In terms of numbers of teachers at post, urban districts have enough, best qualified and well experienced. Teaching and Learning materials are hardly kept well and over a long period in rural areas, partly because of lack of good infrastructure that can safely protect the TLMs, hence they waste away causing gaps in the application of these tools.

This is not so with the urban areas, they have good accommodation to store the TLMs. The state of most rural schools' infrastructure, (except the few that have been supported by foreign donors) can not be accepted to be of any good standard which would promote effective teaching and learning. The gaps in supervision and disparities in social amenities have all pointed to the sharp disparity that exists in the delivery of basic education between the rural and urban settings, which needs very urgent and appropriate steps to bridge the gap in order to promote quality education for all in Ghana. According to the current educational reforms of 2007, conditions of service of the rural teacher shall be improved.

The Government of Ghana (GoG) is seen demonstrating commitment towards achieving 'Education For All', through its poverty reduction strategy; central to this strategy is the provision of quality education. The Ministry of Education, Science and Sports' four thematic areas (of equitable access, quality of education, educational management, and science and technology) outlined in the Education Sector Performance Report (2007), coupled with policies and programmes including Capitation Grant, the Ghana School Feeding Programme, upgrading of Teacher Training Colleges to Diploma awarding institutes are part of GoG's commitment.

Although Government demonstrates its commitment through these programmes, there are un-resolved challenges and inequities associated with the programmes, which translate into issues of exclusion in the educational sector. The quality of education infrastructure in rural areas as well as the quality and quantity of teachers, teaching learning materials and other educational resources is directly reflective of the attention paid to rural education.

2.6 AREA OF SUBJECT SPECIALISATION

Subject matter which is an essential component of teacher knowledge is neither a new nor a controversial assertion. After all, if teaching entails helping others learn, then understanding what is to be taught is a central requirement of teaching. The myriad tasks of teaching, such as selecting worthwhile learning activities, giving helpful explanations, asking productive questions, and evaluating students' learning, all depend on the teacher's understanding of what it is that students are to learn.

Although subject matter knowledge is widely acknowledged as a central component of what teachers need to know, research on teacher education has not, in the main, focused on the development of teachers' subject matter knowledge. Researchers specifically interested in how teachers develop and change have focused on other aspects of teaching and learning to teach. For example, changes in teachers' role conceptions, their beliefs about their work; their knowledge of students, curriculum, or of teaching strategies. Yet to ignore the development of teachers' subject matter knowledge seems to belie its importance in teaching and in learning to teach. Literature is however silent on the needs of science teachers with regards to their areas of specialisation. In addition to this, science teachers’ needs vary with regards to their areas of subject specialisation. The need of the biology teacher is different from that of the chemistry, physics, integrated science and other science related areas. It is more likely that both professionally trained and untrained science teachers be given in-service training in their areas of subject specialisation.

CHAPTER THREE

METHODOLOGY

3.0 OVERVIEW

This chapter deals with the method and instrument used in acquiring information for the study. Under this chapter, the Research Design and Population are covered. It continues with Sampling, Instrumentation and Pilot Testing of the Instrument. Other topics include Reliability and Validity of the Instrument. The chapter ends by focussing on Data Collection Procedure and Data Analysis.

3.1 RESEARCH DESIGN

The research design employed in this study was a survey research design using a questionnaire as the instrument. Survey studies are usually used to find the fact by collecting the data directly from population or sample. It is the most commonly used descriptive method in educational researches. The researcher collects the data to describe the nature of existing condition or look forward the standards against existing condition or determine the relationships that exists between specific events (Cohen & Manion, 1994) The survey design was chosen so that generalizations could be made from the samples representing the population (Creswell, 2005; Kerlinger & Lee, 2000).

Many a time survey study intends to understand and explain the phenomena in a natural setting or provide information to government / other organization or compare different demographic groups or see the cause and effect relationship to make predictions. Neuman (2000) argues that such an approach can be justified in terms of the nature of information gathered. This study gathered information on Ghanaian Senior High School science teachers' in-service needs based on gender, school location and area of specialization. The nature of such data justifies the suitability of the survey design employed.

3.2 POPULATION

A population is any group of individuals that have one or more characteristics in common that is of interest to the researcher (Best, 1993). Target population refers to the entire group of individuals or objects to which researchers are interested in generalizing the conclusions. The target population was made up of all Senior High School science teachers in Ghana. The accessible population is the population in research to which the researchers can apply their conclusions. This population is a subset of the target population and is also known as the study population. It is from the accessible population that researchers draw their samples.

The accessible population were all science teachers in Senior High Schools in the Central Region of Ghana. Reasons for the selection of the accessible population were that smaller populations gives an in depth view of a research. More to that, the researcher due to time and financial constraints decided to use them. Also the accessible population will offer more detailed information and a high degree of accuracy because of their relatively small number(s). Finally in many cases, a complete coverage of the entire population is not possible.

3.3 SAMPLING PROCEDURE

Sampling refers to the processes of selecting a portion of the population to represent the entire population (Encarta, 2007). Sampling enabled the researcher to study a relatively small number of units in place of the target population because inferences were been made about the population with data collected from the sample. Appropriate sample size was needed for the credibility of the results because it addresses the survey population in a short period of time by producing comparable and equally valid results. Also the larger the sample the better the results of the study. All this, was to obtain data that was representative of the whole target population of 418 science teachers in the Central region of Ghana.

A number of sampling techniques were used to obtain a representative sample of the accessible population. Convenience sampling is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher (Castillo, 2009).Convenience sampling was used to obtain the number of science teachers in the study and the districts visited. As a result, 156 science teachers were selected as respondents for this survey. All science teachers in the 21 Senior High Schools were used for this study due to their low numbers.

In all forms of research, it would be ideal to test the entire population, but in most cases, the population is just too large that it is impossible to include every individual. This is the reason why most researchers rely on sampling techniques like convenience sampling, one of the common types of all sampling techniques. Many researchers prefer this sampling technique because it is fast and the subjects are readily available.

Another sampling technique used was stratified sampling."Stratified sampling" is a way of getting an 'average' which represents the entire population or every thing that exists that somebody wants to count or measure (Castillo, 2009). The entire population is broken down into groups that do not overlap and a 'sample' is taken from each group (Castillo, 2009).

Stratified random sampling technique was used to obtain the stratified sample of the respondents (science teachers) taking into consideration; the gender of the respondents (male vs. female), geographical location of the schools involved (rural vs. urban) and the respondents' area of specialization (physics, chemistry, biology, integrated science and others**).** Stratified sampling thus involves the division of the population into a number of homogenous groups or strata. Each group contains subjects with similar characteristics. A sample is then drawn from each group or stratum. The sub samples (male vs. female, rural vs. urban, physics, chemistry, biology, integrated science vs. others) make up the final sample for the study. The table below summarises the demographic data of science teachers who participated in this study. Localities of 5,000 persons and above have been classified as urban since 1960, whiles rural localities have less number of persons (GSS, 2011).

Table 1: School location by Gender and Area of subject Specialisation

Location of Schools	Gender	Major Academic Course					
		Physics	Chemistry	Biology	Integrated Science	Others	Total
Urban	Male	15	24	25	13	7	84
	Female	3	2	11	6	1	23
Rural	Male	7	12	9	8	12	48
	Female	0	1	0	0	0	1
Total		25	39	45	27	20	156

3.4 INSTRUMENTATION AND SCORING

The instrument Science Teacher Inventory of Needs (STIN) developed by Zurub and Rubba (1983) was adapted for this study (APPENDIX A). The instrument is made up of two sections (A and B), where section A involves the demographics or bio data of the respondents. Section B was made up of 72 items distributed among seven dimensions followed by a five-point Likert scale.

Since the instrument is adapted for use by the researcher some pertinent changes in the questionnaire was made to suit the Ghanaian context. For instance in the demographic section, items on ethnicity was dropped and highest level of education with regards to SPM and STPM were changed. Another change was the current status as teacher (probation and temporary), subjects that the teacher is teaching now with regards to lower and upper secondary were changed to suit the Ghanaian context. In ending the demographic section, subjects taught with number of years teaching were also changed to fit into our system.

Some statements in the questionnaire were also rephrased like inculcating spiritual values in science teaching was modified to read, inculcating cultural values in science teaching this is because cultural values is identified in the science curriculum. The drafted version of the adapted instrument also consisted of two sections. Section one was seeking information on the demographic characteristics of the respondents, whiles section two consisted of 70 items pertaining to in-service needs of science teachers (Appendix B).

Some unsuitable statements identified in the original questionnaire include;

1. Inculcating spiritual values in science teaching. (Item, 23).
2. Implementing PEKA (Assessing students' laboratory skills) as required. (Item, 28).
3. Managing the budget for science teaching. (Item, 36).

These statements were corrected to read;

1. Inculcating cultural values in science teaching.
2. Assessing students' laboratory skills as required.
3. Managing the laboratory for science teaching.

In the scoring of the instrument, statements in the questionnaire were assigned with numbers 5, 4,3,2,1 and 0 quantitatively. There were a group of questions with categories of items pertaining to the in-service needs of science teachers. Which respondents were to read carefully and tick in the given boxes based on the scales below:

- A= Strongly Required 5

- ❖ B= Moderately required 4
- ❖ C=Not required because not practiced 3
- ❖ D= Not required because has experience 2
- ❖ E= Strongly not required 1
- ❖ F= Not sure of request 0

Each item constituted a statement, which was followed by a five-point Likert scale ranging from (0) not sure of requirement (1) strongly not required (2) not required because has experience , (3) not required because not practiced (4) moderately required and (5) strongly required. The science teachers' perceived needs of this study are categorized into seven distinct dimensions whereas the original had eight dimensions.

Table 2: The distribution of items for each dimension of science teachers' needs

Dimension	Number of items	Item distribution(Question)
Management of science instruction	16	11, 16, 19, 22, 23, 24, 27, 29,30, 31, 32,33, 34, 35, 37, 38,
Diagnosing and evaluating students	11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 28
Generic pedagogical knowledge and skills	14	56,57, 58, 59, 60, 61, 62, 63, 64, 65,66, 67, 68, 69

Knowledge and skills in science subjects	7	49,50, 51, 52, 53, 54, 55,
Administering science instructional facilities and equipment	10	35,39, 40, 41, 42, 43, 44, 45, 46, , 48
Planning activities in science instruction	8	12, 13, 14, 15, 17, 21, 25, 26
Integration of multimedia technology in science teaching	4	18, 20, 47, 70

3.5 PILOT TESTING OF THE INSTRUMENT

Pilot testing involves conducting a preliminary test of data collection tools and procedures to identify and eliminate problems, allowing programs to make corrective changes or adjustments before actually collecting data from the target population.

The instrument was pilot tested with a sample of 27 Senior High School science teachers (20 teachers from an urban Senior High School and 7 teachers from a rural Senior High School). This ensured a representation of both rural and urban schools and also ensured that problems are addressed from all angles before the main survey. The pilot test was a method used to test the instrument prior to carrying out the research. The teachers were presented with the questionnaire in their various schools. The teachers were again taken through the questionnaire to clarify any unsuitable items in the questionnaire. Some teachers needed extra time to study the items carefully. They were then asked to take the questionnaire home to enable them have enough time to complete it. This was likely to have an effect on the reliability of their responses since the questionnaire was to be completed in their homes or because it's not in a controlled environment. To forestall this, the respondents were informed that the questionnaire was not a test and their responses will not be used to change their status or affect their promotion. Also there were no correct or wrong answers in responses. The intention of the question was to find out their opinions of issues affecting science teaching and learning. To also encourage them they were not to write down their names this was to ensure anonymousity.

After several consultations with the research supervisors and some colleagues, the researcher adapted the questionnaire for use after the pilot test.

3.6 RELIABILITY AND VALIDITY OF THE INSTRUMENT

The reliability of the science teachers' needs assessment instrument is ascertained using the internal consistency approach. This was to reduce costly mistakes and prevent threat to validity of the research. The Cronbach alpha is the preferred index of reliability measure since Ary, Jacobs and Razarieh's (1990) advised that "Cronbach alpha is used when measures have multiple-score items in attitude scales". From table 2, management of science instruction, diagnosing and evaluating students, generic pedagogical knowledge and skills and planning activities in science instruction had internal consistency reliability coefficients of 0.94, 0.90, 0.95 and 0.90 respectively, which are all excellent indications. Knowledge and skills in science subjects and administering science instructional facilities and equipment dimensions had internal consistency reliability coefficients of 0.88 and 0.86 respectively which are good. Finally integration of multimedia technology in science teaching had an internal consistency reliability coefficient of 0.75 which is acceptable (Table 2). However, causes of measurement error or invalidity were as a result of the unsuitable statements like inculcating spiritual values in science, managing the budget for science etc. From table 2, the Cronbach alpha values range from 0.75 to 0.95. It was also found that, the number of items for each dimension did not have any significant impact on the reliability index. For instance, the alpha value generated from planning activities in science instruction dimension (n = 8) is not much different from the alpha value generated from diagnosing and evaluating students dimensions (n = 11).

George and Mallery cited in Gliem and Gliem (2003) provide the following rules of thumb; "> 0 .9 as Excellent", "> 0.8 as Good", "> 0.7 as Acceptable", "> 0.6 as Questionable", "> 0.5 as Poor, and "< 0.5 as Unacceptable". George and Mallery further recommend that Cronbach's alpha of 0.8 is probably a reasonable goal while a minimum level of 0.7 for the internal consistency of the items from the pilot test indicates that the questionnaire was reliable.

The same test, when employed for different purposes should be validated in rather different ways. Considering the main function of the instrument which was to identify science teachers in-service needs developed in this study. It was reckoned that the most suitable approach for establishing the validity is construct validity. By definition, construct validity of a measure is directly concerned with the theoretical relationship of a variable with other variables. It refers to the extent in which a measure "behaves" the way the construct purports to measure with regard to established measures of other constructs. In research, it appears that most studies attempt to maximize both their internal and external validity.

Internal validity addresses how valid it is to make causal inferences about the intervention in the study. The most common threats to internal validity are selection bias, history, maturation, test-retest, differential attrition, and regression towards the mean. The main elements in study design that address internal validity are the use of a treatment and control group, as well as random assignment. By randomly assigning participants, you can be sure that any difference between the treatment group and control group is due to chance alone, and not selection bias.

External validity addresses how generalizable the study's inferences are to the general population. A study's external validity is both dependent on, and at odds with, internal validity. A study that has little to no internal validity cannot claim a causal effect of an intervention, and thus, cannot be generalized. However, in order to strengthen internal validity, studies tend to focus on specific populations (for example, the effects of an intervention on SHS students reading science in the Sekondi-Takoradi metropolis). Limiting the scope of a study allows for greater control over the characteristics of the treatment and control group, as well as some control over history and maturation, the results are less likely to be generalizable. What works for public school students in Cape Coast may not work for students in rural Assin Nsuta because the populations are different.

The construct validity of the needs instrument was established by employing the confirmatory factor analysis. As suggested by De Vaus (2001), "… this inductive approach to scaling clusters item that go together" and extracting items based on the samples respond consistently in harmonious ways. Face validity is concerned with how a measure or procedure appears. It is also a reasonable way to gain information researchers wish to attain. In this regard the face validity of the instrument in the Ghanaian context is expected to work and could be relied on.

In the confirmatory factor analysis, the first step involved extraction of factors via principal component analysis. The Eigen value represents a measure that attaches to the factors and indicates the amount of variance in the pool of original variables that the factors explain. Each construct (factor) will be retained if its Eigen value is more than 1.

The second step involved factor rotation. Varimax rotation method was used due to its advantage in producing factors (constructs/components) that are free and independent of one another.

Table 3: The reliability Coefficients of Science Teachers Needs Assessment Instrument.

Dimension	No. of Items	Cronbach's Alpha Coefficient by Authors	Cronbach's Alpha Coefficient (Pilot Study)
Management of Science Instruction	16	0.953	0.942
Diagnosing and Evaluating Students	11	0.909	0.904
Generic Pedagogical knowledge and skills	14	0.861	0.951
Knowledge and skills in science subjects	7	0.900	0.880
Administering Science Instructional facilities and equipment	10	0.878	0.864
Planning activities in science instruction	8	0.902	0.903
Integration of Multimedia technology in science teaching	4	0.830	0.749

Table 3, compares the reliability coefficients of the Science Teachers Inventory of Needs of the authors and the researchers'. However, the dimension on the use of English language in science teaching was removed from the questionnaire because the Cronbach alpha values generated was unacceptable thus (< 0.5). This was according to George and Mallery cited in Gliem and Gliem (2003). It also appears that, since the medium of instruction in Senior High Schools in Ghana was English it accounted for the Cronbach alpha values generated. In summary, the application of all those procedures finally generated seven dimensions (factors).

3.7 DATA COLLECTION PROCEDURE

The researcher collected an introductory letter from the school of Graduate studies which was sent to the Heads of Senior High schools to enable the researcher undertake the study (APPENDIX C). The teachers' consent were sought to participate in the study before the questionnaire was administered. The questionnaire was personally delivered to the respondents. The respondents were required to write the names of only their schools and not their own names, this was to ensure confidentiality. Since the items are easily comprehensible; it did not take so much time to answer. The maximum period was about thirty five minutes.

Also teachers', who were not willing to answer instantly, were given the right to do so at their own will but within a time frame of one week. In order to ensure reliability in an uncontrolled environment, the respondents were informed that the questionnaire was not a test and that their responses would not be used to change their status or affect their promotion(s). The researcher by making appointments collected the questionnaires on a later date with teacher respondents who could not submit their questionnaires immediately.

3.8 DATA ANALYSIS

Both descriptive and inferential statistics were used to analyse the data. The Statistical Package for Social Sciences (SPSS version 16.0) was used by the researcher to analyse the data. The means, frequencies and standard deviations were calculated using the descriptive statistics function of the software and presented on tables.

The inferential statistics function in the software was also used by the researcher to draw conclusions, inferences or generalisations from the sample to the population or participants of the research. The chi square test for independence served as an alternative to the independent- measures T- test (or ANOVA) in situations where the dependent variable involved classifying individuals into distinct categories. The reasons for using chi square test for independence is that it is used to test whether or not there is a relationship between two variables. The test determines how well the obtained sample proportions fit the population proportions specified.

With regards to research question 1, data was analysed using Z-test for proportional difference which relies on the mean and standard deviation within a distribution. This enabled the researcher to compare the various dimensions with regards to science teachers' in-service needs.

Research questions 2,3and 4 data was analysed using inferential statistics. Chi square analysis revealed significant associations existing between gender, school location and area of subject specialisation.

CHAPTER FOUR

RESULTS

4.0 OVERVIEW

In this chapter, the data obtained from the study is presented and analysed. Data was gathered using a questionnaire (Science Teachers Inventory of Needs). Each research question was analysed after the other. The description of the results are thoroughly explained whilst tables are used to answer the research questions.

4.1 LEVEL OF SCIENCE TEACHERS' NEEDS

To reiterate, the definition of perceived science teachers' need as measured in this study is referred to as an area for in-service help; a situation in which science teachers indicate more than a moderate need. Hence, it was then decided that science teachers' need be categorized as a priority when the percentage of respondents indicating a great need is 40 percent or more. This is in line with Moore and Blankenship (1978) suggestion whereby a priority science teachers' need is defined as ''an area for in-service help when science teachers indicate more than a moderate need'' (page 514). Similarly, the 40 percent cut-off point was also used in previous studies Baird & Rowsey (1989).

Table 4 summarizes the level of needs for each of the seven dimensions as perceived by the 156 Senior High School science teachers in Central Region who participated in this study. On the whole, it could be inferred that science teachers demonstrated that they needed to improve their knowledge and skills in all the seven dimensions of science teachers' needs. More than 60% of the science teachers echoed 'moderately and greatly needed' in all the dimensions except generic pedagogical knowledge and skills dimension.

With regards to Table 4, highlighted figures represent the 40% cut off point as cited by Baird & Rowsey (1989). A greater percentage of the greatly needed scale is demonstrated on the integration of multimedia technology in science teaching dimension (39.7%). This was followed by the administering science instructional facilities and equipments dimension (37.2%). Surprisingly, a similar percentage is proved in management of science instruction dimension and planning activities in science instruction dimension as 33.3% of science teachers attested they greatly needed assistance in these two dimensions of science teachers' needs. It seems that a moderately needed skill is in diagnosing and evaluating students (39.1%).

In terms of science teachers' knowledge and skills in science subject, only 35.9% of the science teachers confirmed that they moderately needed assistance whereas 29.5% of them greatly needed assistance. This result indicated that most of the science teachers who took part in this study observed that their knowledge and skills in science is inadequate to ensure effectiveness and meaningfulness in science instruction. The slightest needed skill is in generic pedagogical knowledge and skills. This is evident when only 10.3% of the science teachers deemed that they needed to improve their knowledge and skills in that aspect while 72.4% of them believed that their knowledge and skills here is enough for effective science instruction. Figure 1 illustrates a comparative illustration of science teachers' needs based on the percentage of the Likert scale (degree of needs) used. (See also Table 4).

Table 4: Level of Needs for Each Dimension

Dimension	Level of Needs N (%)					
	Not Needed		Moderately Needed		Greatly Needed	
Management of Science Instruction	58	**(37.2)**	46	(29.5)	52	(33.3)
Diagnosing and Evaluating Students	60	(38.5)	61	**(39.1)**	35	(22.4)
Generic Pedagogical Knowledge and Skills	113	**(72.4)**	27	(17.3)	16	(10.3)
Knowledge and Skills in Science Subject	54	(34.6)	56	**(35.9)**	46	(29.5)
Administering science Instructional Facilities and Equipment	50	(32.1)	48	(30.8)	58	**(37.2)**
Planning Activities in Science Instruction	45	(28.8)	59	**(37.8)**	52	(33.3)
Integration of Multimedia Technology in Science Teaching	43	(27.6)	51	(32.7)	62	**(39.7)**

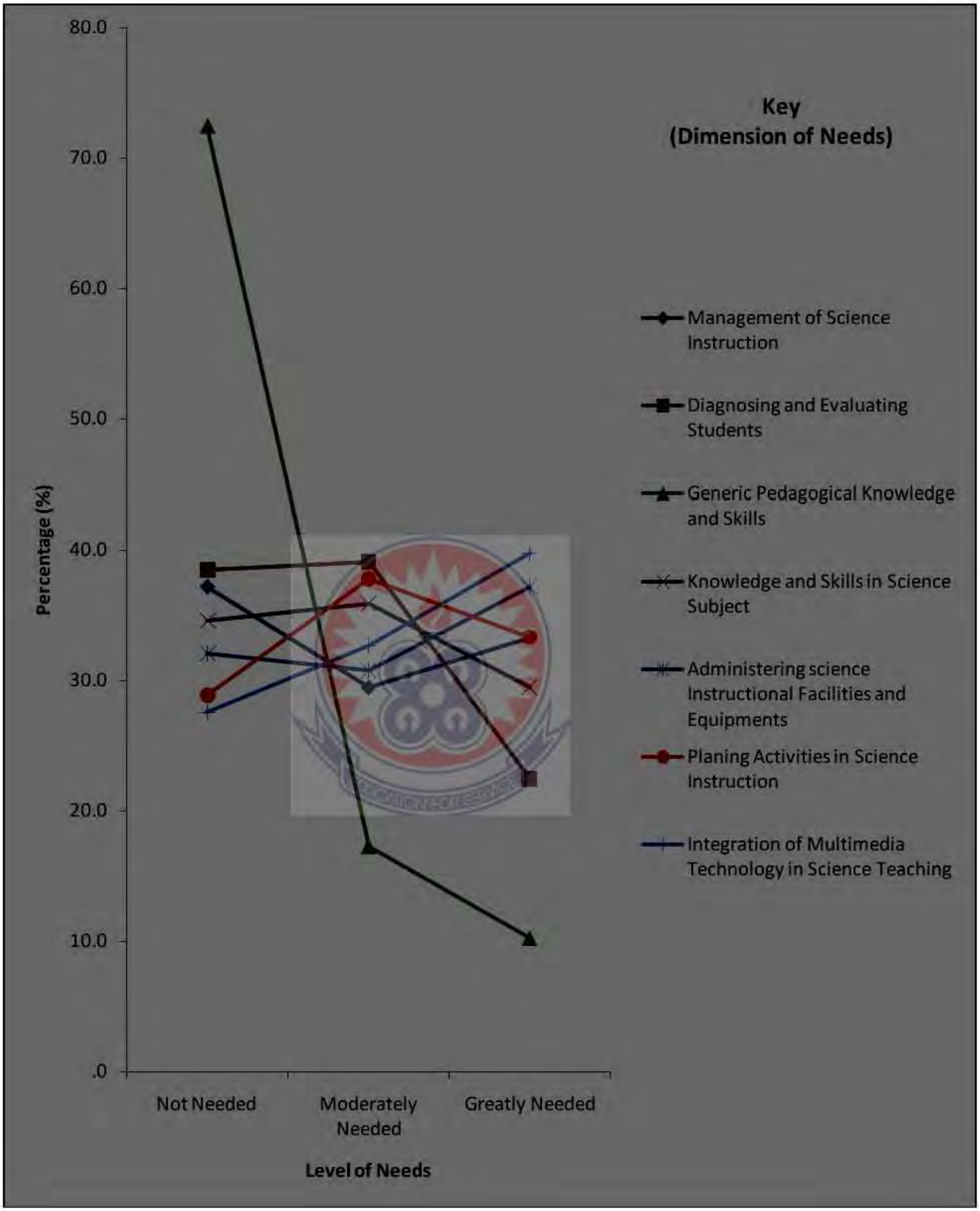

Figure 1: Comparative Illustration of Ghanaian Science Teachers' Needs

4.1.2 The categorization of science teachers' needs

Further analysis of the science teachers' needs with respect to independent variables that characterised them would enhance the conclusion that was to be generated from the analysis. Consequently, the proposed in-service programmes could be tailored according to the science teachers' characteristics.

The following tables are detailed analysis of perceived science teachers' needs of each dimension according to gender, school location and area of specialisation. Based on the aims and objectives of the study and the consideration of the type of data generated from it, the analyses used are mainly cross tab procedures followed by subsequent Chi Square measure of association Kerlinge.r & Lee (2000).

Table 5:

Summary Statistics

Dimensions	**Variables**		**Not Needed**		**Moderately Needed**		**Greatly Needed**		**Chi-Square (χ^2)**	**P-value**
			Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**		
Management of Science Instruction	Gender of Respondents	Male	48	(36.4)	39	(29.5)	45	(34.1)	.302	.860
		Female	10	(41.7)	7	(29.2)	7	(29.2)		
	Location of Schools	Urban	48	(44.9)	33	(30.8)	26	(24.3)	13.957	.001
		Rural	10	(20.4)	13	(26.5)	26	(53.1)		
	Major Academic Course	Physics	9	(36.0)	5	(20.0)	11	(44.0)	4.876	.771
		Chemistry	16	(41.0)	13	(33.3)	10	(25.6)		
		Biology	17	(37.8)	13	(28.9)	15	(33.3)		
		Integrated Science	10	(37.0)	10	(37.0)	7	(25.9)		
		Others	6	(30.0)	5	(25.0)	9	(45.0)		
Diagnosing & Evaluating Students	Gender of Respondents	Male	48	(36.4)	51	(38.6)	33	(25.0)	3.544	.170
		Female	12	(50.0)	10	(41.7)	2	(8.3)		
	Location of Schools	Urban	47	(43.9)	42	(39.3)	18	(16.8)	7.430	.024
		Rural	13	(26.5)	19	(38.8)	17	(34.7)		
	Major Academic Course	Physics	11	(44.0)	8	(32.0)	6	(24.0)	11.317	.184
		Chemistry	19	(48.7)	14	(35.9)	6	(15.4)		
		Biology	14	(31.1)	22	(48.9)	9	(20.0)		
		Integrated Science	13	(48.1)	7	(25.9)	7	(25.9)		
		Others	3	(15.0)	10	(50.0)	7	(35.0)		
Generic Pedagogical Knowledge and Skills	Gender of Respondents	Male	96	(72.7)	21	(15.9)	15	(11.4)	2.005	.367
		Female	17	(70.8)	6	(25.0)	1	(4.2)		
	Location of Schools	Urban	70	(65.4)	25	(23.4)	12	(11.2)	9.840	.007
		Rural	43	(87.8)	2	(4.1)	4	(8.2)		
	Major Academic Course	Physics	17	(68.0)	4	(16.0)	4	(16.0)	14.650	.066
		Chemistry	33	(84.6)	4	(10.3)	2	(5.1)		
		Biology	27	(60.0)	10	(22.2)	8	(17.8)		
		Integrated Science	18	(66.7)	8	(29.6)	1	(3.7)		
		Others	18	(90.0)	1	(5.0)	1	(5.0)		

Note: Significant at 0.05

Table 5: Continued

Knowledge and Skills in Science Subject	Gender of Respondents	Male	45	(34.1)	45	(34.1)	42	(31.8)	2.429	.297
		Female	9	(37.5)	11	(45.8)	4	(16.7)		
	Location of Schools	Urban	40	(37.4)	43	(40.2)	24	(22.4)	8.254	.016
		Rural	14	(28.6)	13	(26.5)	22	(44.9)		
	Major Academic Course	Physics	10	(40.0)	9	(36.0)	6	(24.0)	9.834	.277
		Chemistry	16	(41.0)	14	(35.9)	9	(23.1)		
		Biology	13	(28.9)	20	(44.4)	12	(26.7)		
		Integrated Science	11	(40.7)	8	(29.6)	8	(29.6)		
		Others	4	(20.0)	5	(25.0)	11	(55.0)		
Administering science Instructional Facilities and Equipment	Gender of Respondents	Male	41	(31.1)	38	(28.8)	53	(40.2)	3.396	.183
		Female	9	(37.5)	10	(41.7)	5	(20.8)		
	Location of Schools	Urban	36	(33.6)	38	(35.5)	33	(30.8)	6.443	.040
		Rural	14	(28.6)	10	(20.4)	25	(51.0)		
	Major Academic Course	Physics	8	(32.0)	8	(32.0)	9	(36.0)	11.588	.171
		Chemistry	18	(46.2)	9	(23.1)	12	(30.8)		
		Biology	12	(26.7)	19	(42.2)	14	(31.1)		
		Integrated Science	7	(25.9)	9	(33.3)	11	(40.7)		
		Others	5	(25.0)	3	(15.0)	12	(60.0)		
Planning Activities in Science Instruction	Gender of Respondents	Male	36	(27.3)	50	(37.9)	46	(34.8)	1.328	.515
		Female	9	(37.5)	9	(37.5)	6	(25.0)		
	Location of Schools	Urban	39	(36.4)	37	(34.6)	31	(29.0)	9.716	.008
		Rural	6	(12.2)	22	(44.9)	21	(42.9)		
	Major Academic Course	Physics	9	(36.0)	6	(24.0)	10	(40.0)	9.973	.267
		Chemistry	14	(35.9)	16	(41.0)	9	(23.1)		
		Biology	12	(26.7)	16	(35.6)	17	(37.8)		
		Integrated Science	7	(25.9)	14	(51.9)	6	(22.2)		
		Others	3	(15.0)	7	(35.0)	10	(50.0)		
Integration of Multimedia Technology in Science Teaching	Gender of Respondents	Male	36	(27.3)	47	(35.6)	49	(37.1)	3.739	.154
		Female	7	(29.2)	4	(16.7)	13	(54.2)		
	Location of Schools	Urban	31	(29.0)	33	(30.8)	43	(40.2)	.619	.734
		Rural	12	(24.5)	18	(36.7)	19	(38.8)		
	Major Academic Course	Physics	6	(24.0)	6	(24.0)	13	(52.0)	14.998	.059
		Chemistry	16	(41.0)	13	(33.3)	10	(25.6)		
		Biology	14	(31.1)	17	(37.8)	14	(31.1)		
		Integrated Science	3	(11.1)	7	(25.9)	17	(63.0)		
		Others	4	(20.0)	8	(40.0)	8	(40.0)		

Note: Significant at 0.05

Table 6:

Z-test for proportional difference in Science teachers' most prevalent needs (that is, integration of multimedia technology in science teaching) and other dimensions of science teachers needs

Dimensions	Proportion of strongly needed (P)	Proportional difference (D)	z-test value	p-value
Management of Science Instruction	.333	.064	-1.636	0.051
Diagnosing and Evaluating of Students	.224	.173	-4.417	0.000
Generic Pedagogical Knowledge and Skills	.103	.294	-7.526	0.000
Knowledge and Skills in Science Subject	.294	.103	-2.618	0.004
Administering Science Instructional Facilities and Equipment	.372	.025	-0.654	0.258
Planning Activities in Science Instruction	.333	.064	-1.636	0.051

Note: $\boldsymbol{D = 0.397 - P}$**, where 0.397 represents the proportion of science teachers most prevalent needs; Significant at 0.05.**

4.2 RESEARCH QUESTIONS (RQ)

RQ 1: *What are the most prevalent in-service needs of Senior High School science teachers'?*

Z-test for proportion was used to test the significance of Senior High School science teachers' most prevalent need to that of other needs in keeping themselves abreast of the current demands in teaching and learning instruction. In respect to this, the previous study (from Table 4) revealed that most of the science teachers needed assistance in integrating multimedia in science teaching which proved to be their most prevalent need. On this note, the proportion of science teachers who are in need of integrating multimedia assistance in science teaching was compared to the others.

Firstly, the proportion of science teachers who are in need of integrating multimedia assistance was compared with those in need of management of science instruction assistance. The procedure was as follows:

- Null hypothesis: the proportion of science teachers who are in need of integrating multimedia assistance (most prevalent in-service needs') is the same as those in need of management of science instruction assistance.
- Test statistic: $z = \frac{\hat{p}-p}{\sqrt{\frac{p(1-P)}{n}}}$, where;

  $\hat{P}$ is the proportion of science teachers in need of management of science instruction assistance.

  P is proportion of science teachers who are in need of integrating multimedia assistance

  n is the sample size.

  Now, $\hat{P} = \frac{52}{156} = 0.333$, $P = \frac{62}{156} = 0.397$, $n = 156$

Therefore, $z = \frac{0.333-0.397}{\sqrt{\frac{0.397(1-0.397)}{156}}} = -1.636$

- Decision Criteria: at significant level of 0.05, the decision rule is to reject to hypothesis if z-statistic is less than -1.96 or greater than 1.96. If z-statistic is between -1.96 and 1.96, then we fail to reject the null hypothesis.

In relation to Table 6, we failed to reject the null hypothesis since $z = -1.636\ (-1.96 < z < 1.96)$, thus, the test insignificant at 0.05. We therefore had insufficient evidence to believe that the proportion of science teachers who strongly required management skills in handling science instruction is different from those who strongly required assistance in integrating multimedia in science teaching. Also, there is weak evidence to infer that the proportion of science teachers who need assistance in integration of multimedia technology in science teaching is higher than those who need management skills in handling science instruction, since the $p - value = 0.0505 > 0.05$ is insignificant. Thus, attention should be on both dimensions of science teachers' needs.

The computed value of $z = -4.417 < -1.96$ was in the rejection region, so the null hypothesis was rejected at the 0.05 level. The difference of 6.4 percentage points between science teachers who strongly required assistance in diagnosing and evaluating students and those who strongly required integration of multimedia technology in science teaching is statistically significant. The evidence here is clear that differences exist between the proportion of science teachers who are in need of assistance in multimedia integration in science teaching and those who are in need of assistance in diagnosing and evaluating students. The $p - value = 0 < 0.05$ (highly significant) shows that there is an overwhelming evidence to infer that the proportion of science teachers' who need assistance in multimedia technology integration in science teaching is/are higher than those who need assistance in diagnosing and evaluating students. Thus, attention should be on the former than the latter.

The calculated value of $z = -7.526 < -1.96$ indicated that the null hypothesis is rejected at the 0.05 level. The difference of 29.4 percentage points between science teachers who strongly required assistance in generic pedagogical knowledge and skills and those who strongly required integration of multimedia technology in science teaching is statistically significant. The evidence here is clear that differences exist between the proportion of science teachers who are in need of assistance in integrating multimedia in science teaching and those who are in need of assistance in generic pedagogical knowledge and skills. The $p - value = 0 < 0.05$ was highly significant. This shows that there is an overwhelming evidence to infer that the proportion of science teachers who need assistance in integration of multimedia technology in science teaching is higher than those who need assistance in diagnosing and evaluating students. Thus, attention should be on the former than the latter.

Moreover, the null hypothesis is rejected at the 0.05 level, since the calculated value of $z = -2.618 < -1.96$. Hence, the difference of 10.2 percentage points between science teachers who strongly required knowledge and skills in science subjects and those who strongly required integration of multimedia technology in science teaching is statistically significant. The evidence here is clear that differences exist between the proportion of science teachers who are in need of assistance in integrating multimedia technology in science teaching and those who are in need of knowledge and skills in science subjects. Also, the $p - value = 0.004 < 0.05$ was highly significant. This shows that there is an overwhelming evidence to infer that proportion of science teachers who need assistance in integration of multimedia technology in science teaching is higher than those who need knowledge and skills in science subjects. Thus, attention should be on the former than the latter.

With reference to Table 6, we failed to reject the null hypothesis since $z = -0.654$ $(-1.96 < z < 1.96)$, thus, the test insignificant at 0.05. We therefore had no ample evidence to believe that the proportion of science teachers who strongly required assistance in administration of science instructional facilities and equipment is different from those who strongly required assistance in integrating multimedia in science teaching. Also, there is weak evidence to infer that the proportion of science teachers who need assistance in integration of multimedia technology in science teaching is higher than those who need assistance in administration of science instructional facilities and equipment, since the $p-value=0.2578>0.05$ was highly insignificant. Thus, attention should be on both dimensions of science teachers needs.

With reference to Table 6, we failed to reject the null hypothesis since $z=-1.636\ (-1.96<z<1.96)$, thus, the test insignificant at 0.05. We therefore have very weak evidence to believe that the proportion of science teachers who strongly required assistance in planning activities in science instruction is different from those who strongly required assistance in integrating multimedia in science teaching. Here also, enough evidence is not given to infer from the proportion of science teachers who need assistance in integration of multimedia technology in science teaching is higher than those who need assistance in planning activities in science instruction, since the $p-value=0.0505>0.05$ was insignificant. Thus, attention should be on both dimensions of science teachers need.

RQ 2: *What are the gender differences in Senior High School science teachers' in-service needs?*

With regards to the management of science instruction dimension, a greater percentage of male science teachers (34.1%) greatly needed assistance with respect to this aspect of science teachers perceived needs (table 5). On the other hand, 29.2% of their female counterparts deemed that their managerial skills in science instruction are inadequate. This result may be associated with the fact that most of the schools do not provide in-service training to science teachers in relation to managerial skills. Similarly, 29% of the male science teachers as well as their female counterparts expressed a moderately needed assistance in management of science instruction. The chi-square test yielded a test result of 0.30 and a highly insignificant probability value of 0.860>0.05 between gender and science teachers' perceived needs on management of science instruction dimension. Here, no evidence supported the association between gender and science teachers' perceived needs. Thus, there was no significant association between the perceived needs of female science teachers on management of science instruction and the perceived needs of their male counterparts.

The results shown in Table 5 reveal that 25.0% of the male science teachers greatly needed assistance in diagnosing and evaluating students as compared to 8.3% of their female counterparts. Specifically, most of the male science teachers constituting 38.6%, moderately needed support in diagnosing and evaluating students as half of the females (50%) confirmed that they do not need support in that aspect. Furthermore, there is no significant association between the perceived needs of female science teachers on diagnosing and evaluating students and that of their male counterparts. An evidence is when the chi-square test yielded a result of 3.54 with an insignificant value of 0.170>0.05. This proved that the perceived in-service needs' of male science teachers in diagnosing and evaluating students is not the same as their female counterparts. This however supported the descriptive analysis in the latter. Thus, there is insufficient evidence to support the association between gender and teachers' perceived needs.

Furthermore, the male science teachers' level of need in generic pedagogical knowledge and skills was compared with that of the female science teachers. Similarly, a greater percentage of both male and female science teachers perceived that their generic pedagogical skills and knowledge is adequate. 72.7% of the male science teachers felt it to be unnecessary to improve their generic pedagogical knowledge and skills as 70.8% of the females felt the same. A comparison between the male and female respondents proved that (11.4%) of male science teachers demonstrated a great need. Nevertheless, (25%) of the female science teachers (25%) demonstrated a moderately needed generic pedagogical skills and knowledge. There is no doubt that the chi-square test for association between gender and science teachers' perceived in-service needs on generic pedagogical knowledge and skills dimension yielded a result of 2.00 with an insignificant value of 0.367>0.05. This shows that there is no ample evidence to support the relationship between gender and science teachers' perceived needs. Thus, there is no significant association between the perceived needs of female science teachers on generic pedagogical knowledge and skills and that of their male counterparts.

With reference to knowledge and skills in science subject dimension, the percentage of female science teachers received on 'moderately needed' and 'not needed' is 45.8% and (37.5%) respectively. Nevertheless, most of the male counterpart demonstrated a moderately needed assistance as 34.1% of the male responded to this aspect. Male respondents in the greatly needed category generated 31.8% against 16.7% of females. Furthermore, a weak association is established between the perceived needs of male and female science teachers' knowledge and skills in science subject. In support of this association, the chi-square test yielded a result of 2.43 with a highly insignificant value of 0.297>0.05 for gender and teachers' perceived needs on knowledge and skills in science subject. Thus, enough evidence thus not support the association between gender and teachers' perceived needs on knowledge and skills in science subject, which shows that both male and female science teachers have similar perceived needs.

In the administering science instructional facilities and equipment, a greater percentage of the male science teachers (40.2%) greatly needed assistance to improve their knowledge and skills here. On the other hand, 41.7% of their female counterparts deemed that their skills in administering science instructional facilities and equipment are moderately inadequate. This result may be associated with the fact that most of the schools do not provide in-service training to science teachers in relation with handling science instructional facilities especially laboratory equipment. Similarly, 31.1% of the male science teachers expressed that they have adequate skills in administering science instructional facilities and equipment as 37.5% their female counterparts also expressed that they have adequate skills in administering science instructional facilities and equipment. Moreover, the chi-square test for testing the association between gender and science teachers' perceived needs in administering science instructional facilities and equipment dimension generated a result of 3.40 with an insignificant value of 0.183>0.05. This shows that there was inadequate evidence to support the association between gender and science teachers' perceived needs. Thus, there was an insignificant association between the perceived needs of female science teachers on administering science instructional facilities and equipment and that of their male counterparts.

With planning activities in science instruction dimension, a greater percentage of the male science teachers (34.8%) and (27.3%) was established in both 'not needed' and 'greatly needed' categories. In contrast, 34.8% of the male science teachers expressed a greatly needed assistance in planning science instruction activities while 25% of female science teachers' also expressed a great need. Likewise, the chi-square test yielded a test result of 1.33 with a highly insignificant value of 0.515>0.05 for gender and science teachers' perceived needs on planning activities in science instruction. This shows that there was not enough evidence to support the association between gender and science teachers' perceived needs. Thus, there was no significant association between the perceived needs of female science teachers on planning activities in science instruction and that of their male counterparts.

With reference to the integration of multimedia technology in science teaching dimension, a greater percentage of both male and female science teachers were witnessed on the greatly needed column as they had a respective percentage of 37.1% and 54.2%. These high percentages indicated that both male and female science teachers felt that such skill was relevant and hence important. All the same, 35.6% of the male science teachers demonstrated a moderately needed assistance as they expressed their concern on having inadequate skills in integrating multimedia technology in science teaching. The male respondents who responded in the 'not needed' category generated 27.3% against 29.2% of the females. Moreover, the chi-square test yielded a test result of 3.74 with an insignificant value of 0.154>0.05 for gender and science teachers' perceived needs on integration of multimedia technology in science teaching. This shows that there is no satisfactory evidence to support the association between gender and science teachers' perceived needs. Thus, there was no significant association between the perceived needs of female science teachers on integration of multimedia technology in science teaching and that of their male counterparts.

RQ 3: *What are the in-service needs of Senior High School science teachers' with regards to school location?*

As shown in table 5, 53.1% of science teachers from rural areas expressed their great need in management of science instruction as opposed to only 24.3% of science teachers from urban areas. Concomitantly, a higher percentage was displayed by science teachers in urban areas (44.9%) who perceived that such support was not needed, opposing those in the rural areas (20.4%). With regards to these findings, it seems that most science teachers in the rural areas require managerial skills and assistance in delivering science instruction. The management of science instruction dimension reveals a highly significant association between teachers perceived needs and school location. This was due to the fact that the result of the chi-square test was 13.96, with a highly significant value of 0.001<0.05. Thus, there was enough evidence to infer that the perceived needs of science teachers with respect to management of science instruction in urban areas was not the same as those in rural areas. These results however support generally that science teachers in the rural areas required management skills and assistance in handling science instruction than their urban colleagues.

Detailed analysis of association between school location and perceived science teachers' needs revealed that 34.7% of science teachers in the rural areas greatly needed assistance in assessing their students. More teachers from the urban areas felt that such assistance is unnecessary (rural = 26.5%; urban = 43.9%). Surprisingly, 39.3% of urban area science teachers compared to 38.8% of their rural area counterparts expressed a moderate need. The strongest association is established when the chi-square test reveals a moderate significant association between science teachers perceived needs of diagnosing and evaluating students and school location. Here, the chi-square tests yielded a result of 7.43 with a significant value of 0.024<0.05. Consequently, there was sufficient evidence to infer that in-service needs' of urban area science teachers in relation with diagnosing evaluating students was not the same as science teachers in rural areas.

As for the generic pedagogical knowledge and skills dimension, less than two-thirds of science teachers in urban areas (urban=65.4% < 75%) felt that they had already acquired the necessary knowledge and skills needed in such aspect, whereas more than two-thirds of those in the rural areas (rural=87.8%>75%) felt the same. Surprisingly, most science teachers in the urban areas expressed a great need for the skill as opposed to those in the rural areas (rural = 8.2%; urban = 11.2%). Further chi-square test reveals a highly significant association between teachers perceived needs and school location. This was because the test yielded a result of 9.84 with a significant value of 0.007<0.05. Thus, there was sufficient evidence to infer that the perceived needs of science teachers in the urban areas with regards to generic pedagogical knowledge and skills are not the same as those in rural areas.

Furthermore, science teachers' in-service needs' on knowledge and skills in science subjects was compared within the geographical location of the schools. The comparison revealed that 44.9% of teachers in the rural areas expressed a great need for the skill as opposed to 22.4% of teachers in the urban areas. More teachers from the urban areas felt that they moderately needed such an assistance in this aspect (rural = 26.5%; urban = 40.2%). In contrast, 37.4% of teachers in urban areas felt that they had alreadily acquired such skills. It also appears, the knowledge and skills in science subject dimension reveals a significant association between science teachers perceived needs and school location. This was because the chi-square tests yielded a result of 8.25 with a significant value of 0.016<0.05. Hence, there was much evidence to infer that the perceived needs of teachers in the urban areas are not the same as those of rural areas.

Generally, more than half of science teachers in the rural areas require assistance in terms of administering science instructional facilities and equipment. This was evident where

51% of the science teachers in the rural areas from this geographical region expressed their great need in this dimension as opposed to only 30.8% of science teachers from urban areas. Thirty-three point six percent (33.6%) of teachers in urban areas perceived that such skills and assistance are unnecessary, while 35.5% of them moderately need such skills. Teachers in the rural areas expressed similar views with 20.4% of them moderately need such skills and 28.6% of them felt that such skills are irrelevant. Furthermore, the administering science instructional facilities and equipment dimension; revealed a moderately significant association between teachers perceived needs and school location. This was for the reason that the chi-square test was 6.44 with a significant value of 0.040<0.05. Therefore, there was sufficient evidence to infer that the perceived needs of science teachers in the urban areas are not the same as those of the rural areas. This really supported the view that science teachers in the rural areas require assistance in terms of administering science instructional facilities and equipment than those in the urban areas.

In the planning of science instruction dimension, less than half of science teachers from both rural and urban schools felt that such skills are crucially important (rural=42.9%; urban=29%). Other findings revealed that only 12.2% of rural area science teachers felt that such competency was not needed as opposed to urban area science teachers who displayed a significantly higher percentage of 36.4%. Forty-four point nine percent (44.9%) of those teaching in rural schools indicated a moderate need in planning science instruction compared to those in urban schools (34.6%). On the other hand, the planning activities in science instruction dimension revealed a vast significant association between teachers perceived needs and school location. This was because the chi-square tests yielded a result of 9.716 with a highly significant value of 0.008<0.05. Thus, there was adequate evidence to infer that the perceived needs of science teachers in the urban areas are not the same as those of rural areas.

In the integration of multimedia technology in science teaching dimension, 40.2% of urban area science teachers compared to 38.8% of their rural area counterparts surprisingly expressed a greatly needed assistance in such a dimension. Mostly teachers from rural areas expressed a moderate concern for this skill. 36.7% of them felt that such skill was moderately needed. For urban teachers, the percentage of those who expressed a less concern for such skills were (29%) and the percentage of those who demonstrated a moderate need were (30.8%) shows a little difference. Surprisingly, the integration of multimedia technology in science teaching dimension reveals a highly insignificant association between teachers perceived needs and school location. This was because the chi-square tests yielded a result of 0.619 with a significant value of 0.734>0.05. Therefore, there was no ample evidence to infer that the perceived needs of teachers in the urban areas are not the same as those of rural areas. This indication proved that science teachers in the rural areas need similar support, skills and assistance in integrating multimedia technology in science teaching as those in the urban areas.

RQ 4: *What are the in-service needs of Senior High School science teachers' with regards to their areas of subject specialization?*

From table 5, the highest percentages were recorded in the greatly needed column on management skills in handling science instruction as 44.0%, 33.3% and 45.0% of science teachers who have respectively majored in physics, biology and non-science option subjects revealed that they greatly needed managerial skills in handling their respective subjects. More so, on the area of specialization variable, 37.0% of non-Science option teachers moderately needed the respective knowledge and skills. The science option teachers (chemistry and biology) on the other hand, expressed less concern on managerial skills and assistance except physics teachers. Nevertheless, the percentage of non-science option teachers who opted for 'moderately needed' and 'not needed' for such need is similar (37%). From the result in table 5 again, with regards to major academic course and teachers perceived needs on management of science instruction assistance, the chi-square test was 4.88 with a highly insignificant value of 0.771>0.05. This attested to the fact that the there was no ample evidence to deduce that science teachers perceived needs vary among major academic course.

More than a quarter of integrated science option teachers (25.9%) and non-science option teachers (35.0%) expressed concerns of assistance with reference to diagnosing and evaluating students, while less than a quarter of physics, chemistry and biology option teachers (24.0%, 15.4% and 20.0% respectively) also showed that such dimension of need was very crucial to them. As shown in Table 5, most of the biology teachers (48.9%) felt that they moderately needed assistance in this aspect. Detailed analysis of the association between major academic course and perceived science teachers' needs shows that 48.7% of the chemistry option teachers perceived that they had alreadily acquired the necessary skills in assessing students. With reference to major academic course and science teachers perceived needs of diagnosing and evaluating students, again, the chi-square test of 11.32 with an insignificant value of 0.184>0.05 was detected. This proved that unsatisfactory evidence existed between the significant association of science teachers perceived needs and major academic course. Thus, among the major academic courses, the perceived needs of science teachers on how to diagnose and evaluate students were the same.

In the acquisition of generic pedagogical knowledge and skills dimension, weak associations exist in the major academic course of teachers. More than two-thirds of chemistry teachers (87.8%) and non-science option teachers (90.0%) felt that such skill is unnecessary. In respect to other subjects, more than half both integrated science, biology and physics teachers echoed that their assistance in acquisition of generic pedagogical knowledge and skills are irrelevant. A greater percentage of biology (17.8%) option teachers raised concerns on acquisition of generic pedagogical knowledge and skills as compared to other teachers. Generally, almost all the teachers felt that generic pedagogical knowledge and skills is irrelevant. In addition to the major academic course and science teachers perceived in-service needs' of generic pedagogical knowledge and skills, the chi-square test yielded a result of 14.65 with an insignificant value of 0.066>0.05. This confirmed that there was inadequate evidence to infer that science teachers perceived needs of generic pedagogical knowledge and skills differ among their major academic courses.

With regards to knowledge and skills in science subject, more than half of non-science option teachers portrayed that they greatly needed support in upgrading their mastery of knowledge and skills in science subjects (55.0%). Biology science teachers here felt that they moderately needed assistance in knowledge and skills in science subject (44.4%). Interestingly, it was also found that the highest percentage identified is in the 'not needed' scale which was expressed by 40.0% and 41.0% of physics and chemistry option teachers respectively; viz. the percentage of not needed as expressed by this cohort of science teachers. Furthermore, the chi-square results of 9.83 with a highly insignificant value of 0.277>0.05

was detected in the testing of association between major academic course and teachers perceived needs of knowledge and skills in science subjects. This result established that the difference in science teachers perceived needs of knowledge and skills in mastery of science subjects among their major academic course was highly irrelevant.

The highest percentage of a great need for administering science instructional facilities and equipment competencies is demonstrated by non-science option teachers (60%), followed by integrated science teachers and those majoring in physics (40.7% and 36.0% respectively). On the other hand some of the biology teachers (42.2%) expressed only moderately needed assistance in this dimension, while some of the chemistry teachers (46.2%) uttered that they have the adequate skills and assistance in this dimension. Predictably, with regards to major academic course and teachers perceived needs on administering of science instructional facilities and equipment, the chi-square test was 11.59 with an insignificant value of 0.171>0.05. This result indicated that there was insufficient evidence to infer that science teachers perceived needs on administering of science instructional facilities and equipment assistance differ among major academic course.

In the planning activities of science instruction dimension, the highest percentage of a great need for planning science instruction competencies was demonstrated by half of non-science option teachers (50.0%), followed by teachers majoring in physics (40.0%), and those majoring in biology (37.8%). More than 50.0% of integrated science teachers (51.9%) felt that such skill was moderately needed. At the same time, 41.0% of chemistry teachers echoed similar cries compared to 35.6% and 24.0% of biology and physics teachers respectively. Similarly, non-science option teachers (35%) also indicated a moderate need. Respondents majoring in physics, showed less concern for assistance and skill in this dimension as compared to other option teachers. As for the association between teachers perceived needs of planning activities in science instruction and their major academic course, the chi-square test yielded a result of 9.97 with an insignificant value of 0.267>0.05. Hence, there was no ample evidence to infer that science teachers perceived needs of planning activities in science instruction infer among major academic course.

With the integration of multimedia technology in science teaching dimension, more than 50.0% of physics and integrated science option teachers felt that such a skill was greatly needed. This was evident where 63.0% of integrated science option teachers and 52.0% of physics option teachers expressed their great need in this dimension. As expected, most of the chemistry teachers comprising 41.05% felt that assistance in integration of multimedia technology in teaching was unnecessary as compared to those in other course options. Interestingly, for non-science option teachers, the percentage of responses received on a 'moderate need' and 'greatly needed' scale is similar (40.0%).

With regards to major academic course and science teachers perceived needs of integration of multimedia technology in science teaching, the chi-square test was 14.998 with a insignificant value of 0.0.59>0.05. Here, the indication was that weak evidence exists in the association between major academic course and science teachers perceived needs of integration of multimedia technology in science teaching. Thus, the inference would be that teachers perceived needs of integration of multimedia technology in science teaching differ among their major academic course.

CHAPTER FIVE

DISCUSSION

5.0 OVERVIEW

This chapter discusses thoroughly the summary of the results in the study. The research questions are also regarded as themes in this chapter.

5.1 DISCUSSION OF RESULTS

It could be reiterated that in this study, a particular need is considered a priority science teachers' need when the percentage of greatly needed scale selection is more than 40 percent. Based on Table 4, it could also be inferred that the topmost priority needs are the use of multimedia and the integration of technology in science teaching and learning as well as diagnosing and evaluating students.

With regards to Table 4, a greater percentage of the greatly needed scale was demonstrated in the integration of multimedia technology in science teaching dimension (39.7%). This was followed by the dimension of administering science instructional facilities and equipment (37.2%). Surprisingly, similar percentages occurred in the management of science instruction and planning activities in science instruction as 33.3% of science teachers attested they greatly needed assistance in those two dimensions of science teachers' needs. It seems that a moderately needed skill was required in diagnosing and evaluating students (39.1%). In terms of science teachers' knowledge and skills in science subject, only 35.9% of the science teachers confirmed that they moderately needed assistance whereas 29.5% of them greatly needed assistance.

This result indicated that most of the science teachers who took part in this study observed that their knowledge and skills in science is inadequate to ensure effectiveness and comprehension in science instruction. The slightest needed skill was in generic pedagogical knowledge and skills. This was evident when only 10.3% of the science teachers deemed that they needed to improve their knowledge and skills in that aspect while 72.4% of them believed that their knowledge and skills here is enough for effective science instruction.

Additionally, science teachers also need support in planning and designing their science instruction as well as equipping themselves with generic pedagogical knowledge and skills. On the other hand, science teachers require a moderate need of assistance in managing their science instruction and in measuring students' performance. It was also apparent from the findings that science teachers do not have problems with updating their content knowledge as well as technical skills in administering science instructional facilities and equipment. When such a classification of science teachers' need is compared with previous local studies conducted by Kamariah (1984), Kamariah, Rubba, Tomera & Zurub (1988), and Mohamad (2002), it could be argued that science teachers' needs evolve with time as well as social and political scenarios that navigate the policy implementation of the country. Twenty four years ago, during the wake of the New Ghanaian Science Curriculum implementation, the prominent needs of the Ghanaian science teachers then, mainly involved delivering and managing science instruction, as well as administering science instructional facilities and equipment. This as a whole contributed towards improving one's self competence as a science teacher in meeting new challenges in science teaching.

Currently, in Ghana, we are witnessing a great emphasis on integrating ICT in science lessons. Undoubtedly, the implementation of such new approaches, generate anxiety on the part of teachers, especially in imparting scientific knowledge using ICT as the medium of instruction. It must be pointed out that education in Ghana can be argued to be justifiably intertwined with political interest as it is increasingly the case in the West and particularly in the United Kingdom. Thus, in furnishing science teachers with the necessary knowledge and skills required as a result of new policy implementation, many short courses have been inaugurated.

Nevertheless, most of the programmes were implemented in an *ad hoc* or “bolt on” fashion, and hence failed to equip science teachers with the necessary knowledge and skills. The need for integrating ICT in science instruction successfully would instil in science teachers’ the cognizance of the importance of ICT in every niche of human activities. In this context, the science teachers’ main concern was how they could upgrade their knowledge of integrating ICT towards a more interesting yet meaningful science lesson.

Literature evinces that science teachers’ concern on how to fully utilize ICT facilities effectively in science lessons, was also a major problem in the United States and United Kingdom (Banilower, 2000; Dillion, Osborne, Fairbrothre & Kurina, 2000; Smith, 2000). Although many support systems are to be granted by the government, a wide dissemination of stand alone science teaching software, and organizing short courses on integrating ICT in their lesson. Nonetheless, many science teachers may still feel incompetent and hence need much support in this aspect.

The third main concern of Ghanaian Senior High School science teachers’ is proper planning of science instruction. The main concern about planning is entrenched in the teachers’ inclination to motivate their students to learn science. The existence of a wide spectrum of students’ abilities thus creates a need for teachers to make their lessons interesting and attractive especially for students’ with low ability levels. The science teachers’ awareness of the importance of varying their pedagogical approaches and how to constructively plan their lessons with the support of ICT and other teaching aids also contribute to such pattern of feedback. Another plausible reason for the concern in planning instruction is associated with the government policy of achieving a 60 to 40 ratio of science to art students. This is a new phenomenon which science teachers are currently facing, especially in dealing with students who do not really want to take up science subjects but were forced to do so. The students' lack of interest and the lack of motivation mould their attitudes towards the science subject, which ultimately shape their negative behaviours during science lessons. Several interesting issues emerged when association was gauged between gender, school location, areas of specialization and science teachers' needs. As earlier mentioned, the cohort of science teachers' who require more training in all dimensions of science teachers' needs as measured in this study are female science teachers and non-science option teachers teaching in rural schools.

Arguably, schools in urban areas offer a more conducive environment for the teaching of science particularly in the integration of ICT in teaching and learning Science. This was not surprising as many support systems and infrastructure were made available in urban areas. In addition, these schools are located near Science Resource Centres as well as the District Education Office(s), which provide avenues for exchange of ideas as well as keeping them well informed of the latest policy implementation in science teaching and learning. The needs of non-science option teachers on the other hand, revolve around updating knowledge and skills for effective science instruction.

Based on the findings, several suggestions can be forwarded to meet the current needs of science teachers. Undoubtedly, in-service courses which offer continuous development of science teachers appear to be the best platform in upgrading science teachers' needs as identified in this study. Appendix D displays in graphical manner a proposed framework for the Malaysian secondary school science teachers' in-service training (INSET) model. As shown in Appendix D, the INSET established can take many forms; school-based, central-based, institutionalized training either via public or private institutions, conducted by means of a virtual or a distance learning mode (Craft, 1996; Parkinson, 2004). Compatriot institutions such as the District Education Department and Teacher Education Division can offer support in ensuring effective implementation of the programmes. Appendix D also highlights three main modus operandi which can be undertaken: short courses, professional day, or long term courses such as pursuing a masters or doctoral degree programme. This can also be adapted to suit the Ghanaian context.

5.2 RESEARCH THEMES

RT 1: *What are the most prevalent in-service needs of Senior High School science teachers'?*

It should be reiterated that in this study, a particular need is considered a priority science teachers' need when the percentage of greatly needed scale selection is more than 40 percent. Based on Table 4, it could be inferred that the topmost priority need is the use and integration of multimedia technology in science teaching and learning. Additionally, science teachers also need support in administering science instructional facilities and equipment, management as well as planning and designing their science instruction. On the other hand, teachers only require a moderate need of assistance in diagnosing and evaluating students with regards to measuring students' performance. It was also apparent from the findings that science teachers do not have too much problems with updating their content knowledge as well as technical skills in science instruction. When such classification of science teachers' need is compared with that of about twenty four years ago, during the wake of the New Science Curriculum (of the then Senior Secondary School now Senior High School) implementation, the prominent needs of the Ghanaian science teachers then, mainly involved delivering and managing science instruction, as well as administering science instructional facilities and equipment, which as a whole contributed towards improving one's self competence as a science teacher in meeting new challenges in science teaching.

In furnishing science teachers with the necessary knowledge and skills required as a result of new policy implementation, many short courses have been inaugurated. The need for integrating ICT in science instruction as publicized in the media (written as well as electronic), has successfully instilled in the teachers cognizance of the importance of ICT in every niche of human activities. In this context, the teachers' main concern is how they could upgrade their knowledge of integrating ICT towards a more interesting yet meaningful science lesson.

Literature clearly shows that the teachers' concern on how to fully utilize ICT facilities effectively in science lessons, was also a major problem in the United States and United Kingdom (Banilower, 2000; Dillion, Osborne, Fairbrother and Kurina, 2000; Smith, 2000). More to that, a wide dissemination of stand alone science teaching software, and organizing short courses on integrating ICT in their lessons, nonetheless, many science teachers still felt incompetent and hence need much support in this aspect.

RT 2: *What are the gender differences in Senior High School science teachers' in-service needs?*

Analysis of data also revealed that teachers' gender seems to be associated with their perception towards upgrading their knowledge and skills in science subjects, as well as generic pedagogical knowledge and skills required for effective science instruction. Such needs affect the respondents' perception of the importance of planning effective science instruction. Analysis across gender reveals that female teachers require more attention in equipping themselves with the skills in all the dimensions identified.

There are also specific difficulties of placing female teachers in rural schools. Female teachers may be even less willing to accept a rural posting than their male counterparts, resulting in rural areas having fewer female teachers than urban areas. In some cases, posting single women to unfamiliar areas may cause cultural difficulties and even be unsafe. For an unmarried woman, posting to an isolated rural area may also be seen to limit her marriage prospects. In some countries, single women are not posted to rural areas as a matter of policy. For a married woman, a rural posting may mean separation from her family, as her husband may be unwilling or unable to move for cultural or economic reasons.

Several interesting issues also emerged when association was gauged between gender, school location, areas of specialization and science teachers' needs. As earlier mentioned the cohort of science teachers who require more training in all dimensions of science teachers' needs as measured in this study were female and non-science option teachers teaching in rural schools. Therefore in-service programmes should be organized regularly to constantly monitor students' progress and weakness for the necessary actions to be taken with regards to science teachers needs.

RT 3: *What are the in-service needs of Senior High School science teachers' with regards to school location?*

Based on data interpreted from Table 5, it could be synthesized that school location seems to be a detrimental factor in determining Senior High School science teachers' needs. Most of the rural teachers demonstrated a great need for all the dimensions highlighted.

Arguably, schools in urban areas offer a more conducive environment for the teaching of science particularly in the integration of ICT in teaching and learning Science. This is not surprising as many support systems and infrastructure are made available in urban areas. In addition, these schools are located near Science Resource Centres as well as the Municipal/District Education Office, which provide avenues for exchange of ideas as well as keeping them well informed of the latest policy implementation in science teaching and learning. The needs of non-science option teachers on the other hand, revolve around updating knowledge and skills for effective science instruction.

The rural-urban disparity in living conditions is the major constraint on attracting teachers to rural areas. Many countries report that teachers express a strong preference for urban postings because living conditions in general are so much better in urban than in rural areas. Teachers often express concerns about the quality of accommodations; the working environment, including classroom facilities and school resources; and access to leisure activities and public facilities in rural areas.

Limited opportunities for professional advancement in rural areas also discourage teachers. Urban areas offer teachers easier access to further education and training, while rural areas offer limited opportunities to engage in developmental activities such as national consultations, including those with representative organizations. Teachers in rural areas may even find it more difficult to secure their entitlement to professional development from regional educational administrations and must overcome many obstacles, including corruption by officials.

RT 4: *What are the in-service needs of Senior High School science teachers' with regards to their areas of subject specialization?*

In-service training is a process of staff development for the purpose of improving the performance of an incumbent holding a position with assigned job responsibilities. It promotes the professional growth of individuals. "It is a programme designed to strengthen the competencies of science teachers while they are on the job" (Malone, 1984). In-service training is a problem-centred, learner-oriented, and time-bound series of activities which provide the opportunity to develop a sense of purpose, broaden perception of the clientele, and increase capacity to gain knowledge and mastery of techniques.

Science teachers' area of specialization seems to be associated with teachers' perceptions of the importance of specific skills pertaining to science teaching and learning such as administering science instructional facilities and equipment, diagnosing and evaluating students, generic pedagogical knowledge and skills, planning science instruction and the use of multimedia technology in science teaching. It was also detected that for almost all dimensions, non-option science teachers appear to be those who require more attention in all the dimensions of science teachers' needs as measured in this study. When all the analysis is integrated together, it could be synthesized that specifically, the cohort of science teachers who require more training in all dimensions of science teachers' needs are non-science option and some female teachers in rural areas.

Although teachers play a crucial role in the implementation of new/innovative curricula they are not duly informed about the organisation of orientation or professional development courses. The traditional top-down approach is what the central staff of the Curriculum Research Development Division (CRDD) use, in which most often teachers are blamed for the failure of new educational reforms or curriculum innovations. In this regard change is viewed as transmission of ideas from curriculum developers/researchers to teachers. Professional development programmes should be designed to result in collaborative programme. This means that teachers, administrators, supervisors, non-teaching staff, students and lay persons should be involved. Such programmes should be grounded on the needs of the participants of the study, thus Senior High School science teachers'. That is, the plan should be developed from an assessment of the needs and interests of the persons to be served.

Although subject matter knowledge is widely acknowledged as a central component of what teachers need to know, research on teacher education has not, in the main, focused on the development of teachers' subject matter knowledge. Researchers specifically interested in how teachers develop and change have focused on other aspects of teaching and learning to teach. For example, changes in teachers' role conceptions, their beliefs about their work; their knowledge of students, curriculum, or of teaching strategies. Yet to ignore the development of teachers' subject matter knowledge seems to belie its importance in teaching and in learning to teach. Literature is however silent on the needs of science teachers with regards to their areas of specialisation. In addition to this, science teachers' needs vary with regards to their areas of subject specialisation. The need of the biology teacher is different from that of the chemistry, physics, integrated science and other science related areas. It is more likely that both professionally trained and untrained science teachers be given in-service training in their areas of subject specialisation.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 OVERVIEW

This chapter offers summaries, conclusions, recommendations and limitations. It also gives suggestions for further research work.

6.1 SUMMARY

If teachers are to liberate learners in their classrooms, there is a need for them to change their ways of instruction, and make classroom environments more favourable for all learners to participate in the learning process. In this regard, an all high 39.7% of science teachers' greatly needed assistance in the integration of multimedia technology in science teaching. This was followed by 37.2% of science teachers who also demanded a great need in the administering of science instructional facilities and equipment. The same number of science teachers thus 33.3% also needed in-service programmes in the management of science as well as in planning activities in science instruction. Teachers' knowledge and skills in science subjects recorded 29.5% whilst 22.4% of science teachers found it a need in diagnosing and evaluating students. On the whole 10.3% of science teachers needed to update their generic pedagogical knowledge and skills. These results as indicated in Table 4 highlights the topmost priority of Ghanaian Senior High School science teachers' needs, which is the integration of multimedia technology in science instruction.

6.2 RECOMMENDATIONS

It is recommended that multimedia technology is used as the main teaching tool, in addition to face to face interaction. Loucks-Horsley, *et al.* (1998) argues that the key feature of technology is not only as a tool for presenting ample opportunities for diverse learning experiences, but it can become the best support for professional learning. To ensure that the programmes implemented meet its objectives, continuous monitoring and evaluation by training institutions, governing bodies etc. should be systematically planned and followed.

Professional development programmes should be designed collaboratively. This means that teachers, administrators, supervisors, non-teaching staff, students and lay persons should be involved. Such programmes should be grounded on the needs of the participants of this study, Senior High School science teachers'. That is, the plan should be developed from an assessment of the needs and interests of the persons to be served. Recent work on teacher change and curriculum innovation has suggested a bottom-up approach instead of the traditional top-down innovation model (Driel *et al.,* 2001; Fincher & Tenenberg, 2007; Richards, Gallo & Renandya, 1999). The bottom-up innovation model is more teacher-oriented and suggests that the role of teachers' in curriculum innovation is not merely executing the innovative ideas of others.

More to the point, in strengthening science teaching and learning in Senior High Schools,

- Teachers in Senior High Schools should be given effective preparation and supports to enable them provide exciting and fulfilling teaching and learning of science. Cadres of Senior High School science specialist teachers must be created to provide support, mentor and guide other teachers in a cluster of schools in science teaching.
- Senior High School teachers with weak skills in the sciences should be given support to upgrade their knowledge and skills in an ongoing basis.
- SHS teachers need exposure to the use of community resources in contextualizing the teaching of science and mathematics. Multi-media materials based on local industrial technologies will enliven science teaching and make it relevant. In this regard, the activities of the Centre for School and Community Science and Technology Studies (SACOST) at the University of Education, Winneba is aimed at producing teacher and student support materials that can be used to enrich teaching and learning will need to be encouraged and supported.
- The GES should forge a closer partnership with science subject associations such as GAST to encourage the formation of networks between clusters of SHS to stimulate science teaching and learning at SHS and to ensure that teaching and learning in the schools are properly articulated. ICT should be used to link teachers together for professional development through the sharing of ideas.
- In view of the fact that knowledge in science and technology continues to grow exponentially, regular professional training in-service courses should be organized by GES for teachers.

- Incentives can also be used to encourage teachers to locate in rural areas. Teacher housing is one of the most frequently used incentives and, although it can be expensive to provide, is clearly required in areas where suitable housing is not available for rent. The availability of safe housing is particularly important in encouraging female teachers to locate in rural areas. Access to housing is necessary, but not sufficient, to ensure that teachers locate in rural schools. Additional incentives in the form of bonus payments or hardship allowances are often paid. However, the impact of financial incentives is often limited by the small scale of the additional payment and poor targeting. To be effective, incentives need to be significant in scale, carefully targeted to remote schools, and tied to remaining in the post (teachers who transfer to another school should not retain the hardship allowance). In Zambia, the incentive payment is calculated on a sliding scale, based on distance from the nearest tarred road.
- The lack of access to ICT and the low literacy in ICTs among practitioners has partly contributed to the creation of a big gap between the extent of awareness of teachers about the positive impact of ICTs in teaching and learning Science and Technology and the level of use of these modern tools in the classroom. It is also true that certain mindsets have hindered the quests of some teachers in the use of these effective teaching and learning tools in the classroom. GAST is therefore urged to do the following:
    - Organize workshops at the district and regional levels to conscientize science teachers on the relevance of using technology to enhance teaching and learning of science. Such workshops and short term in-service training could be periodically organized in collaboration with the University of Education,

Winneba to equip teachers not only with the literacy but also the applications of ICT tools in their work.

- Advocate the review of the science curriculum at all levels to make it relevant, meaningful and functional to our national needs
- Insist on the provision of academically rich environment through the provision of computing facilities and access to the internet
- Form study cells at the district and regional levels to give science and technology teachers the opportunity to create and share innovative ideas and practices
- Create a website that could serve as a forum for national and international collaboration with other professional bodies and organizations

6.3 CONCLUSION

This study provides meaningful empirical evidences of effective in-service programmes in the process of upgrading science teachers' professionalism in Ghana. Data gathered in this study provide vital information especially for those involved in designing and implementing INSET, so that all the programmes implemented will be tailored specifically to the immediate needs of science teachers. From this study, science teachers' needs identified revolves around upgrading oneself in meeting the current challenges of teaching and learning science. This as indicated, is determined mostly by socio-political scenario of the country.

Another important feature which emerged from this study is the teachers' personal concern and awareness of the importance of self improvement. Especially in making their lessons meaningful and attractive, this would subsequently lead to improvement in the students' achievement. In conclusion, it is apt to mention that Ghanaian Senior High School science teachers, as empirically indicated in this study, indulge in keeping the best interest of their students. Teachers also maintain that lifelong learning which is at the heart of teacher development.

Also the dictates of our age pose a great challenge not only to the country but more importantly to teachers of science and technology. There is therefore the need to change both what used to be taught a decade ago and how it was taught then. The information environment is being rapidly pushed. This means that the learning opportunities and modes/styles of learning are also changing. Therefore a new approach to the teaching and learning of science and technology needs to be cultivated. The ICTs that create this challenge also offers tools to face it, provided science teachers are adequately prepared to use those tools. The shift in curriculum emphasis is certainly expensive, but the benefits of such investments that gear towards improving teaching and learning outcomes are immense. The infusion of ICTs into the curriculum and the adoption of such tools to aid classroom interactions and activities are issues teachers can no longer overlook. For science and technology to make the expected positive impact on national development, the science and technology curriculum must not only be relevant to the needs of the nation. The science and technology teacher must be abreast with new ways of teaching the subject. Therefore educational policy makers and the government must provide an ICT enabled school environment that would make the flourishing of science and technology possible.

At the national or regional level, it is important that the rural-urban divide be included in routine monitoring of the education system. Once schools are appropriately classified in terms of their geographical isolation, differences in gender and area of subject specialisation may emerge. Careful monitoring of these issues will help to keep the rural-urban divide on the policy agenda, and allow evaluation of the policy measures taken to alleviate the divide.

6.4 LIMITATIONS

According to Best and Khan (1995), limitations are those conditions beyond the researchers control that place restrictions on the conclusions of the study and their application to other situations.

During the study, the researcher faced some problems. These problems included:

- Some teachers were unwilling to fill in the questionnaires.
- Some teachers also did not present the questionnaires for collection.
- Schools geographical locations were widely dispersed.

The research work covered only the Central region of Ghana due to time and financial constriants.The target population used for the study were science teachers from Senior High Schools in Komenda Edina Eguafo Abrem District, Cape Coast Metropolis, Abura Asebu Kwamankese District, Assin South and Assin North Districts. Also the research work is not a textbook, it has its own limitations, but serves as a guide, of which suggestions can be used to improve it.

6.5 SUGGESTIONS FOR FURTHER STUDIES

This research raises issues that need to be addressed with regards to Ghanaian Senior High School science teachers in-service needs; a comparison across gender, school location and area of specialisation. More may also be done with other researchers who may wish to do so. They may research into the effects of science teachers in-service needs in Senior High Schools as well as in Tertiary Institutions. Another area of study can be carried out on the evaluation of science teachers needs.

REFERENCES

Akyeampong K. & Lewin K., (2002) "From Student Teachers to Newly Qualified Teachers in Ghana: Insights into Becoming a Teacher" *International Journal of Educational Development* 22 (3/4).

Anamuah-Mensah, J., (1995). Female Employment in Science and Technology, Journal of STME, Vol.No.2.

Castillo, Joan Joseph (2009). Research Population. Retrieved [28-10-2011] from Experiment Resources: http://www.experiment-resources.com/research-population.html

Cohen, L. and Manion, L., (1994) Research Methods in Education (Fourth Edition), ROUTLEDGE, London.

Kamisah, O., Lilia, H & Subahan, M.M., (2006). What Malaysian science teachers need to improve their science instruction: a comparison across gender, school location and area of specialization. *Eurasia Journal of Mathematics, Science and Technology Education*, 2 (2), 58-81.

Lyons, T., (2008). More equal than others? Meeting the professional development needs of rural primary and secondary science teachers. Retrieved [28-10-2011] from *Teaching Science*, http://www.articlearchives.com/education-training/education-systems-institutions/ 1894440-1.html.

MOEYS (2003). Education Sector Review (prepared by KwasiAnsu-Kyeremeh, Leslie Casley-Hayford, J.S. Djangmah, James Nti and Francois Orivel) Accra: MOEYS.

Subahan M. M, Lilia, H., Khalijah, M.S. & Ruhizan, M. Y., (2001). IRPA Report: Non-option physics teachers: preparation for better teaching. Support Teacher" Journal of Teacher Education 52 (1) Teachers in Ghana". MUSTER Discussion Paper 4. Sussex: Centre for International.

BIBLIOGRAPHY

Abd-El -Khalick F., Bell, R. L., & Lederman, N. G., (1998). The nature of science and instructional practice: Making the unnatural natural. Science Education 82. 417-436.

Adentwi, I.K., (2000) Curriculum Development: An Introduction: Kumasi, Skies.

Adler,I., & Reed,Y., (2002): Researching teachers take-up from a formal in-service professional development programme. In J. Adler & Y. Reed (Eds), Challenges of Teacher Development: An investigation of take-up in S.A (pp.36-52). Pretoria: Van Schaik.

Aduwa-Ogiegbaen Samuel Ereyi, Ede Okhion Sunday Iyamu (2005): Using Information and Communication Technology in Secondary Schools in Nigeria: Problems and Prospects. Educational Technology & Society 8(1): 104-112.

Agbo, S.A., (2003). A Learning Community Model For Professional Development and Transformational Teacher Education: Linking Teacher Preparation with In-Servive Teacher Learning and School Improvement. In: Preston DS (ed.). The idea of Education. Amsterdam, NY: Radopi.

Akyeampong, K. & Stephens D., (2000). "On the Threshold: The Identity of Student Teachers in Ghana". *MUSTER Discussion Paper 4*. Sussex: Centre for International Education, University of Sussex.

Akyeampong K, Djangmah J., Oduro A., Seidu A., & Hunt F., (2007). Access to Basic Education in Ghana: The Evidence and the Issues – Country Analytic Report: CREATE, University of Sussex.

Amir Salleh (1993). In-service training needs assessment for Malaysian secondary school teachers. Unpublished PhD Thesis, The University of Michigan.

Apple, M., (1995): Review of Educational Research, Vol.21, Washington,D.C, American Educational Research Association.

Ary, D., Jacobs, L.C., & Razaviehs, A., (1990): Introduction to Research in Education,4th Edition; Holt,Reinhart and Winston Publishers.

Awuku K., (2000). "Current Structure and Development in Basic Teacher Education" Paper presented at Institute of Education Test Development workshop, Saltpond, Ghana.

Baird, W & Rowsey, R., (1989). A survey of secondary science teachers' needs. School Science and Mathematics, 89(4):272-284.

Banilower, E.R., (2000). The Status of high school physics teaching: 2000 national survey of science and mathematics education. Chapel Hill: Horizon Research, Inc.

Beane, J. A. (Ed.). (1995). *Toward a coherent curriculum: The 1995 ASCD yearbook.* Alexandria, VA: Association for Supervision and Curriculum Development.

Bell, B., and Gilbert, J., (1996). *Teacher development: A model from science education*. London: The Falmer Press.

Berenson, S., Hodgin, K., Ward, C., Andrews,D. & Thomas, R., (1991) Needs Assessment of Elementary Teachers in Mathematics and Science: A Crucial Step Toward Planning a Statewide In-service program. *Journal of Science Teacher Education*, 16-21.

Best, J. W. & Khan, K. L., (1995) *Research in education.* (7thed) New Delhi: Prentice-Hall.

Best, J. W., (1993). Research in Education. New Jersey: Englewood, Cliffs, Inc.U.A.S.

Blankenship, J.W. & Moore, K. D., (1977). A factor-analytic approach to needs assessment, *Journal of Research in Science Teaching*, 14(6):507-514.

Borich, G.D., (1980). A needs assessment model for conducting follow-up studies. *The Journal of Teacher Education,* 3(3), 39 – 42.

Borko, H., (2004). Professional Development and Teacher Learning: Mapping the Terrain: Eduactional Researcher, 33(8), 3-15.

Brophy, J. et. al., (1986). *Teaching*. Educational Practices Series-1. UNESCO: International Academy of Education.

Byrne, (1983): How Teacher Education Matter, Journal of Teacher Education, Vol.51.

Bybee, R.W. et al (2003). Reforming science education. Social perspectives and personal reflections. NY: Teachers College Press.

Commonwealth of Australia., (2003). Journal article by Rae Wear; The Australian Journal of Politics and History, Vol. 45, 1999.

Conrath, M.M., (1986). Comparison of Selected Instructional and Classroom Management Practices of Graduates From Two Science Teacher Education Programs. (ERIC Document Reproduction Service No. ED 274522).

Craft, A., (1996). Continuing professional development: A practical guide for teachers and schools. London: The Open University Press.

Creswell, J. W., (2005). Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research. New Jersey: Pearson.

Cronbach, L.J., (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16, 297 – 334.

Dahama, O. P., (1979). *Extension and rural welfare.* New Delhi: Ram Parsad and Sons.

Darling-Hammond L., Wise A.E., & Klein S.P., (1999) *A License to Teach: Raising the Standards for Teaching*. Jossey-Bass Publishers, San Francisco.

Darling-Hammond, L., Wise, A. E., and Klein, S. P., (1995). A license to teach: Building a profession for twenty-first century schools. In J. Sikula (Ed.), Handbook of research on teacher education (pp. p. 67-101). New York: Macmillan.

Day, C., (1999). Developing teachers: The challenges of lifelong learning. London: Routledge.

De Vaus, D. A., (2001). Surveys in social research. London: Routledge.

Dillion, J, Osborne, J., Fairbrother, R. and Kurina, L., (2000). A study into the professional views and needs of science teachers in primary and secondary schools in England. London; King's College. Education, University of Sussex. Educational Development, 18 (5): pp. 393-403.

Doyle Brunson *et al.,* (2005). "My Story". *Super System 2*. Cardoza Publishing. pp. 41–68.

Driel, J.H.v., Beijaard, D., & Verloop, N., (2001). Professional Development and Reform in Science Education: The Role of Teachers' Practical Knowledge. Journal of Research I Science Teaching, 38(2), 137-158.

Ellis, T.I., (1984). Motivating Teachers for Excellence. ERIC Clearing House on Educational Management: ERIC Digest, Number 6. No : ED 259449.

Encarta (2007): Microsoft Encarta Premium. © 1993-2008 Microsoft Corporation.

Englehardt, L., (1983). *School Discipline Programs That Work.* Paper presented at the National School Boards convention (San Francisco, CA, April 23-26, 1983). (ERIC Document Reproduction Service No. ED 241993).

Erinosho, S.Y., (2009).Teaching science in secondary schools: A methodology handbook African Cultural Institute (The research/publishing division of African Culture International Centre) 110, Demurin Road, Ketu, Lagos, Nigeria.pp.101-104.

Eshun, B. A., (1990). *Sex-related Differences in Mathematics Achievement of Secondary School Students,* University of Cape Coast. Ghana.

Evertson C. M., Emmer E. T., Sanford. I. P. and Clements B. S., (1983). "Improving Classroom Management: An Experiment in Elementary School Classrooms." *The Elementary School Journal* 84.2:173-188.

Evertson. C. M.. And E. T., (1982). "Effective Management at the Beginning of the School Year in Junior High *Classes."Journal of Educational Psychology 74.4:* 485-498.

Fincher,S., & Tenenberg, J. (2007). Warren's question. In Proceedings of Third International Computing Education Research Workshop (ICER) (pp51-60). New York: ACM.

Flippo, E. B. (1961). *Principles of personnel management.* New York: McGraw Hill.

Gardner, R. C. (2000). *Psychological statistics using SPSS for windows*. Upper Saddle River New Jersey: Prentice Hall, Inc.

Gaynor, C., (1998) Decentralisation of Education: teacher management, The International Bank for Reconstruction and Development. Washington DC: World Bank.

Gess-Newsome, J., and Lederman N.G., (1994) "Examining Pedagogical Content Knowledge: The Construct and its Implications for Science Education," *Contemporary Trends and Issues in Education.*

Ghana Statistical Service (2011): Population and Housing Census. Summary Report of Final Results.

Gillespie, T. L., (2006). Engineering a Principle: 'End-to-End' in the Design of the Internet. Social Studies of Science. 36:427-457.

Gillespie, T. L., (2006). Designed to 'Effectively Frustrate': Copyright, Technology, and the Agency of Users. New Media & Society. 8:651-669.

Gliem, Joseph A., Gliem, Rosemary R., (2003): Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. The Ohio State University, 208 Ag. Admin Bldg., 2120 Fyffe Rd., Columbus, OH 43210.

Gottelmann-Duret, G. & Hogan, J., (1998) *The utilization, deployment and management of teachers in Botswana, Malawi, South Africa and Uganda.* Paris: UNESCO.

Government of Ghana, (2002). Introducing information and communications technology in pre-tertiary institutions: A policy framework. Government publishers: Accra.

Harlen, W., (1997). Primary teachers' understanding in science and its impact in the classroom. Research in Science Education, 27: 323 – 337.

Hartl, P., (1994) *Psychologický slovník (The Dictionary of Psychology)*. Praha: Budka,

Hawk, P. P., Coble, C. R., & Swanson, M.(1985). Certification: It does matter. *Journal of Teacher Education, 36*(3), 13–15.

Hedges, J., (2000). *The importance of posting in becoming a teacher in Ghana.* (University of Sussex Centre for International Education MUSTER Discussion Paper No. 13). Retrieved March 22, 2003 from http://www.sussex.ac.uk/usie/muster/reports/MDP%2013- 1102.doc

Hedges, John (2002). 'The importance of posting and interaction with the education bureaucracy in becoming a teacher in Ghana' *International Journal of Educational Development*, 22, 353–366.

Hustler, D., (2003).*Teachers' Perception of Continuing Professional Development*. London: DfES.

IGNOU (2007). Educational Research: Different Types of Studies in Educational Research. Block 2, IGNOU. New Delhi.

Integrated Science Teaching Syllabus For Senior High Schools (2007).

Ives, R., (1984). The Maleness of Science. The Australian Science Teachers' Journal.

Jegede, J.O., Agholor, R. and Okebukola, P.A.O., (1996). Gender differences in the perception of and preferences for the socio-cultural science classroom climate in Nigeria. International Review of education 5(55) 86-108.

Jegede, O., et al., (1996). Towards a culturally sensitive and relevant science & technology education. A symposium held within the 8th symposium of the International Organization for Science and Technology Education (IOSTE), Edmonton, Canada.

Jegede, O. J., (1999). Worldview, collateral learning and the use of science and technology for national development. In Clements, M.A. and Leong, Y. P. (Eds.*) Cultural and language Aspects of Science, Mathematics and Technical Education*, *(pp. 71-86).* University Brunei Darussalam.

Jessop, T. & Penny, A., (1998). "A Study of Teacher Voice and Vision in the narratives of Rural South African and Gambian Primary School Teachers" *International Journal of Educational Development*, 18 (5): pp. 393-403.

Joyce, B. et al., (1993). The *Self-Renewing Schools*. Alexandria: Association for Supervision and Curriculum Development.

Jucious, M. J., (1963). *Personnel management* (5th ed.). Homewood, IL: Richard D. Irwin.

Kamariah, A.B., (1984). *A comparison of the perceptions of Malaysian secondary science teachers and teacher educators regarding the science teaching needs of Malaysian secondary teachers*. Unpublished doctoral dissertation, Southern Illinois University.

Kamariah A. B, Peter Rubba, Audrey N. Tomera & Abdel Rahman Zurub (1988) Jordanian and Malaysian science teachers' prominent perceived professional needs: A comparison. *Journal of Research in Science Teaching*, 25(3): page 170-182.

Kamisah, O., (1999). Inculcating and integrating the use of critical thinking skills in science student teachers in Malaysia. Unpublished Phd Thesis, University of Manchester, United Kingdom.

Kaufman, R., (1972). *Educational system planning*. Englewood Cliffs: NJ: Educational Technology Publications.

Kerlinger, F.N. & Lee, H.B., (2000). Foundations of behavioural research. Fourth edition. Australia: Wadsworth Thompson.

Khan A., (1990). African Women make Grade in Science and Technology: Daily Graphic, November 1, 1990, page 5 column 1-5.

Klaassen & Lujnse, (1996).Teaching and Coherent Science: An Investigation of Teachers' Beliefs About and Practice of Teaching Science Coherently.

Kotler, P., (1982). Marketing for non-profit organizations (2nd Ed). Englewood Cliffs, NJ: Prentice Hall.

Kofi Poku Quan-Baffour, (2007). Continuous Professional Development: A Strategy to Enhance Quality of Teaching at the School level, University of South Africa, South Africa. *The International Journal of Learning, 14*(1), 183-189.

Lang, P.J et al., (1994). The motivational organization of emotion: affect-reflex connections. In: VanGoozen, S., Van de Poll,N.E. and Sergeant, J.A. (Eds.), Emotions: Essays on Emotion Theory. Erlbaum, Hillsdale, NJ, pp. 61–93.

. Lantz, J., (1994a). Mystery in family therapy. *Contemporary Family Therapy, 16*, 53-66.

Lederman, N. G., (1999). Teachers' understanding of the nature of science and classroom practice: Factors that impede the relationship. Journal of Research in Science Teaching, 36(8), 916-929.

Lederman, N. G. & Niess, M. L., (1998). Survival of the fittest. School Science and Mathematics, 98(4), 169-172.

Lee, Hea-Jin., (2001). Enriching the Professional Development of Mathematics Teachers. ERIC Digest. EDO-SE-01-01.

Lee, Hea-Jin., (2004). Developing a Professional Development Programme. *Model Based on Teachers' Needs. Professional Educator,* 27(1-2), 39-49.

Lee, M.N.N., (1992). School science curriculum reforms in Malaysia: world influences and national context. International Journal of Science Education, 14(3), 249-263.

Levy, R.B.-B.,& Ben-Ari, M.,(2007). We work so hard and they don't use it: acceptance of software tools by teachers ACM SIGCSE Bulletin, 39(3), 246-250.

Loucks-Horsley, S., Hewson, P.W., Love, N. and Stiles, K.,(1998). Designing professional development for teachers of science and mathematics. California: Corwin Press, Inc.

Mager, R.F., (1984). *Preparing instructional objectives.* (2nd ed.). Belmont, CA: David S. Lake.

Malone, V. M., (1984). In-service training and staff development. In B. E. Swanson (Ed.), *Agricultural extension: A reference manual.* Rome: FAO.

Marsh, C., (2000). *Handbook for Beginning Teachers.* (2nd Ed.) Sydney: Longman Publishing.

McGarity John R., Butts David P, (1984). The relationship among teacher classroom management behaviour, student engagement, and student achievement of middle and high school science students of varying aptitude: Journal of Research in Science Teaching Volume 21, Issue 1, pages 55–61.

Mohamad, I., (2002). Kajian Keperluan Guru-Guru Sains Sekolah Rendah dalam Pengajaran Sains with Need Analysis Study of Primary School Science Teachers in Science Teaching. Unpublished Masters dissertation, Universiti Kebangsaan Malaysia.

Ministry of Education – (MOE), (2009). *Report on e-Readiness Assessment of Second Cycle Institutions in Ghana*. Accra: ICT in Education Programmes Unit, Ministry of Education.

Moore, K. & Blankenship, J. W., (1978). Relationships between science teachers' needs and selected teacher variables, Journal of Research in Science Teaching, 15(6):513-518.

Murphy, G. L., (2002). Anti-summary and conclusions. In *The big book of concepts* (pp. 477-498). Cambridge, MA: MIT Press.

Nagel,T.,(2003) 'What is quality of education and why is it important for development?'Keynote address. International Conference on Quality in Education. pp.11-13. Oslo Norway.

National Research Council., (1996b). National science education standards. Washington, DC: National Academy Press.

National Research Council., (1996c). The preparation of teachers of mathematics: Considerations and challenges. Washington, DC: National Academy Press.

National Research Council., (1996d). The role of scientists in the professional development of science teachers. Washington, DC: National Academy Press.

Neuman, W.L., (2000). Social research methods: Qualitative and quantitative approaches. Boston: Allyn and Bacon.

Nyerere, J. K., (1988). *20 years of Education for Self-Reliance*. Paper presented at the CHAKIWATA Symposium, Moshi, Tanzania.

Osborne, R., & Freyberg, P., (1985). *Learning in science: The implication of children's science*. Auckland: Heinmann.

Parker, L., (1984). Science for all? The role of Science Teachers in eliminating gender differences in access to scientific knowledge. The Australian Science Teachers' Journal 30(1) 21-24.

Parkinson, J., (2004). Improving secondary science teaching. London: Routledge Palmer. Presented at Institute of Education Test Development workshop, Saltpond, Ghana.

Putnam, R., & Borko, H., (1996). Learning to teach. InD. Berliner & R.Calfee (Eds.), Handbook of Educational Psychology (pp.673-708). New York: Macmillan.

Quasie, J., (1999). Gender bias in the curriculum. Gender Matters 4.

Richards, J.C., Gallo,P., & Renandya, W.A., (1999). Exploring teachers' beliefs and the processes of change. Retrieved11/11, 2010 from http://www.professorjackrichards.com/pdfs/exploring-teacher-change.pdf.

Rubin, A., (1996*). Educational technology: Support for inquiry based learning*.

Rubba, R., (1981). Chemistry teachers' in-service needs: Are they unique? Journal of Chemical Education, 58(5):430-31.

Rust, V. & Dalin, P. (Eds.), (1990). *Teachers and teaching in the developing world*. New York: Garland.

Rutherford, F. J., (1964). The Role of Inquiry in Science Teaching. *Journal of Research in Science Teaching*, Vol. 2, pp. 80-84.

Schmidt, W. H., McKnight C.C, and Raizen, S.A., (1997). *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education.* Boston: Kluwer Academic Publishers.

Shulman, L.S., (1986). "Those Who Understand: Knowledge Growth in Teaching," *Educational Researcher* 15 (2), 4-14.

Shulman, L.S., (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, 57: 1-22. Standards for Teaching. Jossey-Bass Publishers, San Francisco.

Stephens D., (2003). Quality of Basic Education, Professor of International Education, Oslo University College, Oslo. Norway, david.stephens@lu.hio.no.

Smith, P.S., (2000). *The status of high school chemistry teaching: 2000 national survey of science and mathematics education*. Chapel Hill: Horizon Research, Inc.

Stronge James H., (2007).Qualities of Effective Teachers, 2nd Edition.

State of Delaware High School Science Summary, (2002).

http://www.rbs.org/mathsci/states/de/needs_assessment/state/high_science_summer.html

Sweigert, R.L. & Kase, D.H., (1971). *Assessing students' needs using the ESCO model*. Paper presented at the Annual Meeting of the American Educational Research Association, New York City (February 1971). Tallahassee, Fl: Association for International Research.

Tella, Adeyinka., (2007).The place of Information technology in Childhood Education. In Ajiboye, J.O.and D, Mapolelo. Principles and Practice of Childhood Education in Africa. (Chapter in a book). (In Progress).

Tomei, L. A., (2005). Taxonomy for the Technology Domain. USA: Information Science Publishing.

Towse, P., Kent, D., Osaki, F., & Kirua, N., (2002) Non-graduate teacher recruitment and retention: some factors affecting teacher effectiveness in Tanzania. *Teaching and Teacher.*

Travers Paul D.,Rebore Ronald W., (2000) Foundations of Education : Becoming a Teacher Publisher: Allyn & Bacon, Inc**.**

UNESCO (2010). Education for All Global Monitoring Report: Reaching the marginalized. Paris. UNESCO.

UNICEF Ghana, (2006). "Abolition of School fees", Issue Briefing Note 9, July 2006.

Van Dorsal, W. R., (1962). *The successful supervisor.* New York: Harper and Row.

VSO, (2002). What Makes Teachers Tick: A Policy research report on teachers motivation in developing countries. VSO, UK.

Waring, M., (1979). The implementation of curriculum in school science in England and Wales. Journal of Science/ Education 1(3): 257-275.

Walberg, H., (1988). "Synthesis of Research on Time and Learning." *Educational Leadership* 45.6: 76-85.

Wharton-McDonald, R., Pressley, M., & Hampston, J., (1998). Literacy Instruction in Nine First-Grade Classrooms: Teacher Characteristics and Student Achievement. *Elementary School Journal, 99,* 103-119.

Williams, D., Wilson, K., Richardson, A., Tuson, J. and Coles, L., (1999). *'Teachers' ICT Skills and Knowledge Needs'.* Interchange No. 58, Edinburgh: Scottish Office.

Witkins, B.R., (1984). *Assessing needs in educational and social programs*. San Francisco, CA: Jossey-Bass Publishers.

Weiss, I. R., Pasley, J. D., Smith, P. S., Banilower, E. R. & Heck, D. J., (2003). *Looking inside the classroom: A study of K-12 mathematics and science education in the United States*. Chapel Hill, NC: Horizon Research.

Weiss, I. R. & Pasley, J. D., (2006). Scaling up instructional improvement through teacher professional development: Insights from the Local Systemic Change Initiative *CPRE Policy Brief,* (*RB44*), 1-16.

World Bank., (2002a) Financing Education for All by 2015: Simulation for 33 African countries. Washington DC: World Bank Publications.

World Bank., (2002b) Achieving Education for All by 2015. Washington DC: World Bank Publications.

World Education Forum., (2000). The Dakar Framework for Action. Paris: UNESCO "An investigative study of the abuse of girls in African schools." Education "Urban livelihoods and food and nutrition security in Greater Accra, Ghana."

Zurub, A.R. and Rubba, P.A., (1983). Development and validation of an inventory to assess science teachers' needs in developing countries, Journal of Research in Science Teaching, 20(9):867-873.

APPENDIX A

IN SERVICE TRAINING NEEDS FOR MALAYSIAN SECONDARY SCIENCE TEACHER

SECTION 1: RESPONDENT INFORMATION

INSTRUCTIONS: Please tick (√) in the boxes below

1. School:
2. School Address:

3. School location: ☐ Urban ☐ Rural

4. Gender: ☐ Male ☐ Female

5. Ethnicity:
- ☐ Malay
- ☐ Chinese
- ☐ Indian
- ☐ Sabah/Sarawak Aborigin
- ☐ Other (Please state) ____________

6. Age:
- ☐ 21 to 30 years
- ☐ 31 to 40 years
- ☐ 41 to 50 years
- ☐ More than 50 years

7. How many years of teaching experience? : __________ years

8. Highest level of education:
   - SPM
   - STPM
   - Diploma
   - First Degree
   - First Degree with Education. * ***Go to Item 12***
   - Master
   - Education Master
   - Others (Please state) ___________

9. Please state you academic course:

(a) Major
- Physics
- Chemistry
- Mathematics
- Biology
- Science
- Others (Please State) ________

(b) Minor
- Physics
- Chemistry
- Mathematics
- Biology
- Science
- Others (Please State) __________

10. Highest professional qualification
- Teaching Certificate
- Teaching Diploma
- Postgraduate Diploma in Education
- None
- Others (Please State) ________

11. Your current status as a teacher

- [ ] Permanent teacher
- [ ] Probation teacher
- [ ] Temporary teacher
- [ ] Others (Please State) ________

12. Please tick the following subject(s) that you are teaching now

- [ ] Physics
- [ ] Chemistry
- [ ] Mathematics (Lower Secondary School)
- [ ] Mathematics (Upper Secondary School)
- [ ] Biology
- [ ] Science (Lower Secondary School)
- [ ] Science (Upper Secondary School)
- [ ] Others (Please State) __________

13. Please tick number of years teaching based on the subject below

Subject	**Less than a year**	**1 to 3 years**	**4 to 6 years**	**7 to 9 years**	**More than 10 years**
Physics					
Chemistry					
Mathematics (Lower Secondary School)					
Mathematics (Upper Secondary School)					
Biology					
Science (Lower Secondary School)					
Science (Upper Secondary School)					
Others (Please State) ___________					

14. Please state in service courses that you have followed since three years back

Courses Name	Date and period	Sponsored by

SECTION 2: IN SERVICE TRAINING NEEDS FOR SCIENCE TEACHERS

Questionnaires in SECTION 2 contain 72 statements related with dimensions of teachers need in teaching and managing science in classroom. You are requested to read all the statements carefully and tick (√) in the given box based on the scale below:

0	Not sure of requirement
1	Strongly not required
2	Not required because has an experience
3	Not required because not practiced
4	Moderately required
5	Strongly required

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderately required	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
1	Constructing science questions based on teaching objectives						
2	Using test results to identify level of student readiness						
3	Using test bank in science assessment						
4	Using test results to identify student difficulties in learning						
5	Using various oral questions to determine students abilities						
6	Selecting test questions for diagnosis						
7	Using scores of test result to keep track of student's enhancement						
8	Reporting students achievement to parents						
9	Selecting suitable teaching strategies						
10	Using students readiness information for planning the teaching						
11	Understanding the requirements of syllabus						
12	Preparing various of teaching materials						
13	Arrangement of teaching and learning science activities						
14	Motivating students to learn science						
15	Using 'inquiry' strategy in teaching science						
16	Conducting practical classes in science laboratory						
17	Planning science teaching outside classroom (eg: visits)						
18	Using visual-audio tools to support science teaching						
19	Using appropriate teaching strategies in class with various skills of students						
20	Using computer effectively in teaching science						
21	Diversifying the science teaching activities						
22	Managing time in teaching science subject						

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderate requirement	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
23	Inculcating spiritual values in science teaching						
24	Relating science subject with daily life						
25	Using simulation techniques in teaching science						
26	Using appropriate teaching strategies to treat individuals in teaching science						
27	Using library to support science teaching						
28	Implementing PEKA (Assessing students laboratory skills) as required						
29	Conducting demonstration to facilitate students' understanding of the science concept						
30	Teaching science in English						
31	Preparing daily phenomenon related to what to teach						
32	Integrating thinking skills in science teaching						
33	Preparing safe science laboratory environment for students						
34	Controlling students discipline during teaching science						
35	Self reflection before, during and after teaching science						
36	Managing the budget for science teaching						
37	Keeping student record to keep track of their achievement						
38	Using inquiry technique to guage students understanding						
39	Providing questions orally to trace students understanding						
40	Supervising laboratory assistant in preparing material/apparatus						
41	Organizing a conducive science laboratory for learning						
42	Developing rules of keeping materials/apparatus tools in laboratory						
43	Maintaining the laboratory equipment						

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderate requirement	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
44	Selecting suitable science laboratory equipment for teaching						
45	Identifying free and cheap resources of science teaching materials						
46	Selecting suitable support materials (books, film, internet) as teaching aid						
47	Developing low cost teaching science materials						
48	Using science software effectively for teaching using computer						
49	Maintaining living organisms for teaching science						
50	Improving basic mathematics in science						
51	Updating content knowledge in chemistry						
52	Updating content knowledge in physics						
53	Updating content knowledge in biology						
54	Updating scientific skills in chemistry						
55	Updating scientific skills in physics						
56	Updating scientific skills in biology						
57	Updating knowledge about the use of science in daily life						
58	Updating knowledge about career guidance related to science for students						
59	Updating knowledge for social issues related to science						
60	Updating knowledge on cognitive theory, teaching and learning						
61	Obtaining innovative information of teaching science						
62	Be creative in science teaching						
63	Enhancing thinking skills						
64	Enhancing academic qualifications						
65	Updating knowledge on how to be a reflective teacher						

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderate requirement	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
66	Enhancing communication skills in English						
67	Updating the knowledge of appropriate requirements for specific title						
68	Enhancing skills to develop action research						
69	Enhancing teamwork skills						
70	Taking advantage studies in science education						
71	Enhancing professionalism through short courses						
72	Enhancing the knowledge of ICT towards teaching more attractive						
73	Other suggestion of in service courses						

APPENDIX B

IN SERVICE TRAINING NEEDS FOR GHANAIAN SENIOR HIGH SCHOOL SCIENCE TEACHERS

SECTION 1: RESPONDENT INFORMATION

INSTRUCTIONS: Please tick (√) in the boxes below

1. School:
2. School Address:

3. School location: ☐ Urban ☐ Rural

4. Gender: ☐ Male ☐ Female

5. Age:
   - ☐ 21 to 30 years
   - ☐ 31 to 40 years
   - ☐ 41 to 50 years
   - ☐ More than 50 years

6. How many years of teaching experience? : __________ years

7. Highest level of education
   - ☐ Diploma
   - ☐ First Degree
   - ☐ First Degree with Education. * ***Go to Item 12***
   - ☐ Master
   - ☐ Master in Education
   - ☐ Others (Please state) ___________

8. Please state you academic course:

(a) Major
- ☐ Physics
- ☐ Chemistry
- ☐ Biology
- ☐ Integrated Science
- Others (Please State) ________

(b) Minor
- ☐ Physics
- ☐ Chemistry
- ☐ Biology
- ☐ Integrated Science
- Others (Please State) __________

9. Highest professional qualification

- [ ] Teaching Certificate
- [ ] Teaching Diploma
- [ ] Postgraduate Diploma in Education
- [ ] Postgraduate in Education
- [ ] Others (Please State) ________

10. Your current status as a teacher

- [ ] Permanent teacher
- [ ] Intership teacher/ National Service
- [ ] Part-time teacher
- [ ] Others (Please State) ________

11. Please tick the following subject(s) that you are teaching now

- [ ] Physics
- [ ] Chemistry
- [ ] Biology
- [ ] Integrated Science
- [ ] Others (Please State) __________

12. Please tick number of years teaching based on the subject below

Subject	**Less than a year**	**1 to 3 years**	**4 to 6 years**	**7 to 9 years**	**More than 10 years**
Physics					
Chemistry					
Biology					
IntegratedScience					
Others (Please State) ___________					

13. Please state in service courses that you have followed since three years back

Courses Name	Date and period	Sponsored by

SECTION 2: IN SERVICE TRAINING NEEDS FOR SCIENCE TEACHERS

Questionnaires in SECTION 2 contain 70 statements related with dimensions of teachers need in teaching and managing science in classroom. You are requested to read all the statements carefully and tick (√) in the given box based on the scale below:

0	Not sure of requirement
1	Strongly not required
2	Not required because has an experience
3	Not required because not practiced
4	Moderately required
5	Strongly required

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderately required	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
1	Constructing science questions based on teaching objectives						
2	Using test results to identify level of student readiness						
3	Using test bank in science assessment						
4	Using test results to identify student difficulties in learning						
5	Using various oral questions to determine students abilities						
6	Selecting test questions for diagnosis						
7	Using scores of test result to keep track of student's enhancement						
8	Reporting students achievement to parents						
9	Selecting suitable teaching strategies						
10	Using students readiness information for planning the teaching						
11	Understanding the requirements of syllabus						
12	Preparing various of teaching materials						
13	Arrangement of teaching and learning science activities						
14	Motivating students to learn science						
15	Using 'inquiry' strategy in teaching science						
16	Conducting practical classes in science laboratory						
17	Planning science teaching outside classroom (eg: visits)						
18	Using visual-audio tools to support science teaching						
19	Using appropriate teaching strategies in class with various skills of students						
20	Using computer effectively in teaching science						
21	Diversifying the science teaching activities						
22	Managing time in teaching science subject						

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderate requirement	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
23	Inculcating cultural values in science teaching						
24	Relating science subject with daily life						
25	Using simulation techniques in teaching science						
26	Using appropriate teaching strategies to treat individuals in teaching science						
27	Using library to support science teaching						
28	(Assessing students laboratory skills) as required						
29	Conducting demonstration to facilitate students' understanding of the science concept						
30	Preparing daily phenomenon related to what to teach						
31	Integrating thinking skills in science teaching						
32	Preparing safe science laboratory environment for students						
33	Controlling students discipline during teaching science						
34	Self reflection before, during and after teaching science						
35	Managing the laboratory for science teaching						
36	Keeping student record to keep track of their achievement						
37	Using inquiry technique to guage students understanding						
38	Providing questions orally to trace students understanding						

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderate requirement	Strongly require
	I think that I need help for:-	0	1	2	3	4	5
39	Supervising laboratory assistant in preparing material/apparatus						
40	Organizing a conducive science laboratory for learning						
41	Developing rules of keeping materials/apparatus tools in laboratory						
42	Maintaining the laboratory equipment						
47	Using science software effectively for teaching using computer						
48	Maintaining living organisms for teaching science						
49	Improving basic mathematics in science						
50	Updating content knowledge in chemistry						
51	Updating content knowledge in physics						
52	Updating content knowledge in biology						
53	Updating scientific skills in chemistry						
54	Updating scientific skills in physics						
55	Updating scientific skills in biology						
56	Updating knowledge about the use of science in daily life						
57	Updating knowledge about career guidance related to science for students						
58	Updating knowledge for social issues related to science						
59	Updating knowledge on cognitive theory, teaching and learning						
60	Obtaining innovative information of teaching science						
61	Be creative in science teaching						
62	Enhancing thinking skills						
63	Enhancing academic qualifications						
64	Updating knowledge on how to be a reflective teacher						

		Uncertain requirement	Strongly not required	Not required because has an experience	Not required because not practice	Moderate requirement	Strongly required
	I think that I need help for:-	0	1	2	3	4	5
65	Updating the knowledge of appropriate requirements for specific title						
66	Enhancing skills to develop action research						
67	Enhancing teamwork skills						
68	Taking advantage studies in science education						
69	Enhancing professionalism through short courses						
70	Enhancing the knowledge of ICT towards teaching more attractive						

APPENDIX C

UNIVERSITY OF EDUCATION, WINNEBA
SCHOOL OF GRADUATE STUDIES (SGS)
P. O. Box 35, Winneba, Ghana. Tel: (0432) 220027 Fax (0432) 22361 E-mail: graduateschool@uew.edu.gh

SRGS. 55/IL

February 7, 2011

TO WHOM IT MAY CONCERN

DEAN,
SCHOOL OF GRADUATE STUDIES
UNIVERSITY OF EDUCATION
WINNEBA

Dear Sir/Madam,

LETTER OF INTRODUCTION:

MR. AMOAH, JOHN EKOW MBIR

We introduce to you Mr. Amoah, John Ekow Mbir, a postgraduate student of the University of Education, Winneba.

Mr. Amoah, John Ekow Mbir was admitted into the University of Education, Winneba with student identity Number: 8090130023 in 2009/2010 Academic Year to pursue M. Phil in Science Education. He is expected to graduate by July 2011.

The School of Graduate Studies would be very grateful if you could offer Mr. Amoah, John Ekow Mbir the required assistance.

Thank you.

Yours faithfully,

Prof. S. M. Quartey
(Dean)

DEAN,
SCHOOL OF GRADUATE STUDIES
UNIVERSITY OF EDUCATION
WINNEBA

APPENDIX D

A FRAMEWORK OF IN-SERVICE TRAINING MODEL FOR MALAYSIAN SCIENCE TEACHERS