# UNIVERSITY OF EDUCATION, WINNEBA

## ENHANCING THE PERFORMANCE AND INTEREST OF PRE-SERVICE TEACHERS IN SELECTED INTEGRATED SCIENCE TOPICS USING COMPUTER-BASED MODELS

**EDWARD APENEN ADAKUDUGU**

**2014**

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A THESIS IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF PHILOSOPHY (SCIENCE EDUCATION) DEGREE.

**OCTOBER, 2014**

# DECLARATION

## Candidate's Declaration

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

Signature: ............................................................

Date: ................................................................

## Supervisors' Declaration

We hereby declare that, the preparation and presentation of this M. Phil Thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the school Graduate Studies, UEW.

Signature: ......................................

Date: ..............................................

Dr. Ernest Ngman-Wara

(Principal supervisor)

Signature: .......................................

Date: ...............................................

Dr. Thomas Tachie Young

(Supervisor)

# DEDICATION

I dedicate this thesis to the Adakudugu Amali family, especially my late mother Georgina Aguuri Adakudugu.

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# ABSTRACT

The study sought to improve the performance and interest of pre-service teachers in selected integrated science topics using Computer-Based Models (CBM). The study was carried out in Gbewaa College of Education, Pusiga in the Upper East Region of Ghana. Action research design with mixed method approach was utilized in the study. A purposive sampling technique was used to select a sample of 208 pre-service teachers out of a total population of 1021 pre-service teachers of Gbewaa College of Education. Questionnaire, test, observation schedule and interview protocol were the main instruments used for the data collection. A t-test was used to test whether there was any difference between the male and female pre-service teachers' interest in selected integrated science topics and their academic performance. From the analysed data, it was found out that an average of 80% of the pre-service teachers who participated in the study performed creditably in tests1, 2, 3 and 4 in selected integrated science topics. The results indicated a lot of improvement in the performance of the pre-service teachers. They also exhibited positive interest towards learning and studying the selected integrated science topics. Additionally, the findings of the research indicated that the male and female pre-service teachers performed equally well when they were taught selected integrated science topics using CBM. In line with these findings, it was recommended that CBM should be used in the teaching of integrated science in the target institution.

# CHAPTER ONE

## INTRODUCTION

### Overview

This chapter presents the background to the study, statement of the problem, the purpose of the study, objectives of the study, the research questions and significance of the study. The chapter also encompasses delimitation, limitation, operational definition of terms and organisation of the study.

### Background to the Study

Pre-service teachers training has been undergoing some major changes in perspective and approaches over the last and this current century (Pecku, 2011). Each major transformation puts a lot of expectations on the part of the pre-service teacher. The pre-service teacher is expected to acquire new subject matter to enable them deliver well after training and to implement the new educational reforms introduced by the government of Ghana on the recommendations of the Anamuah-Mensah Education Review Committee Report (2007). These transformations may result in different order of commitment from the pre-service teachers and their tutors in the emerging perspectives and expectations.

Since independence, there have been many attempts at transforming pre-service teacher training in Ghana. They include the introduction of Two-year post secondary teacher's certificate 'A' in 1961, three-year post-secondary teacher's certificate 'A' in1975, the 2004 transformation of Colleges of Education (CoE) into diploma awarding institutions and the recent upgrading of CoE to tertiary status (Pecku, 2011). Antwi (1992) attested that Teacher Education (TE) have undergone metamorphosis over the years with corresponding changes. These transformations brought a lot of changes in subject content and methodologies with new expectation on the part of the pre-service teacher to have positive interest in all subject areas especially integrated science. For example, the most recent transformation of 2004 brought in subjects such as Information and Communication Technology (ICT), HIV/AIDS education and integrated science to mention but a few. Integrated science was introduced as a Foundation Development Course (FDC) into the CoE curriculum to replace the General science which was taught in CoE before the new transformation demanding pre-service teachers to develop interest towards the subject in order for them to perform creditably.

The rationale for the introduction of integrated science into the CoE curriculum is to consolidate pre-service teachers' knowledge gained from the Senior High Schools and also intended to provide basic knowledge and practice in the use of effective methods in the teaching of integrated science (CRDD, 2005). The curriculum is also to expose the pre-service teachers to good practices in the teaching of integrated science. This is aimed at developing the spirit of creativity, manipulative skills, critical thinking and for effective communication of scientific ideas. It is also to enable each pre-service teacher to explore and show appreciation of their environment and to develop a healthy attitude and interest towards school science (CRDD, 2005). The ultimate goal is to develop scientific and literacy skills among the Ghanaian pre-service teachers and their future students needed to raise the standard of living of Ghanaians.

Many basic schools teachers, although competent and enthusiastic in most of the subjects they teach, simply do not have positive interest in integrated science and do not feel comfortable teaching it because of their upbringing during their pre-service teacher days (Vaidya, 2011). Yet today, the public is continually reminded of the substantial gap between current integrated science curriculum being taught in our schools and colleges and the scientific and technological orientation needs for tomorrow's career (Hadfield, 2010).

Arguments supporting the need for better integrated science education in the basic schools have been based on the desire to develop in today's students the knowledge, reasoning, and problem-solving skills required for the rapidly changing and technology based society (Plourde, 2002). Today, the study of integrated science is not only what students know or content but also how students come to know it or process. There is a disconnect that exists between the way integrated science is done and the way integrated science is taught. The reality is that schools and colleges are driven by examination which creates students lack of interest in almost every subject especially integrated science.

According to Anamuah-Mensah and Asabere-Ameyaw (2007), students have not benefited much from science and mathematics education since its introduction in the 1960s. This is attributed to pre-service teachers' lack of interest in the study of science and mathematics which transcend to the actual world of work that is teaching. However, authorities have over the years tirelessly sought to increase and sustain interest and performance of students in science and technology as well as other important science related courses by organising programmes such as science and mathematics quiz; Science, Technology and Mathematics Education (STME) clinics, science seminars and so on from the basic level to the Higher levels of education but all these efforts are yielding very little results.

For this, the Government of Ghana has placed high emphasis on Information and Communication Technology (ICT) as a means of improving teaching, governance accountability and transparency for the development of human resources potentials and strengthening national unity. The country's medium-term development plan, captured in the Ghana Poverty Reduction Strategy (GPRS I & II) and the Education Strategic Plan (2003-2015) to enhance these national goals, the Ghana ICT for Accelerated Development (ICT4AD) policy was developed through a nationwide consultation with stakeholders as a plan for the Development of Ghana information society and economy through education (Republic of Ghana, 2003). According to the ICT4AD policy, Ghana's educational system is expected to modernise by using ICT to: (i) improve and expand access to educational training and research resources, (ii) improve the quality of education and training and (iii) make the educational system responsive to the need and requirement of the economy and society with specific reference to the development of the information and knowledge-based economy and society (Republic of Ghana, 2003).

In addition, ICT in whose age societies have existed for some time now is seen by many as being a panacea for all ills. The technologies associated with it have indeed, proven to be the panacea for the advancement in many sectors of the global economy (Kumar, Mittal, & Nandi, 2011). The high precision, swiftness and convenience provided by ICTs have enhanced the global health care system; improved financial transactions across the globe and contributed to education in some parts of the world. On the other hand, use of computers for educational purpose, Traynor (2003) explained that computers are not only as means of helping schools analyse data, but that computers have become pervasive tools towards optimising students' interest in learning in some countries.

Research has also indicated that ICT can play a major role in enhancing and extending practical work. Handheld computers, for example offer new possibilities for collecting and analysing data in the field (Newton, 2000) while digital video can be used to capture processes that cannot be seen in real time (McFarlane & Sakellariou, 2002). Hence, a key problem in integrated science is that many students lose interest in the subject as they progress through school (Murphy, 2003). Research also suggests that ICT may help combat this by giving students more control over their learning and allowing them to study topics relevant to their society (Osborne & Collins, 2000). Therefore, students are more engaged in activities they show increased interest and demonstrate a longer attention span.

In recent years, there has been a shift from the use of science as a vehicle through which students learn and use Information Technology (IT) skills to the use of ICT skills as a tool to assist learning in integrated science. One of these tools is Computer-Based Models (CBM) such as streamed videos, podcast, streamed media, and computer simulations and so on

Considering the enormous positive impact made by ICT in some of the above stated areas of our human endeavours, there is the need to exploit these technologies, blend them with other memory enhancing pedagogies to promote students' interest and performance in such challenging subject as integrated science. Despite the enormous importance of this technology, Ghanaian CoE especially Gbewaa College of Education is yet to tap fully into this technology in the teaching and learning of integrated science. Therefore, it is necessary to research into how computer-based models will influence pre-service teachers' interest and performance in integrated science.

**Statement of the Problem**

Although integrated science is an important subject and much is put into the teaching of this subject, evidence from numerous research studies reported that many students' interest in studying it is very low (Prescott, Mitchelmore & White, 2010) both at Senior High School (SHS) and at Colleges of Education (CoE). The absence of well equipped laboratories for practical activities at SHS and CoE is a contributory factor (Anderson, 2002). The lack of science laboratory equipment, appropriate teaching and learning materials and other curriculum materials in schools and colleges de-motivates students in studying science (Watters & Ginns, 2000).

Pre-service teachers' interest in integrated science and enjoyment of science may be important for good performance in college integrated science. The Second Year pre-service teachers of Gbewaa College of Education performed poorly in integrated science examinations conducted between 2009 and 2013 by the Institute of Education, University of Cape Coast (Institute of Education-UCC, 2013). More than 25% of the pre-service teachers obtained grades between D to E in the examination. In 2013, out of 222 candidates who sat for the CoE second year, second semester examination, 135 (60.81%) either had weak passes or trailed (Institute of Education-UCC, 2013). This has been a worry among stakeholders in education including the Academic Board of Gbewaa College of Education. This situation has created the perception among most pre-service teachers that integrated science is difficult and the subject is the preserve of the more gifted or their academically talented counterparts. This seems to explain why many pre-service teachers lack interest in studying integrated science at the college level.

Research reports (Njoku, 2004) on the status of integrated science in schools and CoE in Nigeria and that of Ghana (Anamuah-Mensah & Benneh, 2006) show that science classroom activities are still dominated by teacher-centred methods, such as lecture and teacher demonstration methods that place students in a passive rather than an active role, which hinders learning. These methods have been found to be ineffective in promoting science learning at the primary, senior high and CoE levels (Burchinal, Mashburn, Pianta, & Vandergrift, 2009; Lynch, 2010). The resultant effect has been pre-service teachers' persistent poor performances in integrated science at both internal and external examinations as has been recorded at Gbewaa College of Education.

Computer Based Model (CBM) uses drills and practice approach to learning concepts or skills. The model acts as the stimulus and elicits a response from the user. It allows for self-paced instruction and it liberates teachers from direct instruction of all learners so as to focus on those learners with particular needs thereby whipping up their interest on integrated science lesson which can improves the performance in the subject.

In Ghanaian schools and colleges where materials and apparatus for practice are either unavailable or insufficient, the use of computer-based models could be a welcome solution. Hence the decision of the researcher to use computer-based models with students of Gbewaa College of Education to improve their understanding of science concepts and thereby improves their performance in the subject.

**Purpose of the Study**

The purpose of the study was to use CBM instruction to influence the interest and performance of second year pre-service teachers of Gbewaa College of Education, Pusiga in selected integrated science topics. For this reason, the researcher undertook this research to find the effects of the use of computer-based models in the teaching and learning of science on pre-service teachers' interest and performance in selected topics of integrated science in Gbewaa College of Education, Pusiga.

**Objectives of the study**

The objectives of the study included:

1. To determine the extent to which CBM can have an effect on the interest of pre-service teachers on selected topics in integrated science
2. To determine the extent to which CBM can improve the performance of pre-service teachers on selected topics in integrated science.
3. To find out whether the effect of CBM on the interest of pre-service teachers on selected topics in integrated science is gender related.
4. To find out whether the effect of CBM on the performance of pre-service teachers on selected topics in integrated science is gender related.

**Research Questions**

The following research questions were used to guide the research:

1. To what extent will the use of CBM have an effect on the interest of pre-service teachers on selected topics in integrated science?
2. What is the effect CBM on performance of pre-service teachers on selected topics in integrated science?

3. What is the difference between the interest of male and female pre-service teachers when they are taught selected integrated science topics using CBM?
4. Are there differences in the performance of male and female pre-service teachers when they are taught selected integrated science topics using CBM?

**Null Hypothesis**

The following null hypothesis was tested in the study:

$H_o$: There is no any significant difference in the performance of male and female pre-service teachers when they are taught selected topics in integrated science using CBM.

**Significance of the Study**

This research will help the pre-service teachers build upon their interest and desire to learn integrated science which will influence their lesson delivery in future. It will also generally develop in their future students the interest and ambition of pursuing science related courses in their academic endeavours since the interest of teachers have an influence on the aspiration of their students.

It is also envisaged that the study will change the teaching of integrated science from the traditional instructional methods which includes lecture, discussion, demonstration and illustration to an interactive mode of teaching and learning of integrated science. This may lead to better improvement in the performance of pre-service teachers in integrated science. Equally the findings of this study will add up to the knowledge about the influence of interest on academic performance in integrated science.

Finally, the Principal and the college board of governors will also have the empirical evidence to back any increase budgetary allocation for the procurement of the appropriate ICT facilities and software programmes for integrated science teaching in the college.

## Delimitation of the Study

The research was restricted to level 200 students of Gbewaa College of Education in the Upper East Region of Ghana. This is because the level 100 pre-service teachers had just entered into the college and the level 300 had gone out for their one year internship programme. Additionally the study was limited to some selected topics from the components of integrated science in the CoE integrated science syllabus.

## Limitation

Some of the setbacks that might have affected the findings of this research may be due to the commitment levels of pre-service teachers to learn selected topics in integrated science with the use of computer based models. A positive interest is likely to produce good results. Another limitation was the selection of level 200 pre-service teachers of Gbewaa College of Education hence generalisations of findings would be limited to only the level 200 pre-service teachers of Gbewaa College of Education, Pusiga. Furthermore, the study was limited to level 200 of the college because the ICT centre of the college where computer-based models lessons were carried out could accommodate only 40 pre-service teachers at a time. Lastly, was the challenge with the use of the pre-service teachers' observation schedule. There was the difficulty in interpreting seen behaviours and some level of complexity in categorising observation.

**Operational Definition of Terms**

1. Interest: refers to the benefit derived on a lesson.
2. Performance: refers to the cumulative assignment and test scores.
3. Computer Based Model: refers to downloaded lesson related you-tube streamed pictures and videos.
4. Interim assessment: refers to the use of assignment and test at various intervals to monitor pre-service teachers learning process cumulatively.
5. Pre-service teacher: a student in Gbewaa College of Education being trained as a teacher.

**Organisation of the Study**

This research work has been carefully organised into five chapters. Every chapter begins with a brief overview followed by the main part of the chapter.

The first chapter is devoted to the introduction which consists of the background to the study, the statement of the problem, the purpose of the study, objectives of the study, research questions, null hypotheses, significance of the study, delimitation, limitation and organisation of the study.

The next chapter treats the review of the related literature and summary of the reviewed literature indicating the foundation of the research work.

The third chapter covers the methodology of the study. This encompasses the research design, population of the study, sampling technique, research instruments and data analysis plan. The fourth chapter also looks at results, finding and discussion. The concluding chapter that is chapter five concentrated on summary of findings, conclusion and recommendations.

# CHAPTER TWO

## LITERATURE REVIEW

### Overview

The review of literature covers the concept of Computer Based Models in integrated science teaching, the importance of Computer Based Models in integrated science and the meaning of interest in science teaching and learning. Additionally, the literature discusses factors influencing interest, the role of interest in learning, interest manifestation and students' interest towards learning integrated science. The literature also encompasses computer based models and interest in science, computer based models and performance in science, and interest in science and its influence on understanding and performance in science. Finally, factors affecting students' interest in school science, gender issues in using computer based models in integrated science teaching, technology and gender in science and summary of the literature review are also dealt with in the literature.

### The Concept of Computer-Based Models in Integrated Science Teaching and Learning

Models are systematic representations of a system, or some simplified aspect of a system (Glynn & Duit, 1995) that include rules and relations, concepts and objects. They are used to describe, represent and explain the mechanisms underlying the physical phenomena. Good models extend across individual systems and are complete descriptions of the understanding of fundamental mechanisms in nature. Although such models can be expressed in a number of communication media (verbal, graphical, mathematical), they are essentially conceptual in nature (Hestenes, 1997).

Conceptual models are epistemological constructs of the physical sciences aiming at providing operational descriptions of physical systems, i.e. they are interpretive representations with predictive capability.

In contrast, mental models are epistemological constructs of the psychological sciences. In the current understanding of the human mind, concepts are coded into networks in long-term memory. These networks are called mental models and although often they relate to specific situations (including, but not restricted to physical phenomena) they tend to be transient in nature (Anderson, Howe, & Tolmie, 1996).

There has been a longstanding interest in investigating the role of conceptual models and the process of constructing them in the context of science teaching (White & Frederiksen, 2000). Active construction of self-formulated models is thought to help children come to an understanding of the nature of scientific inquiry and, in particular, appreciate the role of modelling as an ever evolving activity of core importance to the scientific enterprise (Wilensky & Resnick, 1999). More recently, computer-based modelling media have been recognized as potentially powerful tools for implementing a modelling approach to learning in science. Several programmes (for example Model-based Analysis and Reasoning in Science Curriculum (MARS) project) tried to develop curriculum aiming at developing physical concepts among students and simultaneously develop the abilities necessary for constructing models of physical phenomena (Raghavan & Glaser,1995). Modelling is the essence of scientific thinking and models are both methods (processes) and products of science (Harrison & Treagust, 1998).

Computer-based models have some basic principles generally accepted as the basis for designing a classroom-learning environment emphasise learners' active roles in learning and knowledge construction, as well as learners' engagement in authentic learning activities. As a result, school curricula are changing in order to become more student-centred, connect school subject matter to real-life authentic situations, and promote student understanding, conceptual change, and thinking rather than rote memorization or drills and practice. Essentially, contemporary curricula and teaching practices aimed at contextualize or situate students' learning in authentic, rich, and relevant learning experiences.

Many aspects of technology like computer-based model make it easier to create environments that fit the principles of a learner-centred environment (Bransford, Brown, & Cocking, 2001). In this new way of teaching and learning, ICT is not considered a means for delivering information to learners but a tool for engaging them in inquiry-based learning, scaffolding their knowledge construction, and facilitating conceptual understanding (Jonassen & Reeves, 1996). Also as Bransford, Brown and Cocking (2001) argued, ICT can help students visualize difficult to understand concepts, build models for facilitating understanding, and interact with specific parts of the learning environment to explore and test ideas. They also argued that technologies do not guarantee effective learning and that inappropriate uses of technology can actually hinder learning.  Pedersen and Yerrick (2000) also argued that it is a primary responsibility of teacher education programmes to adequately prepare pre-service teachers to teach science with computers in accordance with current science education visions.

Penner (2000/2001) argued that one method that could possibly assists the inquiry learning process is computer modelling. Undoubtedly, science educators (Frederiksen & White, 1998) have long recognized the importance of models and the process of modelling or model building in understanding abstract science concepts and phenomena. Jonassen (2004) also argued that the most powerful method for engaging, fostering, and assessing conceptual change is the construction of qualitative and semi-quantitative models that represent their conceptual understanding of what learners are studying. It should be mentioned, however, that computer modelling experiences can be inappropriate for children under the age of 10, because working with models requires a certain level of abstraction in thinking that develops progressively with age but in general, not prior to the age of 10. Concrete science experiences inquiring into real objects can be more beneficial, meaningful, and motivating for students under the age of 10.

Computer-based models are human artefacts of a content domain and are usually based on extensive concrete experiences. A model is an external representation, which can be executed or manipulated by the learner in order to control variables and test hypotheses. A model constitutes a conceptual system and consists of objects or entities, variables or characteristics, and cause and effect relationships among variables (Lesh & Doerr, 2003). In essence, a model of a phenomenon constitutes a simplified analogue which does not exactly match in complexity with the real one, but it is helpful enough to study and better understand the real phenomenon. Gilbert (1991) suggested that science should be viewed as a process of constructing predictive conceptual models. This will enable students to analyse and synthesise scientific facts, as well as integrate them with scientific theory and give them a unified view of science (Gilbert, 1993). In essence, the primary purpose of modelling is the construction and revision of conceptual understanding (Jonassen, 2004). Building explicit models externalises internal mental models and gradually fosters conceptual change.

According to Bliss (1994), there are two types of modelling, namely, explorative modelling and expressive modelling. In explorative modelling, learners are asked to explore a ready-made model that represents somebody else's conceptions. Thus, in explorative modelling learners try out a model, look at cause and effect relationships, and draw conclusions based on the results of their exploration. They can also modify the model if there is the need to do so.

**The Importance of Computer-Based Models in Integrated Science**

A number of science educators feel that the computer-based models offer tremendous potential for the enhancement of the teaching and learning of science concept. Switzer and White (1984) and Akpan and Andre (1999) discuss the place of the computer-based models in science classroom. According to these authors the computer-based models, as with any technology, the ultimate objective of its use in the classroom is to enhance learning. In addition, the simulation's ability is to provide opportunities for learners to develop skills in problem identification, seeking, organising, analysing, evaluating, and communicating information. Nakhleh (1983), Switzer and White (1984) and Waugh (1984) all support the fact that it is in the area of simulations that computers have the potential to deal with higher learning outcomes in a way not previously possible inside the science classroom.

The role of computer-based models in teaching and learning is beyond dispute that its contributions in educational and instructional process are so significant. According to Doğanay (2002), the advantages supplied by this method are as follows:

i. It increases efficiency in education and instruction; it makes for the effectiveness of learning in classroom.
ii. It makes education and instruction interesting, enjoyable and attractive.
iii. It motivates the students in the lesson by the help of sound, pictures and music.
iv. It makes it easier to repeat complicated problems, concepts and processes many times.
v. It contributes to students' intelligence development.
vi. It gives the students concrete experiences similar to real life.
vii. It causes the students to attain rich information sources.
viii. Mistakes in texts written can be corrected easily, and some additions and omissions can be inserted easily too.
ix. It gives the students courage, ambition and excitement and in this way it makes the development and success of students easier.
x. It develops the students' self-confidence. (pp. 45-48)

It can be deduced from the above that some of them play a major role in promoting the development of interest in pre-service teachers towards science thereby enhancing their academic performance in integrated science.

In addition to these studies, other research studies examined the impact of CBM on academic performance and interest. Students who used CBM technology to contribute to already learn skill sets, improved their academic performance and interest in that particular subject (Attewell, 2001). Despite the positive impact of technology in enhancing a favourable learning environment, barriers do exist that limit the effectiveness of technology in the classroom situation.

**The Meaning of Interest in Science Teaching and Learning**

There are numerous publications on the meaning of interest construct in everyday and scientific language use (Schiefele, 2009). General agreement can be found with regard to the central characteristics of the interest constructs for example that it is a multidimensional construct whose operational definition requires both cognitive and emotional categories (Gardner, 1996; Krapp, Hidi, & Renninger, 2004; Schiefele, 2009). Interest is characterised as an affective variable (Rennie & Punch, 1991). However, enjoyment can occur for many reasons, and interest is only one of these. Interest describes the cognitive and affective relationship between a student and particular classes of subject matter. The decisive criterion of the interest constructs which enables it to be clearly distinguished from several neighbouring motivational concepts is its content specific. An interest is always directed towards an object, activity, field of knowledge or goal. One must be interested in something (Gardner, 1996).

Although there is a wide range of interest definitions, all of them agree that interest is the tendency to think, feel, or act positively or negatively toward elements in the environment (Petty, 1995). Social psychologists have long viewed interest as having three components: the cognitive, the affective, and the behavioural. The cognitive component is a set of beliefs about the attributes of the interest element and its assessment is performed using paper-and-pencil tests. The affective component includes feelings about element and its assessment is performed using psychological indices (heart rate). Finally, the behavioural component pertains to the way people act toward the element and its assessment is performed with directly observed behaviours (Eagly & Chaiken, 1993).

Many studies have shown that interest-triggered learning activity led to a higher degree of deep-level learning (Krapp, 2002). Interest is a relationship between an individual and an object. Most researchers differentiate between individual and situational interests (Krapp, Hidi & Renninger, 2004). Individual interest is understood to develop gradually and affect one's knowledge and values over time, while situational interest appears suddenly as a response to something in the environment and is more emotional in nature (Hidi, 1990). Situational interest is thought to have only short-term impact, whereas individual interest is believed to be more stable and have a long term impact. Every individual has the tendency to deal with something in their environment. If it gives something good to them, possibly, they will have interest in it.

Interest in something is arising from the individual's interest because of their requirement or their feeling that something (they will be learning) will have meaning for them. Students who have certain needs or desires toward something, will have high interest and are more enthusiastic to achieve what they want to do. As Gordon (2012) said interest is a condition that correlate with someone own need, aspiration and desire. Thus, students' interest in and excitement about what they are learning is one of the most important factors in education.

Interest motivates people to choose the best and the most interesting activity in life. Because each activity has its own characteristics, as such people always select activities and things that are interesting. Additionally, Crow and Crow (2008) state that an interest is a motivating force that impels an individual toward participation in one activity rather than another. It indicates that interest provides a strong motivation in learning. Marimba (1992) said that interest is tendency to a subject that we feel there is an importance to the subject with happy feeling about it.

Interest is being related to science which is also connected to student participation in science lessons and exhibition of effective performance (Norby, 2003). While Gardner has described science-related interest as a learned tendency to evaluate objects, people, events and situations in a specific way or a set of propositions related to science, Norby with his studies that aimed at determining the effects of interest on science education, has put forward that students' interest towards science lessons affect their academic achievement, their gaining scientific interest and their tendency to continue studying in the field of science (Altinok, 2004).

According to some of the definition above, it can be concluded that interest is feeling of like and attention to something which is taking someone's fancy without command or compulsion from outside.

**Factors Influencing Students' Interest in Integrated Science**

There are some factors that influence a person interest according to Osborne, Simon and Collins (2003). These include:

**Enjoyment**

Enjoyment means the pleasure felt when having a good time or good act of receiving from something. Someone who can enjoy something especially the lesson, he or she will give a good action, by giving an attention to teacher's explanation or reading a book.

**Motivation**

Motivation is some kind of internal drive which pushes someone to do or think in order to achieve something. In learning, motivation is important. Learner motivation makes teaching and learning immeasurably easier and more pleasant. Interest will increase if there is motivation both from internal and external factors.

Motivation is one of the affective factors in integrated science. Its role in learning has been the source of speculation for many years; however, many experiments and research that have been done suggested that scores on self rating motivation are closely related to school attainment.

Someone who has motivation in his subject area, will have the interest to read the subject area books, go to historic places of interest, and join his subject area community like other people who have their interest in different areas. They will find the information and try to examine and implement what they are interested in.

Someone who has motivation will try something harder, and would not surrender. He will read books to increase his achievement. On the contrary, those who have weak motivation will easily feel hopeless. They would not concentrate in their lessons and they will like to disturb another people.

The students' motivation in learning integrated science also affects their marks in the subject. It is believed that the students with high motivation in learning integrated science will be more successful than students with low motivation or no motivation at all.

## Attention

Attention is represented by concentration or activity of soul to perception. If the student gives good attention to integrated science, certainly the student has an interest in the subject. In other words, interest comes from attention.

Attention is important in learning. Learning is most effective when a person is paying attention. Poor attention can be a sign of disorders in people learning process. Someone who has attention in something means that he or she has interest in something. In other words, it is general interest that leads a person to know more.

## Need

Need is defined as circumstance in which something is lacking or necessary or require some course of action. Needs also means a condition or situation in which something is required or wanted. Students need to learn integrated science is caused by the lack of knowledge of the subject. Need could motivate the people to give their attention to the lesson. Interest that appears from people's need encourages the people to put their best efforts. For instance, the people who need knowledge from the integrated science book will try to learn the language and terms of the subject more.

There are many kinds of needs. Not one of them can best be achieved when separated from the teaching and learning process. Individuals differ in their need to achieve something. Some are highly motivated internally to succeed both in competitions with others or in working alone. Others are motivated by fear or failure and are less likely to take the risk which leads to achievement. The need to achieve can become a motivational factor in learning.

### Desire

The natural longing for excitement and enjoyment or the thought of any good, impels to action or effort its continuance or possession. If a person has desire to learn integrated science automatically he or she will try to know it more.

### The Role of Interest in Learning

Interest plays an important role in the learning process. If there is the intention in learning, at least, they who study need to have positive interest in the lesson.

According to emotional interest theory, the addition of interesting but irrelevant material to a textbook lesson energizes readers so that they pay more attention and learn more after all. Although the material is irrelevant to the explanation, it is related to the topic and intended to heighten the reader's curiosity and interest in the topic.

According to emotional interest theory, emotional interest adjuncts, such as seductive text or seductive illustrations, influence the reader's efforts by promoting his or her enjoyment of the text. The increase in emotional arousal influences the reader's cognition; that is, the increase in enjoyment causes the reader to pay more attention to and encode more of the material in the text. If emotional interest theory is correct, we can predict that adding emotional interest adjuncts to text will result in increases on tests of retention and transfer (Kintsch, 1980).

Interest will become a motivation force, strength to encourage somebody to learn. Students who like the lesson will look like being encouraged to learn continually than the others who only accept the lesson. They just do not move to learn more and more because of the lack of encouragement or interest.

**Interest Manifestation**

From the foregone definitions, it appears interest is not quantifiable. It is a psychological construct, and therefore it can only be detected by indirect methods. Interest manifests itself in different ways. Its manifestations are linked to concepts such as perceptions, personality and perceptual selectivity. To show the existence of a relationship between interest and beliefs or perceptions, Crawley and Koballa (1994) stated; beliefs that an individual holds about the consequences of engaging in the specific behaviour within subject effect or personal norm help the person form an interest towards engaging in the behaviour.

In an attempt to examine and understand the interest and performance of second year college pre-service teachers' toward integrated science using CBM, interest manifestation was considered.

**Students' Interest towards Learning Integrated Science**

On interest, a personality factor is considered in this study as that variable which could predict the level of learning difficulty of the student in a particular area of study. To learn effectively students need to integrate new material into their existing knowledge base, construct new understanding, and adapt existing conceptions and beliefs as needed. According to Bolarin (1988), interest is the key to educational successes. For this submission, Bolarin observed that, at any level of graduation, learners will learn better in subjects or courses if they have some degrees of likeness for such subjects or the courses. This implies that learners will fail to learn little if they do not like the subjects. Interests therefore, at a higher stage become subjective feeling of value which is experienced when striving. This feeling implies an end-point on object, a reward, purpose or situation in which one is interested and for which an individual strives at (Johnson, 1992). This means that when one is interested in a thing, one is ready to devote attention to it.

Thomas, according to Bolarin (1988) found that with the ability held constant, through statistical techniques, students with educational interest had higher grade point averages in specific related courses than those with low interest level. The afore mentioned therefore, is in agreement with the submission of Lavin (1965), that there is a reciprocal relationship between interest and learning achievements as each reinforces the other. This then indicates that interest measure can serve as a motivating factor of attention and thus enhancing good memory to the learners. Therefore, the level of learning difficulty of students is minimised for those with good personalities, right attitudes and high level of educational interest in a particular subject. Consequently, effort must be made to see that students develop the right interest or attitude to learning and where such is hindered by the teacher or any other factors, attempt must be made for necessary adjustments.

Uyoata (2002) investigated the effects of computer-based instructional mode on primary school pupils' interest or attitude towards science. He indicated that computer based instructional mode proved to be more potent in stimulating pupils' interest to developing more positive interest towards science than the conventional method of teaching. Opara (2002) also investigated the efficacy of self-regulation process of students' interest in quantitative chemical analysis.

It was found that teaching method was significant on the interest of students in quantitative chemical analysis. This confirms that self- regulation enhanced the interest of students in the experimental group more than the students in the traditional group. The reason for this observation could be due to the fact that the stages used in the process of self-regulation were meant to actively involve the learner, as well as create an environment in which equilibration can occur in the minds of learners. Local materials used were meant to capture the interest of students and to help them link materials in the environment with activities in the classroom. Hassan (1975) who investigated the influence of some selected variables including instructions on the development of students' interest in science. He found out that certain instructional factors are important in the development of science interest among the secondary students. Attitude to science and interest could play a substantial role among the students studying science, but the problem of which of the two variables will possess the strongest strength for producing performance in science still remain inconclusive. These necessitate the imperativeness of such variables for further verification in this study.

**Computer-Based Models and Interest in Science**

Computer-Based Model (CBM) is an important tool for the teaching and learning of integrated science. CBM allows the scientific method to be applied to phenomena for which traditional observation, measurement and/or experimentation are not feasible or possible. Unlike a beaker or a spectrometer, CBM tools often impart all aspects of scientific inquiry, from hypothesis development to analysis. This makes the use of CBM an excellent vehicle for studying scientific phenomena.

The profound interest in student-centered learning, combined with the multiple affordable information and communication technology (ICT) and recent research results on learning, paved the way to thinking about teaching and learning differently than before. Some basic principles generally accepted as the basis for designing a classroom-learning environment emphasize learners' active roles in learning and knowledge construction, as well as learners' engagement in authentic learning activities. As a result, schools and colleges curricula are changing in order to become more student-centered, connect school subject matter to real-life authentic situations, and promote student understanding, conceptual change, and thinking rather than rote memorization or drills and practice.

Many aspects of technology make it easier to create environments that fit the principles of a learner-centered environment (Bransford, Brown, & Cocking, 2001). In this new way of teaching and learning, ICT is not considered a means for delivering information to learners, but a tool for engaging them in inquiry-based learning, scaffolding their knowledge construction, and facilitating conceptual understanding (Jonassen & Reeves, 1996). Also as Bransford *et al*. (2001) argued, ICT can help students visualize difficult to understand concepts, build models for facilitating understanding and interact with specific parts of the learning environment to explore and test ideas. They also argued that technologies do not guarantee effective learning and that inappropriate uses of technology can actually hinder learning. Recent reviews of the literature on technology and learning concluded that technology has great potential to enhance student achievement, when teachers know how to use it appropriately (International Technology Education Association, 2002).

Research indicates that CBM engagement with pre-service teachers influences interest in science. According to Dillon, Franks, and Marolla (1975), pre-service teachers need to be relatively free from pressures in schools and have freedom to wonder, explore, and discover in order to develop interest in science. Joyce and Farenga (1999) examined the science perceptions of high ability pre-service teachers and ascertained that they had already decided their like or dislike for science before they entered into the classroom. These students believed that their early exposure to the use of CBM in science built their experience in different subject matters which played a key role in the development of their interest.

**Computer-Based Models and Performance in Science**

In recent years the role of CBM as a tool to raise educational performance has attracted growing attention from both policy makers and academic researchers. While the former tend to be enthusiastic about the use of CBM in teaching and learning, the latter have little evidence to support such an enthusiasm.

CBM are certainly not new to the educational arena; however, as a result of research validation and technological development and with a greater push towards good performance, CBM has been growing exponentially (Buzzetto-More, Werner, & Martinez, 2008).

Research by Kerka (2001) found teachers who utilize CBM as having more students who are able to sensitize many disciplines of knowledge in a single situation. Also, Astleitner (2002) in a study found that critical thinking and higher order operations significantly increase when students learn through CBM. Astleitner (2002) observed that analysing positions, reflecting on judgments, and evaluating results are key elements of both higher order thinking and performance.

Looking at the link between CBM and student performance seems nowadays as a misunderstanding of the role and nature of these technologies. In fact, since CBM is general purpose technology (GPT), it needs to be specified in order to meet the needs expressed by students and to be adapted to the local context and constraints (Antonelli, 2003; Youssef, 2008). A variety of models of usages can be identified leading to the same outcome. CBM brings widened possibilities for the learning processes that are independent from place and space. CBM also allows more flexible (asynchronous) and more personalised learning. It offers new methods of delivering higher education.

**Interest in Science and its Influence on Understanding and Performance in Science**

Interest toward science plays an important role in scientific literacy performance. It encompass an individual's interest in, and response to science, his or her feelings, beliefs and values that orient personal postures and actions. An important aim of science education is for students to develop interest in, and support for, the science enterprise, as well as to acquire and apply scientific knowledge for personal and social purposes (Bybee, McCrae, & Laurie, 2009).

According to Bloom (2010), the way students perceive and evaluate their acquaintance with any kind of knowledge is very important in their learning process. If students are not interested in science, they tend to put little effort to learn and understand the meaning of concepts that are being taught to them. It was shown that the most effective factor contributing to students' decisions to study science is their interest in the subject (Lindahl, 2003). It is suggested that when students feel that they are familiar with concepts or issues from their previous studies, and feel confident enough to explain them influences their motivation and achievements. Such data are very important for developing learning materials and for planning teaching strategies (Arzi, Ben-Zvi, & Ganiel, 1986). It is assumed that students who are interested in science and understand the scientific concepts, will have more positive interest towards science and science studies compared to those who have learning difficulties in the science disciplines. Munby (1988) claimed that an interest consists mainly of three characteristics: feeling, cognition, and behaviour.

Freedman (2000) studied the relationship among laboratory instruction, interest toward science and performance in science of students enrolled in a ninth-grade physical science course in a large urban high school. He concluded that interest toward science influences performance and additionally that a hands-on laboratory programme influences the interest toward science of students and also influences their performance in science.

Simpson and Troost (1982) referred to interest towards science and science learning and concluded that people are committed to science when they better understand it and want to take more science courses and to continue reading about science. Fair-Brother (2000) claimed that pupils learn only if they want to learn. There are many problems regarding the way science is taught in school, especially if a consideration is made on non-science oriented students as an important target population. Many countries tended to give students a taste of an assortment of facts considered as important by the scientific community. Apparently, the idea underlying this philosophy was the feeling that if students will have access to knowledge, their ability to cope with the modern world as well as their interest towards science will improve. Unfortunately, it appears that in general these hopes and the feeling nowadays favours the idea that 'less is actually more'. O'Neill and Polman (2004) wrote:

> We suggest that on a societal scale, schools would function more effectively if they covered less content, in ways that would allow students to build a deeper understanding of how scientific knowledge claims and theories are constructed. This would be of use to all students in their decision making outside of school and beneficial to those pursuing postsecondary studies in science as well (p.235).

According to New Zealand Ministry of Education, there is often a positive link between student engagement, when defined in terms of their interest, enjoyment, self-belief and self confidence, future motivation in science, and their performance in science (Ministry of Education, New Zealand, 2009). Other researchers found out that although positive interest can increase students' actual science performance, high science performance does not necessarily create positive interest toward science by the students (Papanastasiou & Michalinos, 2002). In order to measure interest toward science, Programme for International Students Assessment [PISA] integrated both non-contextualized questions in the student questionnaire, and contextualized questions (within a unit) in the achievement test (Osborne, 2007). The students' questionnaire contained questions in each of the three areas—interest in science, support for scientific inquiry, responsibility towards resources and environment. Findings from PISA analyses on science interests show that the connection between science performance and science interest is complex and difficult to discern (Osborne, 2007).

The first stumbling block for research into interest towards science is that such interest does not consist of a single unitary construct but rather, consist of a large number of sub-constructs all of which contribute in varying proportions towards an individual's interest towards science. Various researchers have incorporated a range of components in their measures of interest to science including: the perception of the science teacher anxiety toward science; the value of science (Brown, 1995), self-esteem at science; motivation towards science (Piburn, 1993), enjoyment of science (Crawley & Black, 1992; Koballa, 1995), interest of peers and friends towards science; attitudes of parents towards science; the nature of the classroom environment

(Haladyna, Olsen, & Shaughnessy, 1982), achievement in science and fear of failure on course (Breakwell & Beardsell,1992; Koballa, 1995).

While some may question the value of scientific knowledge (De Boer, 2000), lack of interest in science remains a matter of concern for any society attempting to raise its standards of scientific literacy (Osborne, Simon, & Collins, 2003). This becomes especially so with the evidence that children's interest and attitude to science declines from the point of entry to secondary school (Breakwell & Beardsell, 1992).

Interest refers to a resulting curiosity in something by an individual due to the interaction of the person with the context and situation, and it is also known as actualized individual interest or situational interest ( Hidi & Harackiewicz, 2000). Osborne, Simon, and Collins (2003) view it as a particular type of interest towards some specific action to be performed towards an object (interest towards doing school science). Crawley and Coe (1990) explored interest as a specific issue of students' attitude to school science, and their attitude to studying further courses in science in school with a view to gaining information of their effect on student subject choice. In an analysis of science education from a socio-cultural perspective, Lemke (2001) points out that student interest in, attitudes toward, and motivation toward science, and student willingness to entertain particular conceptual accounts of phenomena depend on community beliefs, acceptable identities, and the consequences for a student's life outside the classroom.

Research studies have identified gender, personality, structural variables and curriculum variables as factors that influence students' interest towards science (Osborne *et al.*, 2003). Most studies show that boys have more positive interest towards science than girls (Breakwell & Beardsell, 1992; Jovanovic & King, 1998; Jones, Howe, & Rua, 2000).

Studies in structural variables indicate that socio-economic class of students has unclear effects on interest towards science (Osborne *et al*., 2003), but parental support is positively related to interest towards science (Jones *et al*., 2000). Involvement in science extracurricular activities produced mixed results: Positive (Kingsland, 1991) and negative (Breakwell & Beardsell, 1992) while attitude of peers and friends remained a significant determinant of interest towards science. Classroom and the quality of teaching are very strong factors that positively affect interest towards science (Piburn, 1993; Osborne & Collins, 2000). Curriculum variables have not been found to affect students' interest (Simpson, Koballa, Oliver, Crawley, 1994) but students' perceived difficulty of science has been determined to be a major factor with negative relationship to students' interest towards science (Crawley & Black, 1992; Havard, 1996).

Some studies have shown a moderate relationship between interest towards science and achievement (Shrigley, 1990; Beaton *et al*., 1996). Others have indicated that while there is only a moderate correlation between interest towards science and achievement, they have also observed that this correlation is stronger for both high and low ability students (Jovanovic & King, 1998; Osborne & Collins, 2000). Thus, they linked 'doing well' in science to 'liking science' but other findings indicate that students can achieve higher in science without holding a positive interest towards science (Osborne *et al*., 2003).

However individual interest has a profound effect on cognitive functioning and performance because individuals interested in a task or an activity pay more attention, are persistent for longer periods of time, and acquire more and qualitatively different knowledge than individuals without interest (Hidi, 1990).

**Factors Affecting Students' Interest in School Science**

Factors that are suggested to cause a decline in positive interest towards science are many and complex, but include: Intense preparation for any national tests (in countries where they exist); the perceived difficulty of post-primary school science; teaching approaches; student-related factors and issues arising during the transition from primary to post-primary school.

A recent study of primary teachers in England by Collins, Reiss and Stobart 2012 revealed that test preparation affected the nature of teaching in the final year at primary level, resulting in a reduction in time for practical activities. The consequent, negative impact on older primary pupils' interest towards science was raised as a concern (Collins, Reiss & Stobart, 2012). The repetitive nature of revision classes for the science "transfer tests" in Northern Ireland has also been suggested as a factor that may lead to a declining interest in science in later primary years (Murphy & Beggs, 2002). In Ireland, although standardised tests for science are not used at the end of primary school, it is unclear whether the "effort and pressure" associated with preparation for post-primary entrance assessments (O'Brien, 2004) has a negative impact on the teaching of other subjects, such as science, in sixth class.

In a review of international literature, it was found out that some students perceived post primary school science to be a difficult subject, and that this led them to be discouraged from further study (Osborne *et al.*, 2003). Irish students regarded Junior Certificate science as demanding and difficult (Matthews, 2007). A longitudinal study of early post-primary students in Ireland also suggested this. At the end of their first year, students were asked to indicate subjects which they found to be difficult. Science was regarded in this way by 40% of respondents, placing it third after Irish and foreign languages (Smyth, Dunne, McCoy, & Darmody, 2006). In another study, the lack of science uptake at upper post-primary level was found out to be related to its perceived difficulty (Smyth & Hannan, 2006). These studies involving Irish students were conducted prior to the introduction of the current Junior Cycle Science Syllabus, and hence it is not possible to say whether the perceived difficulty of the subject has changed.

Smyth and Hannan's study also pointed out other factors that might influence the later choices made by post-primary students about scientific study. At lower post-primary level, some of the factors identified were: the effect of "streaming" and ability in general; teachers and teaching methodologies; and as for the Realistic Opportunities for Supported Employment (ROSE) project, students' perceptions of the usefulness of scientific study (Smyth & Hannan, 2006).

In the cases of streaming and ability, gender appeared as an additional factor: Girls in top and bottom classes in streamed schools were less likely to take biology than those in other class groupings. Male students who chose science related courses, and female students taking any scientific subjects to leaving certificate, were found out to be disproportionately of higher ability, regardless of streaming. Students who had experienced more "negative interaction" with teachers were less likely to take science related subject subsequently, although a link with lower examination performance by these students was also detected. An earlier study by the same authors showed a higher uptake of science in schools where teachers emphasised practical activities and student participation at both lower and upper post-primary levels (Smyth & Hannan, 2002, cited in Smyth & Hannan, 2006). Although these studies pre-date the introduction of the current science curricula, it is encouraging to note that interactive teaching and in particular, an emphasis on practical activities, are key features of the approaches promoted in both the Primary Science Curriculum (DES, 1999) and the current Junior Cycle Science Syllabus (DES, 2003).

**Gender Issues in Using Computer-Based Model in Integrated Science Teaching**

Gender in common usage refers to the sexual distribution between male and female. Social scientists however refer to the term as a social construction rather than a biological phenomenon (Halpern, 2000a).

Gender shows some connection in Science and Technology Education (STE) in a number of different ways. One set of issues relates to the relative participation rates of boys and girls in programmes of science, technology and vocational education. Gender and science is a cross-cultural comparative study of children's interests, experiences, attitudes and perceptions that may be of relevance for learning science with particular emphasis on gender.

Gender issues too have been correlated with performance of pre-service teachers in academic tasks in a number of studies but without any specific conclusion. But there is a general conclusion that shows general imbalances that exist in computer use, access, career and interest level. That is why Davies, Klawe, Ng, Nyhus and Sullivan (2005) based on their reconsideration of gender issues suggested that current gender imbalance in technology and the role that technology will play in the future should be a concern to men and women, practitioners, policy makers and parents.

Various studies revealed that male students perform better than females in physics, chemistry, and biology (Novak & Mosunda, 1991; Danmole, 1998) while others revealed that female students are better than males (Kelly, 1978). Some studies by researchers such as that of Bello (1990) did not find any form of influence being exerted by gender on students' academic performance in the sciences. Gender factor on the use of CBM has also being of interest to researchers. Spencer (2004) found out no significant influence of gender on the achievement of college students in science and mathematics when they were exposed to science and mathematics courseware in online and traditional learning environments. However, female online learners were significantly less likely to complete the course compared to their traditional female counterparts or male online counterparts.

In a re-examination of studies on access, use, interest, and achievement with computer, Kirkpaktrick and Cuban (1998) concluded that when female and male students at all level of education had the same amount and type of experiences on computers, female achievement scores and interest are similar in computer classes and classes using computer. Imhanlahimi and Imhanlahimi (2008) also found out that the traditional method instruction proved to be superior when compared to Computer-Based Models. This re-examination has shown that when CBM is used on its own, that is, used to replace the teacher, the result is not uniform. Thus, some researchers found the use of CBM to be superior to the conventional approach; others found the use of conventional approach being superior to CBM.

Gender is a factor which is associated with achievement in science and in relation to the effect of computer-based model. However, it appears not to be an important factor. Bello (1990), Spencer (2004) and Yusuf and Afolabi (2010) studied the influence of gender on working with computer-based model on students performance in biology and found out that gender had no influence on the performance of students in biology whether they were taught with CBM in individualised or cooperative setting. Also Choi and Gennaro (1987) studied the effect of using CBM experiments on Junior High School students understanding of the volume displacement concept. They also assessed the differential effect on students' understanding of the volume displacement using student gender as an additional independent variable. They noted that there were no significant differences in performance between males and females using CBM in the learning of the volume displacement concept although males having had hands-on laboratory experiences performed better on the post-test than females having had the hands-on laboratory experiences. Choi and Gennaro (1987) therefore, suggested that when gender gaps in achievement exist, they persist during the use of computer-based models. It can therefore be deduced that the use of computer-based models instructions packages enhanced the performance of both male and female students without any statistically significant difference between them.

One specific issue which has generated much debate in educational circles over the years is the question of whether differential cognitive ability exists or does not exist between male and female students in a defined learning task. A definite answer to this question seems to be a complex one. The complexity arises because both the empirical and theoretical literature has produced diverse and contradictory results. While some studies (Halpern, 2000b) indicated that male students perform better than female students in many areas of science, some also (Virginia, 2005; Walt, 2005) claimed that female students outperform male students in sciences while some also (Daramola, 1992; Oladunni, 1995) reported no gender difference in academic ability.

In science education, for example, a wealth of research has examined gender difference in science performance with a view of reducing gender inequity both at school and during working life as well as encouraging both sexes to develop interest in science so as to meet the challenges of modern science and technology worldwide (Brusselmans-Dehairs & Henry, 1994; Nurudeen, 2010). Much of the earlier studies (Maccoby & Jacklin, 1974) have reported that males have better science and computer-based learning of science than females. Subsequently, Maccoby (1987) maintained that males still have superior skills in science and computer based learning of science than the females. However, Stage, Kreinberg, Eccles and Becker (1985) having reviewed extensive literature in gender difference and science performance, drew three conflicting conclusions. First, that high school boys performed a little better than high school girls on test of science reasoning involving word problems; second, that boys and girls performed equally on tests of integrated science and basic science knowledge; and third, that girls occasionally out performed boys on tests of analytical skills of science.

Meanwhile, Hyde (1993) and Hyde and Mezulis (2001) believed that the cognitive differences between males and females have been exaggerated. Indeed, Hyde (1993) pointed out that there is considerable overlap in the distribution of male and female scores on science and computer-based science tasks. However, Druva-Roush (1994) cited specific domain where gender differences existed in science, pointing out that girls seem to outperform boys in computational science tasks and do less well on problem-solving whereas boys outperform girls on computer-based science tasks. Similarly, the report of the research on the Trends in International Mathematics and Science Study (TIMSS) (TIMSS, 1999; Fierros, 1999) showed that males do better than females in mathematics and science generally though in certain areas such as life science and certain types of mathematical problems, females performed better than males.

Many factors have been identified by researchers as the causes of the low science achievement among secondary school students. These include shortage of qualified staff (Ale, 1989), poor facilities, lack of equipment and instructional materials (Odogwu, 1994), overcrowded classrooms, lack of interest of students towards science (Aiken 1976); poor reading habit, science anxiety, culture and beliefs, gender difference among others.

Factors relating to interest and gender differences in science achievement are among those widely examined in the study of the causes of poor performance in science among students. According to Ma and Kishor (1997) the variable interest is one of the most potent factors that relates to achievement.

**Technology and Gender in Science Teaching**

A seven year studies conducted by Mayer-Smith, Pedretti, and Woodrow (1998) in which data were collected using classroom observations, students' interviews, questionnaires, achievement records, and journal entries proved that classrooms which were considered to be technologically rich showed little difference between male and female in performance and participation within the science classroom. The results of this study were more remarkable because the classrooms used in the study did not have interventions in place to specifically address gender (Mayer-Smith, Pedretti, & Woodrow, 1998).

The Mayer-Smith *et al.*'s study is part of a larger picture in which the previously held presumption that there is an inherent biological incompatibility between femininity, science and computing has shifted. Studies have shifted from this idea of an inherent incompatibility to models and questions which explore the relationship between computer experience and anxiety. Studies by several authors have shown the gender gap, and in turn anxiety about computer use, no longer exists in the same way it did, if at all (Yeaman, 1992;Ayersman, 1996; Barrett & Lally, 1999). In fact, gender differences found via meta-analysis in 1997 were statistically significant though only very slightly (Prentice & Miller, 1992). A continuation of this trend suggests technology use would eventually become gender neutral.

While gender does not seem to affect interest toward technology, the question of outcome and achievement shows some level of disagreement. A study conducted by Barrett and Lally (1999) measuring usage levels (contributions) in an online class showed a difference between males and females.

**Influences of Gender on Academic performance**

There has been a renewed debate on the controversial issue of gender differences in mathematics and science performance. The most comprehensive reviews of the research in the area of gender differences have shown very few true differences between mathematics and science and between men and women (Halpern, 2000a). Other researchers have also shown a decline in the differences between the genders in the past few decades on standardized test, suggesting that the more exposure that women are getting in mathematics and science classes, the better their scores. Even though this research puts into questions whether gender differences still exist in academic achievement, many researchers are still finding differences in performance as well as general interest in areas related to mathematics and Science. Thus, achievement alone cannot be the sole reason for women as they make their progress in the academic ladder.

Work by Eccles, Lord, Roeser, Barber, and Jozefowicz (1997) revealed that gender differences in enrollment in advanced mathematics and science courses in high school are mediated by gender differences in expectations for success in mathematics and science and perceived value of competence in the subjects.

**Summary**

Scientific and technological developments started a new period called "Information Age". In this modern era, science has become the backbone for the prosperity in each and every field of life. Historically, the early paths of science instruction followed the philosophy of exercising students' minds through rote memorization of information. During the 1960's however, research done by Jean Piaget and Jerome Bruner, as well as others, began to change this approach of thinking about science instruction (Cole & Beuhner-Brent, 1991). These newly developed philosophies of learning styles and learning environments supported the assumption that "learners actively construct individual world views based on personal observations and experiences, and that learners respond to formal instruction in terms of pre-existing intuitive perspectives" (Cole & Beuhner-Brent, 1991).

From these studies, the students' feelings towards and their achievement in a subject reveals a relationship. Interest develops as one develops a perception and it changes as one interacts with the environment. Achievement in schools and colleges will determine whether one will have a positive or negative interest towards the subject. Therefore, it is evident that the teaching of integrated science may be improved in terms of approach by the use of various teaching methods and resources such as CBM. Interest as a psychological factor may also contribute towards achievement in integrated science. Some challenges are inevitable in learning a complex subject like integrated science. However, the effectiveness of the method used will among other things; include pre-service teachers' interest and how effectively the novel method such as CBM is used to manage the situation.

Ecological concept, transport in plants, pollution and genetics form the bases of college integrated science, and for some time now they continue to be the topics that pose problems to students (Youssef, 2008). Most teachers and researchers attributed the persistence of the challenges to inappropriate use of technology and lack of teaching and learning materials, especially CBM and other models. The use of innovative method of teaching to reduce the level of abstraction in the teaching of integrated science is the way forward.

Pre-service teacher difficulty in selected integrated topics as indicated from the above can be traced back to the initial and lack of technology to aid in the teaching of integrated science. Pre-service teachers' performance and interest towards integrated science depend on the way scientific ideas are introduced to them at the fundamental stages of learning.

# CHAPTER THREE

## METHODOLOGY

### Overview

This chapter covers the research methodology employed in the study. It discusses the research design, research setting, population and sampling technique. The data collection instruments, data collection procedure, validity and reliability of the research instruments, data analysis and ethical issues are also discussed in this chapter.

### Research Design

The nature of a research is determined by how the gathered information is used to solve the stated problem of the study. The nature of this study called for a multidimensional research design. As such, the research design used for this study was action research design with a mixed method approach in which multiple methods of data collection and analysis were used.

Burns (2000) acknowledges action research as an influential tool for school and classroom investigation. The choice of action research design for this study was centred on the following:

1. Action research design remedying problems in a specific situation or somewhat improving a given set of circumstances as a single level was used for the study.
2. Action research design also serves as a means of in-service training thereby equipping the teacher with new skills and methods, sharpening analytical

powers and heightening self-awareness since the researcher used the same classes he was teaching for the research.

3. It is a means of injecting additional or innovatory approaches to teaching and learning into an ongoing system which normally inhibits innovation and change since a CBM has to be developed for the intervention.
4. Finally, it is a means of providing a preferable alternative to the more subjective, impressionistic approach to problem-solving in the classroom since the classes that the researcher was teaching was used for the study.

A mixed method research approach is an approach which is conducted by the use of various methods to collect data (Cronholm, & Hjalmarsson, 2011; Creswell, 2012). In mixed method quantitative and qualitative data is collected. According to Anderson (2006), several purposes are captured as the major reasons for using the mixed method research approach. Anderson indicated that, mixed method research approach makes researchers seek to view problems from multiple perspectives so as to enhance and enrich the meaning of a single perspective. Plano-Clark (2010) also indicated that the approach helps to merge quantitative and qualitative data to develop a complete understanding of the problem and a complementary picture and to validate or triangulate results. The rationale behind the choice of the mixed method research approach in this study was to obtain complete and detailed information on pre-service teachers with regard to the use of CBM in promoting interest and performance in integrated science.

**Research Setting**

The scene is exclusively one of the last ends of the Upper East Region of Ghana. It is bordered on the east by the Republic of Togo, on the north by Republic of Burkina Faso, on the west by Bawku Municipality, and on the south by Garu-Tempane District in the Upper East Region of Ghana. This part of the country was formerly part of the Trans-Togoland. The college was established in 1953 to capture the land from Togo after it was carved out of Togo to add to the Northern Territories of the then Gold Coast (now Ghana). The setting therefore has a long time history with Togo.

The inhabitants in the college community are predominately peasant farmers of varied ethnic groups such as the Kusasis, Bimmobas, Yaangas, Mosis and Busangas. However, a number of them are Government workers and business people. The college is the only higher institution and with the only recently established private Senior High School in 2011 in the District.

The college is one of the colleges with the latest additional introduction of French programmes in 2013. The introduction of the French programme was as a result of the strategic location of the college, that is, its proximity to two francophone countries.

It is the college policy in line with the Government of Ghana policy to help provide subject teachers for all subject areas in the basic level including French. The college is deprived and less endowed in terms of infrastructure, staff, equipment, resources and road network.

**Population**

The target population for the study was pre-service teachers of Gbewaa College of Education, Pusiga. The target population was made up of 1021 pre-service teachers, comprising 590 for level 100, 208 for level 200 and 223 for level 300 in the 2013/2014 academic year. The accessible population for the study however comprised all the level 200 pre-service teachers of Gbewaa College of Education. The accessible population consisted of 68 females and 140 males. The accessible population were used based on their original class grouping. Each of the classes consisted of 11 females and 23 males with the first two classes taking 12 females and 24 males. The class grouping was done by the assessment officer with the use of computer generated grouping where the pre-service teachers were assigned randomly by letters from A-F and any letter assigned to a pre-service teacher became the designated class for that pre-service teacher.

**Sampling Technique**

The sample consisted of 208 level 200 pre-service teachers from six intact classes of A to F from Gbewaa College of Education. The sample was made up of 68 females and 140 males. Purposive sampling technique was used to obtain the sample for the study. According to (Small, 2009), purposive sample also commonly called a judgmental or subjective sample is one that is selected based on the knowledge of a population and the purpose of the study. Purposive sampling was very useful for this situation because intact classes of 208 pre-service teachers of level 200 were used where targeted sample was needed quickly and proportionality of sampling was not the main concern. Also, purposive because the level100 pre-service teachers had just been admitted into the college, therefore they had not yet done enough content in integrated science. Secondly, the level 300 were also out of campus for the CoE Internship Programme. Thirdly, the level 200 classes were assigned to the researcher to teach integrated science during the second semester of the 2013/2014 academic year.

**Research Instruments**

Four instruments were used to collect data for the study. The instruments were test, questionnaire, observation and interview. The test and the questionnaire were used to collect quantitative data while the observation schedule and interview were used to collect qualitative data.

**Test**

A test dubbed Interim assessment for Pre-service Teachers (IAPT) was a short assessment often administered multiple of times during a session. It is a form of assessment educators use to evaluate when students are on their learning progress and to determine whether they are on track to perform well on future assessments, such as standardized tests or end of course examinations.

IAPTs are usually administered periodically during a course or in a school year (for example, every one or two weeks) and separately from the process of instructing students. Generally speaking, an IAPT falls between formative assessment and summative assessment because the purposes or stakes of interim assessments typically comes between the goals of learning or instruction and measuring or documenting what had been learned.

The IAPT consisted of a total of 24 items in four sets of six items per each selected topic used for the test. Each set included five test items and one take home test (assignment) for each topic taught (Appendix A). The topics included; fundamental ecological concepts, pollution, transport in plants and heredity respectively. Most of the items were fill in and short answer items. It was in the form of five test items and one take home test (assignment) item. Most of the items were selected from past examination questions on Foundation Development Course (FDC) 224 of Colleges of Education developed by the Institute of Education, University of Cape Coast for the past four years (2009-2013). These were chosen because of their standard nature. The items were developed by a team of examiners selected from the various CoE and moderated by a team of Chief Examiners from the University of Cape Coast. Other parallel items were also developed by the researcher to supplement those of Institute of Education.

The IAPT was used to monitor pre-service teachers' progress and identify skill gaps in them, and for teachers to modify instruction to suit learners' need. Students' growth scores require to be a factor in evaluating teachers and to hold educators accountable for making content knowledge accessible to their students (Mathis, 2012).

**Questionnaire**

Pre-service Teachers Interest in Science Questionnaire [PTISQ] (Appendix B) was used to collect information on the pre-service teachers' interest level in integrated science after the use of the CBM during instruction. The PTISQ had thirty closed ended items. The first two questions were to collect personal information of the respondents and 28 items to collect information on respondents' interest in integrated science. Each item consisted of a statement followed by a five-point Likert type options ranging from 5=strongly agree, 4=agree, 3=neutral, 2=disagree to 1=strongly disagree. PTISQ was only one scale with different types of items.

### Observation schedule

The third instrument that was used was an observation checklist (Appendix C). Pre-service Teachers Observation Schedule (PTOS) was used to collect information on pre-service teachers' participation on selected integrated science topics during the intervention stage as a measure of their interest in integrated science. This was also used to identify some of the indicators of pre-service teachers' interest in integrated science with regard to the use of CBM. According to Patton (1990), a PTOS overcomes one of the key disadvantages of interviews and questionnaire, that is, the information the respondents provide may not be accurate. Such inaccuracies occur either due to the respondents' lack of awareness of their own behaviour, lack of an accurate memory of what they do, deliberate lies to make them appear better than they are or a desire to tell the researcher what they think the researcher wants to hear. The PTOS consisted of 10 optional types of items to collect information on pre-service teachers' interest on the use of computer based simulation. Each item consisted of an indicator of interest in CBM statement followed by a four likert type of options ranging from 4=always, 3=often, 2=sometimes to 1=never. This PTOS was in one scale.

### Interview

The fourth instrument used was an interview (Appendix D) that sort to buttress the information obtained from the observation checklist and the questionnaire on pre-service teachers' interest in integrated science.

An interview consists of a series of well-chosen questions which are designed to elicit a portrait of a student's understanding about a scientific concept or set of related concepts (Southerland, Smith & Cummins, 2000). It could be opened-ended or semi-structured or closed-ended or structured.

A semi-structured interview was used to probe further the information on the pre-service teachers' interest in integrated science captured by both PTISQ and PTOS. Some of the information that could not be obtained by means of PTISQ and PTOS could possibly be obtained from the interview. The interview consisted of eight items comprising open-ended questions.

**Validity of the Research Instruments**

To ensure that participants' scores on the instruments made meaning and for good conclusions to be drawn from the study to the research population, the instruments were presented to two senior lecturers as well as my supervisors in the Faculty of Science Education, University of Education, Winneba for their critique and suggestions on the items as suggested by Best and Khan (1995). This was to improve the face validity of the instruments.

To ensure face validity of the PTISQ, it was given to experts from the Department of Science Education, University of Education, Winneba who examined the items critically and gave their comments to the researcher. The researcher then modified the items using the suggestions put forward by the experts.

Equally a sample of the questionnaire was answered by 50 students of Bimbilla College of Education which has a similar setting, conditions and features with Gbewaa College of Education. Their responses were used by the researcher to assess the validity of each questionnaire item and necessary adjustments were then made where indicated.

The IAPT items were also given to my supervisors in the Department of Science Education, University of Education, Winneba who examined the items and gave their comments on them. The main aim of the IAPT was to evaluate the concept developed by the pre-service teachers in integrated science and to assess the overall progress achieved in integrated science by the pre-service teachers. This helped in the identification of gaps in the pre-service teachers in the learning of integrated science at the college level. The researcher also pilot-tested the IAPT instruments with 50 pre-service teachers in Bimbilla College of Education during the two weeks of the pilot study. The items were sampled based on equal number of items per topic treated. For the pilot study, 12 items were used based on the topics (Fundamental ecological concept and Pollution) treated.

**Reliability of the Research Instruments**

In order to ensure that the research instruments produce, consistent results that are accurate and precise devoid of any ambiguities (Hackman, 2002) as much as possible, all the research instruments were pilot tested using 50 students from Bimbilla College of Education in the Northern Region of Ghana which has similar conditions as Gbewaa College of Education. Data from the questionnaires were statistically analysed to determine the reliability of the instruments. Reliability refers to the extent to which a measurement instrument such as a questionnaire, a test yields the same results on repeated application (Durrheim, 1999). It means the degree of dependability of measurement instrument. Two instruments were subjected to reliability tests that is, the questionnaire instrument and the observation instrument.

To estimate the internal consistency of the scores on the main questionnaire instrument, Cronbach alpha (Appendix F) was calculated and the reliability coefficient found to be 0.78. According to Fraenkel and Wallen (2003), reliability should be at least 0.70 and preferably higher.

An interrater reliability analysis using the Kappa statistic (Appendix G) was performed to determine consistency among raters for the observation instrument. In statistics, inter-rater reliability, inter-rater agreement, or concordance is the degree of agreement among raters. It gives a score of how much homogeneity, or consensus, there is in the ratings given by judges. Inter-rater reliability is also a measure of reliability used to assess the degree to which different judges or raters agree in their assessment decisions. Inter-rater reliability is useful because human observers will not necessarily interpret answers the same way; raters may disagree as to how well certain responses or material demonstrate knowledge of the construct or skill being assessed. In calculating the reliability of the observation instrument, the services of two observers were employed to observe 10 students. Their observations using the observation checklist were cross-tabulated and Kappa values were calculated for the rate of agreement in observations between the two observers. The interrater reliability for the raters was found to be Kappa = 0.73 ($p < 0.001$), 95% CI (0.504, 0.848). This is interpreted as a substantial agreement. As a rule of thumb values of Kappa from 0.40 to 0.59 are considered moderate, 0.60 to 0.79 substantial, and 0.80 outstanding (Landis & Koch, 1977). Most statisticians prefer for Kappa values to be at least 0.6 and most often higher than 0.7 before claiming a good level of agreement.

**Intervention stage**

The intervention process was conducted over a six weeks period. The process involved the use of CBM to teach the first four selected topics. The topics covered were fundamental ecological concepts, pollution, transport in plants and heredity. The first four topics were selected based on the topics assigned to the researcher to teach during the second semester of the 2013/2014 academic year.

The intervention went through some major stages as indicated in figure 1. First of all, selection of various models that were relevant to the selected topics of integrated science was done via the internet with the aid of an Internet Download Manager (IDM) (Appendix E). Another stage was the grouping of CBM into each topic as indication in the course outline which was tried by a colleague and four selected pre-service teachers from a different college. The researcher and his colleague tutor then came together for discussion on the CBM and modifications were made on some of them. Finally, the instructional process of each topic was done by taking the learners through each lesson step by step with the help of CBM. The researcher only served as a guide on each instructional process. The intervention process is as indicated in figure 1.

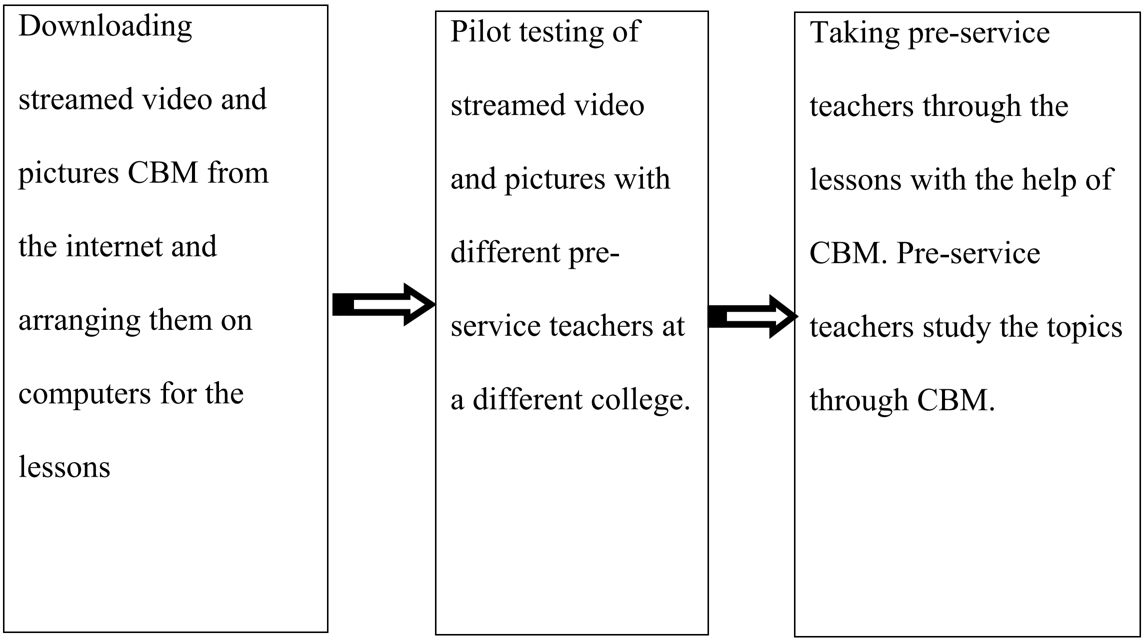


**Figure 1: The Intervention Process**

### Steps on How to Use Computer-Based Models

1. Selection of picture and videos from computer programmes for each selected topic to be used as models.
2. Building specific models for each selected topic.
3. Observing/ reflecting on the models built.
4. Referring to literature in each specific topic on relevant books
5. Identifying the types of models involved in the formation of each selected topic.
6. Writing the key information for each selected topic.
7. Group or class discussion.

### Data Collection Procedure

The data collection started with the presentation of an introductory letter from the Head of the Department of Science Education, University of Education, Winneba to the Principal of Gbewaa College of Education, seeking permission to conduct the study which took place within the third week of January, 2014.

The Pre-service Teachers Interest in Science Questionnaire (PTISQ) was one of the instruments that were used for the data collection. The PTISQ was used as pre-PTISQ and post-PTISQ that sourced for information on pre-service teachers' interest in integrated science before and after the intervention process. The PTISQ consisted of 30 closed ended items which respondents were given the whole day to make careful consideration of the indicators in completing the questionnaire and to return them to the researcher at the end of the day. The pre-PTISQ was administered within the first week of February, 2014 before the intervention process and that of post-PTISQ was done within the first week of June, 2014 after the intervention process. Both the pre-PTISQ and post-PTISQ recorded a recovery rate of 100% respectively because the questionnaires were recovered within the same day of administering.

The next instrument that was used for the data collection was the Pre-service Teachers Observation Schedule (PTOS). The PTOS was done during eight randomly selected sessions during which five observers carried out the observation for the classes that utilises CBM. The PTOS consisted of 10 likert scale items in which the observers were expected to tick the indicators observed on the learners during the classes that utilised CBM. The process of PTOS started by the training of observers within the first week of January, 2014 on the indicators they would be observing during the intervention stage. The actual process of PTOS took place between the months of February to June, 2014.

Semi-structured interview was another instrument that was used for the data collection. The interview was done after the intervention stage. The interview was done on 20 pre-service teachers who were randomly selected. The interview consisted of eight items that were intended to source for pre-service teachers' interest in integrated science after the intervention with the use of CBM. It also included other probing questions that were posed by the researcher during the interview as when and where the need arose. The interview process of data collection took place within the third week of June, 2014.

The fourth instrument used for the data collection was also the test dubbed Interim Assessment for Pre-service Teachers (IAPT). IAPT was used during the period of intervention. The IAPT was used after each completed topic. This consisted of four set of items that were used after the treatment of each topic. It was used to source for pre-service teachers performance in integrated science after the treatment of each selected topic with the use of CBM. IAPT was done between the months of February to June, 2014.

**Data Analysis**

The data collected from the questionnaire and observation were analysed using Statistical Product and Service Solutions (SPSS version 16.0) for windows was used to analyse the data. Descriptive statistics was used to organise the data collected from questionnaire and observation into frequencies and percentages in order to answer the research questions. A t-test analysis was used to also find out whether there was any significant difference between male and female pre-service teachers' interest in integrated science and their academic performance in the subject. The data collected from the test (interim assessment) were also organised cumulatively into groups: that is excellent, very good, good, average (fair) and below average (poor). The data collected from the interview were also reported. This was done to answer the research questions 1, 2, 3 and 4 formulated for the study.

**Ethical Issues**

The researcher needed to protect the identity of the students and the institution, develops a trust with them and promote the integrity of the research. In order to ensure proactive participation of the intact respondents and their college, confidentiality of their information and opportunity that was offered in this study was made known to them in order to protect the rights and welfare of participants and to minimise the risk of physical and mental discomfort from the information they provided. To maintain confidentiality, names and index numbers were not used to identify the respondents. Instead, codes were assigned to each respondent for easy data analysis. After the data collection, round off activities like expressing gratitude to all respondents, the observers, the staff and Principal of the college for the permission, participation and commitment granted for this study was done.

# CHAPTER FOUR

## RESULTS AND DISCUSSION

### Overview

In this chapter, the analyses of data collected from the questionnaires, interview, test (interim assessment) and observation schedules to pre-service teachers are presented. The results were then used to answer the research questions formulated for the study. This chapter is divided into two sections. The first section presents the demographic characteristics of the respondents. The second section presents the findings based on the research questions for the study.

The research questions 1 and 3 were analysed qualitatively while the research questions 2 and 4 were analysed quantitatively.

### Demographic Information of the Sample

The study sample was made up of 208 pre-service teachers (140 males and 68 females).

Figure 2 shows that for the study sample 67% (n=140) were males and 33% (n=68) were females.

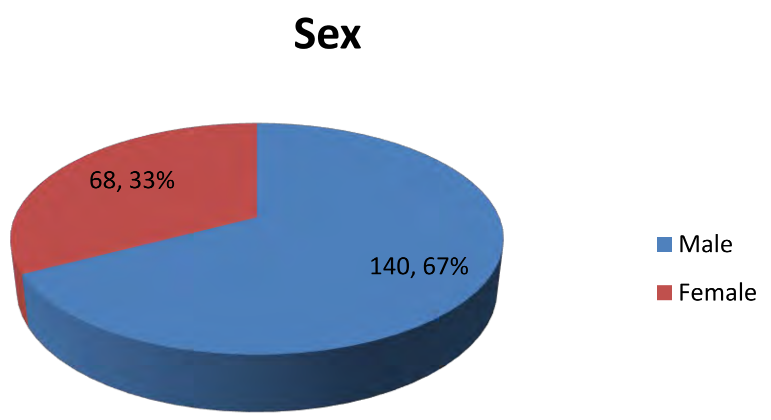


**Figure 2: Sex of the Respondents**

Table 1 provides the age distribution of the sample used in the study. The dominant age group ranged between 24 – 26 years (38%, n=79) followed by 21 – 23 years (21%, n=44), followed by ages 27 – 30 years (17%, n=35) and finally followed by ages 18 – 20 years and 31 and above with (12%, n=24) respectively.

**Table 1: Age Distribution of Respondents**

| Age (Years) | Frequency | Percentage (%) |
|---|---|---|
| 18 – 20 | 24 | 12 |
| 21 – 23 | 44 | 21 |
| 24 – 26 | 79 | 38 |
| 27 – 30 | 35 | 17 |
| 31 and above | 26 | 12 |
| **Total** | **208** | **100** |

Figure 3 provides the respondents' programmes of study at SHS. The dominant subject was Arts (37%, n=78) and the least programme offered was Visual Arts (3%, n=6). Further details are provided by figure 3. It can be seen from the results that majority of the students did not have a strong background in science. Majority of the students offered arts and business based courses and as such these categories of students do not take science seriously at the SHS level. Thus it can be said that these students have a weak background in science and it would be understandable that they would find it difficult to maintain an active interest in integrated science.

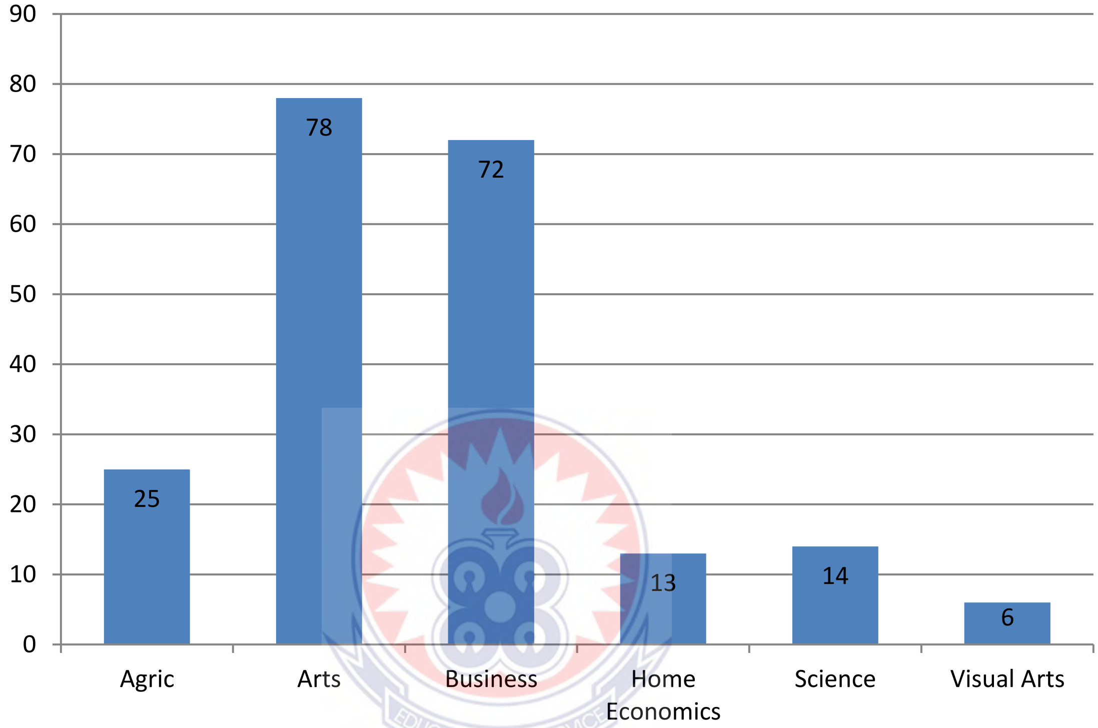


**Figure 3: Programmes Offered by the Respondents at the SHS Level**

## The Use of CBM have an Effect on Pre-service Teachers' Interest in Integrated Science

### Pre-intervention Questionnaire

The purpose of question 1 was to find out or investigate how the use of CBM in teaching the pre-service teachers' integrated science affected their interest in learning the subject. As indicated previously, the CBM was introduced to the pre-service teachers as a way of stimulating their interest in the learning of the subject and the question sought to measure and ascertain if the CBM had any sort of effect whatsoever on their interest in the subject. The data was collected using a pre-designed instrument to measure the extent of interest in the subject. The questionnaire was administered prior to the introduction of the CBM and this presented the researcher with the baseline information which formed the basis for the comparison. The same instruments were administered after the CBM had been introduced to the students and they had been exposed to the CBM and were now conversant with it. The data was analysed using descriptive statistics of the Likert scale items presented in the questionnaire and a comparison of the pre-intervention questionnaire and post-intervention questionnaire made. The results of the analyses are presented in the tables below. Table 2 presents the pre-questionnaire data for pre-service teachers on their interest in integrated science before the CBM programme was used to teach them. For the interpretation of the mean scores, they were compared against the Likert scale items where Strongly Agree was given a value of 5, Agree was given a value of 4, Neutral was given a value of 3, Disagree a value of 2 and Strongly Disagree a value of 1 as indicated in figure 4.

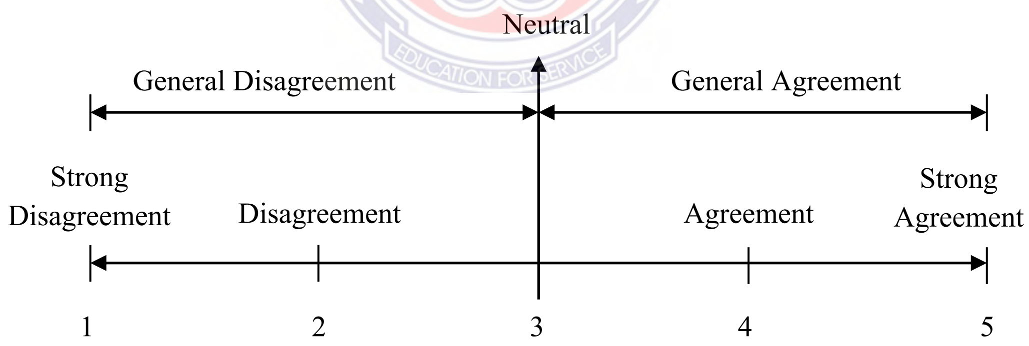


**Figure 4: An Illustration of the Neutral Position on the Five-point Likert-type Scale**

**Table 2: Pre-intervention questionnaire on Interest of Pre-Service Teachers in Integrated Science**

Note that questions 1 and 2 were used to elicit demographic details from the students.

| Question/item | SA | A | N | D | SD | Mean | Interpretation |
|---|---|---|---|---|---|---|---|
| Q3 | 122 (59%) | 71 (34%) | 8 (4%) | 1 (0.5%) | 6 (3%) | 1.55 | **Disagree** |
| Q4 | 54 (26%) | 97 (47%) | 34 (16%) | 16 (7%) | 7 (3%) | 2.16 | **Disagree** |
| Q5 | 18 (9%) | 35 (17%) | 46 (22%) | 73 (35%) | 36 (17%) | 3.36 | **Neutral** |
| Q6 | 9 (4%) | 46 (24%) | 52 (25%) | 72 (35%) | 26 (15%) | 3.27 | **Neutral** |
| Q7 | 13 (6%) | 40 (19%) | 29 (14%) | 78 (37%) | 48 (23%) | 3.52 | **Agree** |
| Q8 | 157 (75%) | 42 (20%) | 1 (0.5%) | 5 (2.4%) | 3 (1.4%) | 1.34 | **Strongly Agree** |
| Q9 | 65 (31%) | 72 (35%) | 38 (18%) | 21 (10%) | 12 (6%) | 2.25 | **Disagree** |
| Q10 | 5 (2%) | 9 (4%) | 11 (5%) | 83 (40%) | 100 (48%) | 4.27 | **Agree** |
| Q11 | 7 (3%) | 22 (11%) | 34 (16%) | 80 (38%) | 65 (31%) | 3.84 | **Agree** |
| Q12 | 16 (8%) | 53 (25%) | 30 (14%) | 76 (36%) | 33 (16%) | 3.27 | **Neutral** |
| Q13 | 19 (9%) | 63 (30%) | 82 (39%) | 33 (16%) | 11 (5%) | 2.78 | **Neutral** |
| Q14 | 21 (10%) | 77 (37%) | 58 (28%) | 44 (21%) | 8 (4%) | 2.72 | **Neutral** |
| Q15 | 44 (21%) | 107 (51%) | 31 (15%) | 20 (10%) | 6 (3%) | 2.22 | **Disagree** |
| Q16 | 10 (5%) | 37 (18%) | 40 (19%) | 79 (38%) | 42 (42%) | 3.51 | **Agree** |
| Q17 | 11 (5%) | 35 (17%) | 23 (11%) | 80 (38%) | 59 (28%) | 3.68 | **Agree** |
| Q18 | 87 (42%) | 87 (42%) | 18 (9%) | 9 (4%) | 7 (3%) | 1.86 | **Disagree** |
| Q19 | 69 (33%) | 82 (39%) | 32 (15%) | 18 (9%) | 7 (3%) | 2.10 | **Disagree** |
| Q20 | 42 (20%) | 92 (44%) | 38 (18%) | 24 (11%) | 12 (6%) | 2.38 | **Disagree** |
| Q21 | 23 (11%) | 57 (27%) | 32 (15%) | 66 (32%) | 30 (14%) | 3.11 | **Neutral** |
| Q22 | 12 (6%) | 37 (18%) | 35 (17%) | 83 (40%) | 41 (20%) | 3.50 | **Agree** |
| Q23 | 22 (5%) | 68 (33%) | 54 (26%) | 43 (21%) | 21 (10%) | 2.87 | **Neutral** |
| Q24 | 10 (5%) | 14 (7%) | 25 (12%) | 80 (38%) | 79 (38%) | 3.98 | **Agree** |
| Q25 | 17 (8%) | 18 (9%) | 31 (15%) | 82 (39%) | 60 (29%) | 3.72 | **Agree** |
| Q26 | 32 (15%) | 80 (38%) | 51 (24%) | 35 (17%) | 9 (4%) | 2.56 | **Neutral** |
| Q27 | 22 (11%) | 41 (20%) | 30 (14%) | 76 (36%) | 39 (19%) | 3.33 | **Neutral** |
| Q28 | 30 (14%) | 60 (29%) | 40 (19%) | 54 (26%) | 24 (11%) | 2.91 | **Neutral** |
| Q29 | 29 (14%) | 57 (27%) | 43 (21%) | 62 (30%) | 17 (8%) | 1.91 | **Disagree** |
| Q30 | 85 (41%) | 91 (44%) | 13 (6%) | 10 (5%) | 9 (4%) | 1.88 | **Disagree** |

## Post-intervention Questionnaire

Table 3 presents the post- intervention questionnaire data for pre-service teachers on their interest in integrated science after the CBM programme was used to teach them.

**Table 3: Post-intervention questionnaire on Interest of Pre-service Teachers in Integrated Science**

| Question/item | SA | A | N | D | SD | Mean | Interpretation |
|---|---|---|---|---|---|---|---|
| Q3 | 122 (59%) | 81 (38.5%) | 2 (1%) | 1 (0.5%) | 2 (1%) | 4.46 | **Agree** |
| Q4 | 73 (35%) | 113 (54%) | 9 (4%) | 10 (5%) | 4 (2%) | 4.16 | **Agree** |
| Q5 | 5 (2%) | 17 (8%) | 46 (22%) | 91 (43%) | 49 (24%) | 4.36 | **Agree** |
| Q6 | 59 (28%) | 105 (51%) | 13 (6%) | 22 (11%) | 9 (4%) | 4.27 | **Agree** |
| Q7 | 4 (2%) | 12 (6%) | 15 (7%) | 103 (50%) | 74 (36%) | 1.52 | **Disagree** |
| Q8 | 157 (75%) | 42 (20%) | 1 (0.5%) | 5 (2.4%) | 3 (1.4%) | 4.34 | **Agree** |
| Q9 | 65 (31%) | 72 (35%) | 38 (18%) | 21 (10%) | 12 (6%) | 3.62 | **Agree** |
| Q10 | 5 (2%) | 9 (4%) | 11 (5%) | 83 (40%) | 100 (48%) | 1.27 | **Strongly Disagree** |
| Q11 | 7 (3%) | 22 (11%) | 34 (16%) | 80 (38%) | 65 (31%) | 1.74 | **Disagree** |
| Q12 | 16 (8%) | 53 (25%) | 30 (14%) | 76 (36%) | 33 (16%) | 1.27 | **Strongly Disagree** |
| Q13 | 19 (9%) | 63 (30%) | 82 (39%) | 33 (16%) | 11 (5%) | 3.86 | **Agree** |
| Q14 | 21 (10%) | 77 (37%) | 58 (28%) | 44 (21%) | 8 (4%) | 3.72 | **Agree** |
| Q15 | 44 (21%) | 107 (51%) | 31 (15%) | 20 (10%) | 6 (3%) | 3.82 | **Agree** |
| Q16 | 10 (5%) | 37 (18%) | 40 (19%) | 79 (38%) | 42 (42%) | 1.51 | **Disagree** |
| Q17 | 11 (5%) | 35 (17%) | 23 (11%) | 80 (38%) | 59 (28%) | 1.38 | **Strongly Disagree** |
| Q18 | 87 (42%) | 87 (42%) | 18 (9%) | 9 (4%) | 7 (3%) | 3.86 | **Agree** |
| Q19 | 69 (33%) | 82 (39%) | 32 (15%) | 18 (9%) | 7 (3%) | 4.30 | **Agree** |
| Q20 | 42 (20%) | 92 (44%) | 38 (18%) | 24 (11%) | 12 (6%) | 3.38 | **Neutral** |
| Q21 | 23 (11%) | 57 (27%) | 32 (15%) | 66 (32%) | 30 (14%) | 1.11 | **Strongly Disagree** |
| Q22 | 12 (6%) | 37 (18%) | 35 (17%) | 83 (40%) | 41 (20%) | 3.30 | **Neutral** |
| Q23 | 22 (5%) | 68 (33%) | 54 (26%) | 43 (21%) | 21 (10%) | 3.87 | **Agree** |
| Q24 | 10 (5%) | 14 (7%) | 25 (12%) | 80 (38%) | 79 (38%) | 1.98 | **Disagree** |
| Q25 | 17 (8%) | 18 (9%) | 31 (15%) | 82 (39%) | 60 (29%) | 1.67 | **Disagree** |
| Q26 | 32 (15%) | 80 (38%) | 51 (24%) | 35 (17%) | 9 (4%) | 3.56 | **Agree** |
| Q27 | 2 (1%) | 7 (4%) | 10 (5%) | 125 (60%) | 64 (31%) | 2.33 | **Disagree** |
| Q28 | 52 (25%) | 130 (63%) | 4 (2%) | 14 (7%) | 6 (4%) | 3.91 | **Agree** |
| Q29 | 49 (24%) | 137 (66%) | 10 (5%) | 9 (4.5%) | 3 (1.5%) | 3.91 | **Agree** |
| Q30 | 58 (28%) | 139 (67%) | 7 (3%) | 3 (1.5%) | 1 (0.5%) | 3.88 | **Agree** |

Table 4 presents a comparison of the mean response scores for the pre-intervention questionnaire (pre-IQ) and post intervention questionnaire (post-IQ) and the interpretation of the mean scores as compared to the Likert scale items used in measuring the responses.

**Table 4: Comparison of Pre-intervention questionnaire and Post-intervention questionnaire Data of Pre-service Teachers' Interest in Integrated Science**

| Question/item | Pre-IQ | | Post-IQ | |
|---|---|---|---|---|
| | Mean | Interpretation | Mean | Interpretation |
| Q3 | 1.55 | Disagree | 4.46 | Strongly Agree |
| Q4 | 2.16 | Disagree | 4.16 | Agree |
| Q5 | 3.36 | Neutral | 4.36 | Agree |
| Q6 | 3.27 | Neutral | 4.27 | Agree |
| Q7 | 3.52 | Agree | 1.52 | Disagree |
| Q8 | 1.34 | Strongly Disagree | 4.34 | Agree |
| Q9 | 2.25 | Disagree | 3.62 | Agree |
| Q10 | 4.27 | Agree | 1.27 | Strongly Disagree |
| Q11 | 3.84 | Agree | 1.74 | Disagree |
| Q12 | 3.27 | Neutral | 1.27 | Strongly Disagree |
| Q13 | 2.78 | Neutral | 3.86 | Agree |
| Q14 | 2.72 | Neutral | 3.72 | Agree |
| Q15 | 2.22 | Disagree | 3.82 | Agree |
| Q16 | 3.51 | Agree | 1.51 | Disagree |
| Q17 | 3.68 | Agree | 1.38 | Strongly Disagree |
| Q18 | 1.86 | Disagree | 3.86 | Agree |
| Q19 | 2.10 | Disagree | 4.30 | Agree |
| Q20 | 2.38 | Disagree | 3.38 | Neutral |
| Q21 | 3.11 | Neutral | 1.11 | Strongly Disagree |
| Q22 | 3.50 | Agree | 3.30 | Neutral |
| Q23 | 2.87 | Neutral | 3.87 | Agree |
| Q24 | 3.98 | Agree | 1.98 | Disagree |
| Q25 | 3.72 | Agree | 1.67 | Disagree |
| Q26 | 2.56 | Neutral | 3.56 | Agree |
| Q27 | 3.33 | Neutral | 2.33 | Disagree |
| Q28 | 2.91 | Neutral | 3.91 | Agree |
| Q29 | 1.91 | Disagree | 3.91 | Agree |
| Q30 | 1.88 | Disagree | 3.88 | Agree |
| Overall mean | 2.05 | | 3.08 | |

Note: the overall average mean for the pre- intervention questionnaire (pre-IQ) was 2.05 and that of the post intervention questionnaire (post-IQ) was 3.08.

It could be seen that there was an observed difference in the responses on the pre-intervention questionnaire and post- intervention questionnaire. The overall average mean of the pre- intervention questionnaire was 2.05 and that of the post- intervention questionnaire was 3.08. A t-test analysis carried out to determine whether the observed difference was statistically significant.

**Table 5: Results of t-test Analysis of Pre-intervention questionnaire and Post-intervention questionnaire Scores of Pre-service Teachers**

| Statistics | N | Mean | SD | df | t-cal | P. value |
|---|---|---|---|---|---|---|
| Pre-IQ | 28 | 1.03 | 2.12 | 27 | 8.15 | 0.02 |
| Post-IQ | | | | | | |

The results t(28) = 8.71, $p < 0.02$ shows that there is a statistically significant difference in the pre and post intervention interest questionnaire scores of pre-service teachers with respect to their interest in integrated science.

## Observation Schedule Responses

The purpose of the observation instrument in the form of a separate questionnaire was used to further elicit information about students' actions and general interest in class during the use of CBM. The instrument was administered during 8 randomly selected sessions during which five (5) different observations were carried out by five different observers during classes that utilized CBM. The questionnaire items utilized a Likert scale in its design. The data was analysed using descriptive statistics. The responses of observers from each of the observations were collated and an average was struck and the percentage responses for each item are presented in the Table 6.

**Table 6: Observation Schedule Responses**

| Question/item | Always | Often | Sometimes | Never |
|---|---|---|---|---|
| Q1 | 73% | 17% | 10% | 0% |
| Q2 | 15% | 57% | 25% | 3% |
| Q3 | 32% | 40% | 23% | 5% |
| Q4 | 25% | 55% | 15% | 5% |
| Q5 | 25% | 52% | 13% | 10% |
| Q6 | 8% | 63% | 22% | 8% |
| Q7 | 57% | 28% | 12% | 3% |
| Q8 | 15% | 55% | 27% | 3% |
| Q9 | 30% | 42% | 20% | 8% |
| Q10 | 70% | 2% | 5% | 0% |

The percentage of responses in table 6 shows that the use of CBM in teaching science had a positive effect on their interest and learning of integrated science. This can be deduced from the high frequency of positive responses of students from the observation checklist about how CBM has affected pre-service teachers learning of integrated science.

**Qualitative Data Analysis**

A qualitative data analyses of pre-service teachers' comments made during the interview session is presented below with respect to their impressions about the effects of CBM on their interest in integrated science. Data was collected from twenty students in the form of a focus group interview session. The students who participated in the focus group session were randomly selected and were made up of ten (10) males and ten (10) females. Two interview sessions were conducted for the students and each interview session was made up of 10 students each i.e. 5 males and 5 females each. The responses of the interviews were transcribed and a thematic analysis was done to code and group responses to the various questions on students' impressions about the use of CBM in the teaching of integrated science. A few of their comments are presented below.

One student stated that:

> "My learning of science has increased. And now I am very punctual to class and I find that I am able to understand the concepts and this has improved my confidence in discussing science with my colleagues."

Another student commented that

> "I am now able to answer questions in class and I understand everything better. This is because with the CBM I am now able to go over concepts I don't understand to make sure that I get them before I move on to the next topic or lesson."

Another student also commented that

> "I am no longer bored in class because CBM ensures that I pay attention to what is going on as CBM used things that I can visualize and not some abstract things that I cannot relate with."

**The Use of CBM to Improve the Performance of Pre-service Teachers in Integrated Science**

The intent of question 2 was to investigate whether the use of CBM will improve upon the performance of the pre-service teachers' scores in Integrated Science. The data used in answering this question was in the form of the pre-service teachers' scores on test and assignments, which were conducted at various points during the use of CBM. The test and assignment scores were collated and finally cumulatively graded over 100 for the final score, which was used to ascertain their level of performance in the subject.

Table 7 presents a summary of the overall performance of the students in the tests and assignments given to them during the use of CBM in teaching integrated science. The scores on each test and assignment were cumulatively graded over 100 for the final score. The grading scale used was 80 - 100 for Excellent, 70 – 79 for Very Good, 60 – 69 for Good, 50 – 59 for Fair and less than 50 for Poor.

**Table 7: Cumulative Test Scores of Pre-service Teachers during the Use of CBM**

| Grading | Frequency | Percentage |
|---|---|---|
| Excellent | 119 | 57 |
| Very Good | 82 | 39 |
| Good | 2 | 1 |
| Fair | 0 | 0 |
| Poor | 5 | 3 |
| **Total** | **208** | **100** |

For the table 7, the Mean Total Test score was 79 with a maximum score of 90 and minimum of 21. Fifty seven percent (57%, n=119) of the students received an Excellent grading, 39% (n=82) received a Very Good grading, 1% (n=2) received a Good grading and 3% (n=5) received a Poor grading. No student received a Fair Grading scheme score.

Table 8 presents a breakdown of the average performance of students on tests during the period of using the CBM in teaching integrated science to pre-service teachers.

**Table 8: Average Performance of Pre-service Teachers in Tests Administered**

| Statistics | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| **Mean Score** | 62 | 76 | 81 | 87 |
| **Max** | 76 | 81 | 88 | 95 |
| **Min** | 21 | 36 | 39 | 45 |

From the table 8 it can be seen that there was a progression in the average performance of students from test 1 to test 4. This can also be seen in the increase in both the maximum and minimum scores from test 1 to test 4. This shows an increase and improved performance of students as they used the CBM for learning Integrated Science.

**Difference in Interest Levels of Male and Female Pre-service Teachers in CBM Taught Lessons.**

The purpose of research question 3 was to ascertain if there was a difference in interest with regard to gender of pre-service teachers when they are taught integrated science using CBM. The post-treatment questionnaire instrument was utilized in collecting the data for this question. The questionnaires were grouped by gender and analysed using descriptive statistics after which the mean responses for each gender was calculated and compared against each other. Table 9 presents male and female responses to the post treatment questionnaire on pre-service teachers' interest when they are taught integrated science using CBM. The table presents their mean responses for the various questions as well as their interpretation. For the interpretation of the mean scores, they were compared with the Likert scale items where Strongly Agree was given a value of 5, Agree was given a value of 4, Neutral was given a value of 3, Disagree a value of 2 and Strongly Disagree a value of 1.

**Table 9: Comparison of Male and Female Pre-service Teachers Interest in Integrated Science Post-intervention questionnaire Scores**

| Question/item | Male | | Female | |
|---|---|---|---|---|
| | Mean | Interpretation | Mean | Interpretation |
| Q3 | 4.38 | Agree | 4.46 | Agree |
| Q4 | 4.23 | Agree | 4.16 | Agree |
| Q5 | 4.33 | Agree | 4.36 | Agree |
| Q6 | 4.22 | Agree | 4.27 | Agree |
| Q7 | 1.55 | Disagree | 1.52 | Disagree |
| Q8 | 4.37 | Agree | 4.34 | Agree |
| Q9 | 3.67 | Agree | 3.62 | Agree |
| Q10 | 1.33 | Strongly Disagree | 1.27 | Strongly Disagree |
| Q11 | 1.83 | Disagree | 1.74 | Disagree |
| Q12 | 1.34 | Disagree | 1.27 | Disagree |
| Q13 | 4.01 | Agree | 3.86 | Agree |
| Q14 | 3.75 | Agree | 3.72 | Agree |
| Q15 | 3.88 | Agree | 3.82 | Agree |
| Q16 | 1.49 | Disagree | 1.51 | Disagree |
| Q17 | 1.40 | Strongly Disagree | 1.38 | Strongly Disagree |
| Q18 | 3.91 | Agree | 3.86 | Agree |
| Q19 | 4.21 | Agree | 4.30 | Agree |
| Q20 | 3.43 | Neutral | 3.38 | Neutral |
| Q21 | 1.12 | Strongly Disagree | 1.11 | Strongly Disagree |
| Q22 | 3.20 | Neutral | 3.30 | Neutral |
| Q23 | 3.98 | Agree | 3.87 | Agree |
| Q24 | 2.01 | Disagree | 1.98 | Disagree |
| Q25 | 1.77 | Disagree | 1.67 | Disagree |
| Q26 | 3.75 | Agree | 3.56 | Agree |
| Q27 | 2.13 | Disagree | 2.33 | Disagree |
| Q28 | 4.01 | Agree | 3.91 | Agree |
| Q29 | 4.02 | Agree | 3.91 | Agree |
| Q30 | 3.91 | Agree | 3.88 | Agree |
| **Average Mean** | **3.12** | | **3.08** | |

Table 9 shows that there is a negligible difference in the responses of males and females with respect to their interest in the use of CBM in learning integrated Science. The interpretations of their responses are the same as shown in the table above. However, the averages mean response for males and females have 3.12 for the males and 3.08 for the females with an observed difference of 0.04. Thus, this mean difference was subjected to t-testing to identify whether it was statistically significant or not.

**Table 10: Results of t-test Analyses of Male and Female Pre-service Teachers Post-intervention questionnaire Scores**

| Statistics | N | Mean | SD | df | t-cal | P. value |
|---|---|---|---|---|---|---|
| **Male** | 28 | 0.04 | 1.51 | 27 | 6.71 | 0.07 |
| **Female** | | | | | | |

The results from table 10 show that there was no statistically significant difference ($t(28) = 6.71, p > 0.05$) in the interest of males and females with the use of CBM in teaching integrated science.

## Difference in Performance between Male and Female Pre-service Teachers in Integrated Science after CBM Lessons

The intent of research question 4 was to investigate the difference in performance between males and females in the use of CBM in teaching integrated science. The data used in answering this question was in the form of the pre-service teachers' scores on test and assignments, which were conducted at various points during the use of CBM. The test and assignment scores were collated and finally cumulatively graded over 100 for the final score, which was used to ascertain their level of performance in the subject.

Table 11 presents a summary of the overall performance of male and female students on the four tests and assignments given to them during the use of CBM as a teacher for integrated science. The grades on each test and assignment were cumulatively scored over 100.

**Table 11: Cumulative Test Scores of Male and Female Pre-service Teachers during the Use of CBM**

| Sex | Mean Test Score |
|---|---|
| Male | 79 |
| Female | 78 |

Table 11 shows the comparison of Male and Female average or mean performance on the tests. The results showed an observed difference of 1 mark between the average performance of males and females. This observed difference was tested to ascertain whether it was statistically significant.

Table 12 presents a breakdown of the average performance of male and female students on the various tests during the period of using the CBM in teaching Integrated Science to pre-service teachers.

**Table 12: Average Performance of Pre-service Teachers by Sex on Tests**

| Statistics | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| **Male Mean Score** | 68 | 77 | 82 | 88 |
| **Female Mean Score** | 67 | 76 | 81 | 87 |

There was an observed difference of 1 mark in the scores. A t-test used to determine if the difference was statistically significant.

**Table 13: Results of t-test Analyses of Test Scores by Sex**

| Statistics | N | Mean | SD | df | t-cal | P. value |
|---|---|---|---|---|---|---|
| Male mean score | 4 | 1 | 0.91 | 3 | 2.43 | 0.12 |
| Female mean score | | | | | | |

The results shows that there was no statistically significant difference $t(4) = 2.43, p > 0.12$) in the performance of males and females with the use of CBM in teaching integrated science.

**Hypothesis Testing**

To determine whether there was any statistical significant sex difference in the performance of pre-service teachers when they are taught selected topics in integrated science using CBM. Research question 4 was therefore formulated into a null hypothesis as:

> $H_o$: There is no any significant difference in the performance of male and female pre-service teachers when they are taught selected topics in integrated science using CBM.

The mean score of male pre-service teachers and that of their female counterparts increased from test 1 to test 4 by an observed difference of one mark between the two groups. But that of the males was slightly higher than that of the females. Apart from that the performance in the last test (test 4) was still seen to favour the male pre-service teachers.

When a sample t-test was used to test for any significant difference, it was realised that the mean score for both the male and female pre-service teachers showed no significant difference ($t (4) = 2.43, p>0.05$) (table 13). It was concluded that there was no significant difference between the performance of male and female pre-service teachers with regards to the use of CBM in teaching selected topics in integrated science. This means that both groups were comparable on their understanding of selected topics of integrated science before and after the treatment with the use of CBM. Sex therefore did not seem to have any significant influence on the interest and performance of pre-service teachers through the use of CBM in the teaching of selected topics of integrated science. Therefore, the null hypothesis was failed to be rejected.

## Discussions

### Findings on the effects of the use of CBM on pre-service teachers' interest in integrated science

The findings of the data analyses for research question one revealed that there was a statistically significant difference in the use of CBM to improve upon the interest of pre-service teachers in integrated science. There was an observed improvement in pre-service teachers' interest in integrated science with the use of the CBM.

The results of the analyses show that interest should be a major factor in the learning process. If there is no intention in learning, at least, students who are studying need to have a positive interest in the lesson. According to emotional interest theory, the addition of interesting but irrelevant material to a textbook lesson energizes readers so that they pay more attention and learn more after all. Although the material is irrelevant to the explanation, it is related to the topic and intended to heighten the reader's curiosity and interest in the topic.

According to emotional interest theory, emotional interest adjuncts, such as seductive text or seductive illustrations, influence the reader's affection by promoting his or her enjoyment of the text. The increase in emotional arousal influences the reader's cognition; that is, the increase in enjoyment causes the reader to pay more attention to and encode more of the material in the text. If emotional interest theory is correct, we can predict that adding emotional interest adjuncts to text will result in increases on tests of retention and transfer (Kintsch, 1980).

Interest will become a motivation force, that, as a strength to encourage somebody to learn. They who like the lesson will look like being encouraged to learn continually than the others who only accept the lesson. They just do not moved to learn more and more because of the lack of encouragement or interest.

This goes to confirm the assertions by a number of science educators who are of the view that computer based models offers tremendous potential for the enhancement of the teaching and learning science concept. Switzer & White (1984) and Akpan & Andre (1999) discuss the place of the computer based models in science classroom. According to these authors the computer based models, as with any technology, the ultimate objective of its use in the classroom is to enhance learning. In addition, the simulation's ability is to provide opportunities for learners to develop skills in problem identification, seeking, organizing, analyzing, evaluating, and communication information. Nakhleh (1983), Switzer and White (1984) and Waugh (1984) would all support the fact that it is in the area of simulations that computers have the potential to deal with higher learning outcomes in a way not previously possible inside the science classroom.

The role of computer based models in teaching and learning is beyond dispute that its contributions in educational and instructional process are so significant. According to Doğanay (2002), the advantages supplied by this method are as follows:

i. It increases efficiency in education and instruction; it makes for the effectiveness of teaching in classroom.
ii. It makes education and instruction enjoyable and attractive.

iii. It motivates the students to the lesson by the help of sound, pictures and music.

iv. It makes it easier to repeat complicated problems, concepts and processes many times.

v. It contributes to students' intelligence development.

vi. It gives the students concrete experiences similar to real life.

vii. It causes the students to reach rich information sources.

viii. Mistakes in texts written can be corrected easily, and some additions and omissions can be inserted easily, too.

ix. It gives the students courage, ambition and excitement and in this way it makes development and success of students easier.

x. It develops the students' self-confidence. (pp. 45-48)

Many aspects of technology make it easier to create environments that fit the principles of a learner-centred environment (Bransford, Brown, & Cocking, 2001). In this new way of teaching and learning, ICT is not considered a means for delivering information to learners, but a tool for engaging them in inquiry-based learning, scaffolding their knowledge construction, and facilitating conceptual understanding (Jonassen & Reeves, 1996). Also as Bransford, Brown & Cocking (2001) argued, ICT can help students visualize difficult-to-understand concepts, build models for facilitating understanding, and interact with specific parts of the learning environment to explore and test ideas. They also argued that technologies do not guarantee effective learning and that inappropriate uses of technology can actually hinder learning. Pedersen & Yerrick (2000) also argued that it is a primary responsibility of teacher education programs to adequately prepare pre-service teachers to teach science with computers in accordance with current science education visions.

Penner (2000/2001) argued that one method that could possibly assist the inquiry learning process is computer modelling. Undoubtedly, science educators (Frederiksen & White, 1998) have long recognized the importance of models and the process of modelling or model building in understanding abstract science concepts and phenomena. Jonassen (2004) also argued that the most powerful method for engaging, fostering, and assessing conceptual change is the construction of qualitative and semi-quantitative models that represent their conceptual understanding of what learners are studying. It should be mentioned, however, that computer modelling experiences can be inappropriate for children under the age of 10, because working with models requires a certain level of abstraction in thinking that develops progressively with age but, in general, not prior to the age of 10. Concrete science experiences inquiring into real objects can be more beneficial, meaningful, and motivating for students under the age of 10.

Computer based models are human artefacts of a content domain and are usually based on extensive concrete experiences. A model is an external representation, which can be executed or manipulated by the learner in order to control variables and test hypotheses. A model constitutes a conceptual system and consists of objects or entities, variables or characteristics, and cause- and-effect relationships among variables (Lesh & Doerr, 2003). In essence, a model of a phenomenon constitutes a simplified analogue, which does not exactly match in complexity with the real one, but it is helpful enough to study and better understand the real phenomenon. Gilbert (1991) suggested that science should be viewed as a process of constructing predictive conceptual models. This will enable students to analyse and synthesise scientific facts, as well as integrate them with scientific theory and give them a unified view of science (Gilbert, 1993).

**Findings on the use of CBM to improve the performance of pre-service teachers' in integrated science**

The findings of the data analyses for research question two revealed that there was a statistically significant difference in the performance of pre-service teachers in the use of CBM to improve upon the interest of them in integrated science. There was an observed improvement in pre-service teachers' performance in integrated science with the use of the CBM. The pre-service teachers scored higher marks in the test with an observed increase in test scores as they continued to interact with the CBM in learning integrated science.

The findings of the data analyses for research question 2 are in line with Freedman (2000) who studied the relationship among laboratory instruction, interest toward science and performance in science of students enrolled in a ninth-grade physical science course in a large urban high school. He concluded that interest toward science influences performance and additionally that a hands-on laboratory programme influences the interest of students toward science and influences their performance in science knowledge. Freedman defined interest toward science as the students' perception of their ability to perform in science.

According to Koballa and Glynn (2007), attitudes are feelings of like or dislike. Simpson and Troost (1982) referred to interest towards science and science learning and concluded that people are committed to science when they better understand it and want to take more science courses and to continue reading about science. Fair-Brother (2000) claimed that pupils learn only if they want to learn. There are many problems regarding the way science is taught in school, especially if a consideration is made on non-science-oriented students as an important target population. Many countries tended to give students a taste of an assortment of facts considered as important by the scientific community. Apparently, the idea underlying this philosophy was the feeling that if students will have access to knowledge, their ability to cope with the modern world as well as their interest towards science will improve. Unfortunately, it appears that in general these hopes were not realised and the feeling nowadays favours the idea that 'less is actually more'. O'Neill and Polman (2004) wrote:

> We suggest that on a societal scale, schools would function more effectively if they covered less content, in ways that would allow students to build a deeper understanding of how scientific knowledge claims and theories are constructed. This would be of use to all students in their decision making outside of school and beneficial to those pursuing postsecondary studies in science as well (p. 235).

According to some other authors, there is often a positive link between student engagement, when defined in terms of their interest, enjoyment, self-belief and self-confidence, future motivation in science, and their performance in science (Ministry of Education, New Zealand, 2009). Other researchers found that although positive interest can increase students' actual science performance, high science performance does not necessarily create positive interest toward science by the students (Papanastasiou & Michalinos, 2002). In order to measure interest toward science, Programme for International Students Assessment (PISA) integrated both non-contextualized questions in the student questionnaire, and contextualized questions (within a unit) in the achievement test. The student questionnaire contained questions in each of the three areas-interests in science, support for scientific inquiry, responsibility towards resources and environment.

Ibrahim (2000) believed that teachers' qualifications and exposure can go a long way to bring about pupils' high academic performance. It is probably for this reason; Ibukun (2009) asserted that no education system can rise above the quality of its teachers.

Considering the assertions of Ibrahim (2000), Adodo (2007), and Ibukun (2009), it implies that teachers' role in the preparation of students to succeed in examinations cannot be undermined.

An early notable contribution towards its elaboration was made by Klopfer (1971) who categorised a set of affective behaviours in science education as:

1. The manifestation of favourable attitudes and interest towards science and scientists;
2. The acceptance of scientific enquiry as a way of thought;
3. The adoption of Scientific Attitudes and interest;
4. The enjoyment of science learning experiences;
5. The development of interests in science and science-related activities;
6. The development of an interest in pursuing a career in science or science related work (pp. 34-45).

The first stumbling block for research into interest towards science is that such interest does not consist of a single unitary construct but rather, consist of a large number of sub-constructs all of which contribute in varying proportions towards an individual's interest towards science. Various researchers have incorporated a range of components in their measures of interest to science including: the perception of the science teacher; anxiety toward science; the value of science (Brown, 1995; Piburn, 1993), self-esteem at science; motivation towards science; enjoyment of science (Crawley & Black, 1992; Koballa, 1995), attitudes of peers and friends towards science; attitudes of parents towards science; the nature of the classroom environment (Haladyna, Olsen, & Shaughnessy, 1982), achievement in science and fear of failure on course (Breakwell & Beardsell,1992; Koballa, 1995).

Interest refers to a resulting curiosity in something by an individual due to the interaction of the person with the context and situation, and it is also known as actualized individual interest or situational interest (Hidi & Harackiewicz, 2000). Osborne, Simon, and Collins (2003) view it as a particular type of interest towards some specific action to be performed towards an object (interest towards doing school science). Crawley and Coe (1990) explored interest as a specific issue of students' attitude to school science, and their attitude to studying further courses in science in school with a view to gaining information of their effect on student subject choice. In an analysis of science education from a socio-cultural perspective, Lemke (2001) points out that student interest in, attitudes toward, and motivation toward science, and student willingness to entertain particular conceptual accounts of phenomena depend on community beliefs, acceptable identities, and the consequences for a student's life outside the classroom.

While some may question the value of scientific knowledge (De Boer, 2000), lack of interest in science remains a matter of concern for any society attempting to raise its standards of scientific literacy (Osborne, Simon, & Collins, 2003). This becomes especially so with the evidence that children's interest to science declines from the point of entry to secondary school (Breakwell & Beardsell, 1992).

**Findings on difference in interest level of male and female pre-service teachers in CBM taught lessons**

The findings of the data analyses for research question three revealed that there was no statistically significant difference in the interest of male and female pre-service teachers with respect to the use of CBM in teaching Integrated Science.

The results of the data analyses for research question 3 are in line with the finding made from the re-examination of studies on access, use, interest, and achievement with computer, Kirkpaktrick and Cuban (1998) concluded that when female and male students at all level of education had the same amount and type of experiences on computers, female students interest are similar in computer classes and classes using computer. Imhanlahimi and Imhanlahimi (2008) also found out that the traditional method of instruction proved to be superior when compared to Computer Based Models. Even though this research puts into questions whether gender differences still exist in academic achievement, many researchers are still finding differences in performance as well as general interest in areas related to mathematics and science.

**Findings on difference in performance between male and female pre-service teachers in integrated science after CBM lessons**

The findings of the data analyses for research question four revealed that there was no statistically significant difference in the performance of male and female pre-service teachers with respect to the use of CBM in teaching integrated science.

The results of the data analyses for research question 4 are in line with the observation that sex differences in mathematical and scientific reasoning have begun to decline, and females' enrolments are up in mathematics and science courses (Campbell, Hombo, & Mazzeo, 2000; Freeman, 2004). Programs like CBM designed to interest girls in science and that demonstrates how this knowledge will allow them to help others appear to be working.

The science and mathematical skills of boys and girls, as well as men and women, are substantially equal, according to a new examination of existing studies in the current online edition of journal Psychological Bulletin. One portion of the new study looked systematically at 242 articles that assessed the science and math skills of 1,286,350 people, says chief author Janet Hyde, a professor of psychology and women's studies at the University of Wisconsin-Madison. These studies, all published in English between 1990 and 2007, looked at people from grade school to college and beyond. A second portion of the study examined the results of several large, long-term scientific studies, including the National Assessment of Educational Progress. In both cases, Hyde says, the difference between the two sexes was so close as to be meaningless.

The idea that both genders have equal science and mathematics abilities is widely accepted among social scientists, Hyde adds, but word has been slow to reach teachers and parents, who can play a negative role by guiding girls away from mathematics-heavy sciences and engineering. “One reason researchers are still spending time on this is because parents and teachers continue to hold stereotypes that boys are better in science and maths, and that can have a tremendous impact on individual girls who are told to stay away from engineering or the physical sciences because Girls cannot do the mathematics”.

Scientists now know that stereotypes affect performance. There is lots of evidence that what we call ‘stereotype threat’ can hold women back in science and mathematics. If, before a test, you imply that the women should expect to do a little worse than the men that hurts performance. It's a self-fulfilling prophecy.

Parents and teachers give little implicit messages about how good they expect kids to be at different subjects and that powerfully affects their self-concept of their ability. When you are deciding about a major in physics, this can become a huge factor.

These findings reinforce the findings of the current study that there is no significant or a negligible difference in performance with respect to gender.

# CHAPTER FIVE

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### Overview

The purpose of this study was to investigate the effect of the CBM use of integrated science instruction on the interest and performance of level 200 pre-service teachers of Gbewaa College of Education, Pusiga. This chapter summarizes the research findings and looks at the conclusions and recommendations made by the researcher.

### Summary

The research was conducted to find out the interest and performance towards the use of CBM as a teaching approach for pre-service teachers in integrated science of Gbewaa College of Education, Pusiga in the Upper East Region. A sample size of 208 pre-service teachers was used. The data analyses revealed that there was an improvement in the interest of pre-service students in integrated science with the use of CBM and this improvement was found to be statistically significant as the p-value of pre and post questionnaire was $p \leq 0.02$. The data analyses also revealed that there was a positive improvement in pre-service teachers' performance in integrated science with the use of CBM as a form of instruction and this improvement was found to be statistically significant. The data analyses also revealed that there was a negligible or statistically insignificant difference in the interest of male and female pre-service teachers with the use of CBM as an approach to instruction. The findings revealed that indeed the use of CBM as a form of instruction in integrated science had a positive impact on the interest and performance of level 200 pre-service teachers of Gbewaa College of Education, Pusiga.

**Conclusion**

The purpose of this study was to investigate the effect of the CBM use of integrated science instruction on the interest and performance of level 200 pre-service teachers of Gbewaa College of Education, Pusiga. The descriptive statistical analyses of the findings revealed that indeed the use of CBM as a form of instruction in integrated science have positive impact on interest and performance of level 200 pre-service teachers of Gbewaa College of Education, Pusiga. This simply means that teachers especially those teaching integrated science can use computer based models for teaching which can improve upon the interest and performance of students enrolled in that subject. Computer based Models of teaching and learning, when used effectively can engage and enhance students interest in studying various subjects especially the so called 'difficult' subjects like integrated science, mathematics etc.

This research work is a contribution to knowledge on the use of computer based models (CBM) to improve upon the interest and performance of pre-service teachers' in integrated science in Gbewaa College of Education, Pusiga. This study has documented results ascertaining the positive impacts of the use of CBM on students learning of integrated science. This is indeed necessary and consequently in Ghana where many students are faced with numerous problems in their academic work due to the negative perceptions people hold in the teaching of integrated science.

**Implications**

CBM can have an influence on the interest and performance of pre-service teachers in integrated science. Thus integrated science teaching should be designed in such a way that it incorporates CBM as a mode of lesson delivery for students in Gbewaa College of Education.

Teachers teaching in Gbewaa Colleges of Education should take advantage of the possibilities afforded by CBM and find ways of incorporating it into their teaching activities to ensure that students get the maximum out of lessons by stimulating their interest and ensuring that they are adequately engaged.

The Principal and academic board need to look at new models of learning and plan their time table that takes advantage of CBMs. This will go a long way in ensuring that students performance in so called 'difficult' subjects are improved and this will in turn lead to a greater effect on the learning of integrated science.

**Recommendations**

Based on the results and conclusion from the study, the researcher would like to make the following recommendations with the view that when properly adhered they would be an influence on the interest and performance of pre-service teachers and indeed other pre-service teachers in integrated science in Gbewaa College of Education:

i. There is the need to create awareness of the usefulness of CBM as an instructional method of influencing the interest and performance of students in Gbewaa College of Education.

ii. There is the need for the colleges to provide various CBM support systems for students to help them in their academic work.

iii. There is also the need to replicate this study in other subject areas in the college.

iv. In addition, workshops and seminars should be organized for tutors in Gbewaa Colleges of Education on the use of CBM in providing instruction and on how to provide CBM support systems to enable tutors perform better in their academic work.

**Suggestions for Further Research**

Based on the findings of this study, the following suggestions for further research are made:

1. It would be appropriate if this study is done in other Colleges of Education in the other regions of the country if possible to assess the impact of CBM as instructional mode of having an influence on the interest and performance of students and come out with stronger conclusions.
2. Future studies could also investigate the impact or effect of the use of CBM in other subject areas. Hence further research needs to be carried out in the area and expanded to include other municipalities in other regions on the attitudes of tutors of Colleges of Education towards the academic work of pre-service students.

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# APPENDICES

## APPENDIX A

### Interim Assessment for Pre-service Teachers (IAPT)

Code number.................................. Sex........................... Time: 35 minutes each

Answer all questions. Answer the five questions into the answer sheet provided and the take home test (assignment) will be collected the next day.

**Class test 1 (for topic one)**

1. The part of the earth's surface and the atmosphere that is habitable by living things and is divided into biomes is known as...........................
2. Mention any four abiotic factors that influence living organisms in an ecosystem.
3. Write down the use of each of the following ecological instruments;

   a. Hygrometer b. Barometer c. Secchi disc d. Anemometer
4. What is symbiosis?
5. With an example explain the meaning of a food chain.

**Class test 2 (topic two)**

1. What is pollution?
2. State one cause, 2 pollutants, one effect and one control of land pollution.
3. State one cause, 2 pollutants, one effect and one control of water pollution.
4. State one cause, 2 pollutants, one effect and one control of air pollution.
5. State one cause, one effect and one control of noise pollution.

**Class test 3 (topic three)**

1. What is diffusion?
2. What is osmosis?
3. Explain the following; a. Plasmolysis b. Turgidity
4. Mention four factors that favour plasmolysis in plants.
5. Write down two effects of plasmolysis in plants.

**Class test 4 (topic four)**

1. Give the meaning of the following terminologies used in genetics;

   a. Chromosomes b. Alleles
2. A heterozygous albino father got married to another heterozygous mother. Use any proper genetics analysis to show the possible offspring they would produce.
3. Give the two Mendel's laws of inheritance.
4. At which stage of mitosis will the centromeres split into two, the spindle fibres pull the daughter centromeres to opposite poles and the separated chromatids are pulled along behind the centromeres.
5. Give two significance of mitosis.

**Assignment 1 (topic one)**

a. Mention an ecological instrument and describe briefly how it is used.

b. Draw the nitrogen cycle as a nutrient input/recycling and briefly explain its parts.

**Assignment 2 (topic two)**

Identify any two most common types of pollution in your community and write briefly on them.

**Assignment 3 (topic three)**

Carry out an experiment to demonstrate osmosis in a living tissue. Write your report under the following heading; title, materials, procedure, observation, conclusion, suggestion (if necessary).

**Assignment 4 (topic four)**

Describe briefly how a particular blood group is inherited by an offspring.

# APPENDIX B

## Pre-service Teachers' Interest in Science Questionnaire (PTISQ)

**Introduction**

The following questionnaire is part of a study being conducted for a Master of philosophy degree. You are required to respond to the items as sincere as possible. The information you provide will only be used for the purpose of research and will be **kept confidential**. Therefore, **do not** write your name or index number on this questionnaire.

Please note that there are no right or wrong responses to these items but what is only appropriate to you. Please, the questionnaire consists of two parts, part A is design to collect personal information and part B is also design to collect general information. Each item is followed by five options; choose the option that best describes your opinion by indicating a tick (√) in the appropriate box. Thank you very much for your co-operation.

**A. Personal information**

1. Sex: Male □ Female □ Age...............................
2. SHS/SSS programme : Science □ Agric □ Arts □ home economics □ Business □ Visual art □ technical □

**B. General information**

| Question/item | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 3. Integrated science is useful to my teaching profession. | | | | | |
| 4. Integrated science is something which I enjoy very much. | | | | | |
| 5. Solving integrated science questions is fun for me. | | | | | |
| 6. Integrated science is easy for me. | | | | | |
| 7. I would like to spend less time in school doing integrated science. | | | | | |
| 8. Integrated science is useful in life. | | | | | |
| 9. I would not like to teach integrated science after my training. | | | | | |
| 10. No matter how hard I try, I cannot understand integrated science. | | | | | |
| 11. I feel uneasy when someone talks to me about integrated science. | | | | | |
| 12. I often think, "I can't do it," when an integrated science problem seems difficult. | | | | | |

| Question/item | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| 13. I am good at doing integrated science problems. | | | | | |
| 14. Sometimes I do more integrated science problems than are given in class. | | | | | |
| 15. I remember most of the things I learn in integrated science. | | | | | |
| 16. It makes me nervous to even think about studying integrated science. | | | | | |
| 17. It scares me to have to take integrated science as one of the core subjects. | | | | | |
| 18. It is important to me to understand the topics I do in integrated science. | | | | | |
| 19. I have a good feeling toward integrated science. | | | | | |
| 20. I always like doing integrated science tests, assignments and homework. | | | | | |
| 21. I cannot concentrate on integrated science for too long. | | | | | |
| 22. I would like to have fewer integrated science lessons. | | | | | |
| 23. I understand the integrated science concepts very easily. | | | | | |
| 24. I hate integrated science courses. | | | | | |
| 25. I am bored during integrated science lessons. | | | | | |
| 26. Sometimes I read ahead in my integrated science. | | | | | |
| 27. Integrated science is a difficult subject. | | | | | |
| 28. I feel happy with my results in integrated science. | | | | | |
| 29. I like studying integrated science more than any other subject. | | | | | |
| 30. I try to do the very best I can in integrated science. | | | | | |

## APPENDIX C

### Observation schedule

**Pre-Service Teachers' Observation Schedule (PTOS)**

Class.......................................... Date..........................................

Please make careful consideration of each behaviour characteristic in completing this questionnaire. Each indicator is followed by options. Choose the option that best describes learners' behaviour during the lesson by indicating a tick (√) in the appropriate box. Thanks for your services as an observer.

| SN | Indicator | Always | Often | sometimes | Never |
|---|---|---|---|---|---|
| 1. | Students are always punctual and regular to class when CBM is used. | | | | |
| 2. | They contribute during science lessons when CBM is used | | | | |
| 3. | CBM enable students to concentrate during science lesson | | | | |
| 4. | CBM makes students to ask for clarification during science lessons | | | | |
| 5. | CBM enable students to respond to question during science lessons | | | | |
| 6. | CBM improve students participation on the lesson | | | | |
| 7. | students pay attention to the lesson when CBM is used | | | | |
| 8. | CBM help in explaining concepts and ideas better during lesson | | | | |
| 9. | CBM improve student peer discussion | | | | |
| 10. | CBM makes students to learn a lot during science lessons | | | | |

# APPENDIX D

## Interview protocol

### Semi-structured interview protocol

1. What is /are your favourite subject(s) at the college?
2. Overall, how interesting do/did you find science lessons at the college with the use of CBM?
3. Do you enjoy learning science easily or with difficulty when using CBM?

   **Probing question**: Why? What would make it easier for you?
4. How does science compare to your favourite subject(s) at the college? [Rephrase, if science is their favourite]. What make it different? What makes it different from English and/or mathematics?

   **Probing question**: Find out about comparisons with other subjects in terms their experience, the content (in terms of both knowledge and skills), the way in which the subject is taught, the homework etc.
5. What, if anything, has encouraged you personally to learn science? How/why?

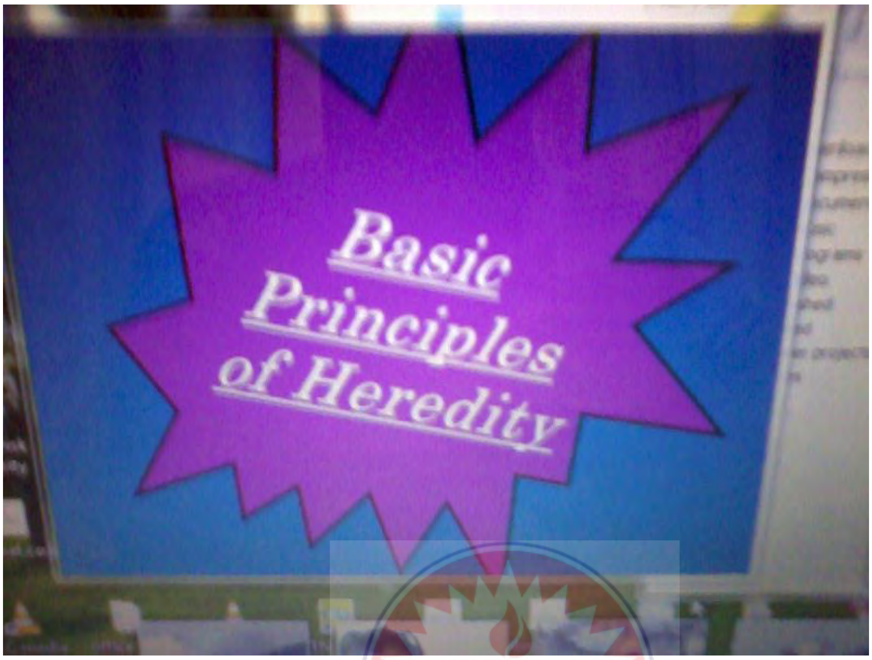
   **Probing question**:  Enjoyment of subject, friends, teachers, practical work, relevance to real life, benefits for study/career, parents' encouragement etc. Why? / in what way(s) have these factors) encourage you?
6. How important do your parents think it is for you to do well/bad in science at the college?
7. What, if any, has/ would discourage you personally from learning science?

   **Probing question**: Level of difficulty, friends, poor teaching, and no opportunity for future study / career after college, why/ in what way(s) have these factors discouraged you?
8. How important is it that science is taught in the college with CBM?

# APPENDIX E

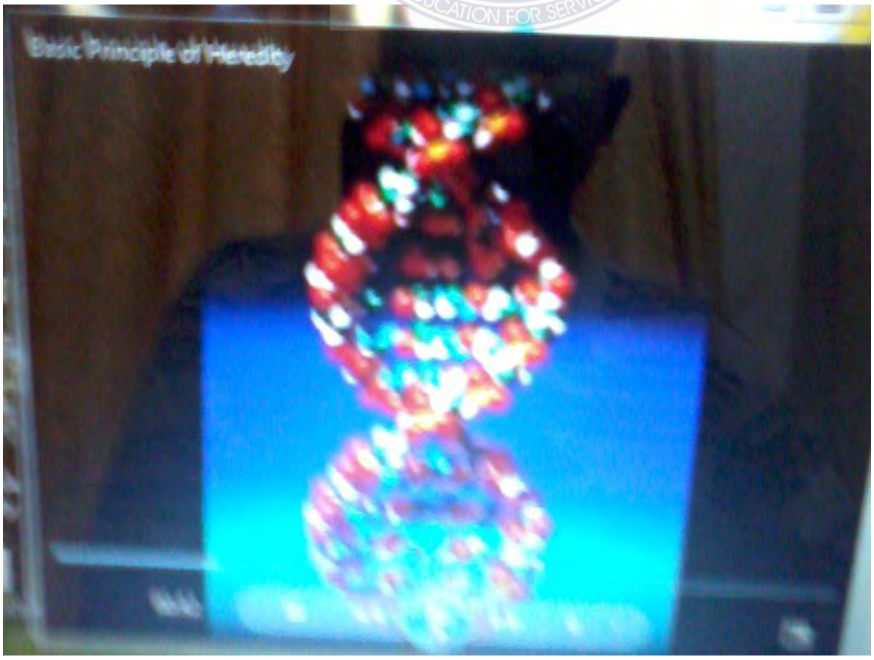
## Computer Based Models

### Appendix E1



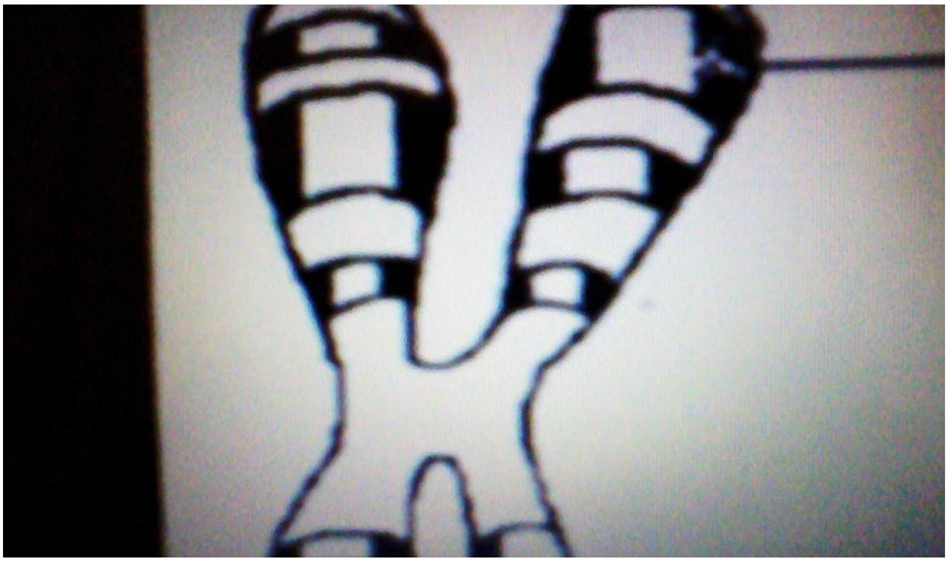

**Scene Captured Picture of structure of CBM (streamed video) of heredity as subtopic**

### Appendix E2



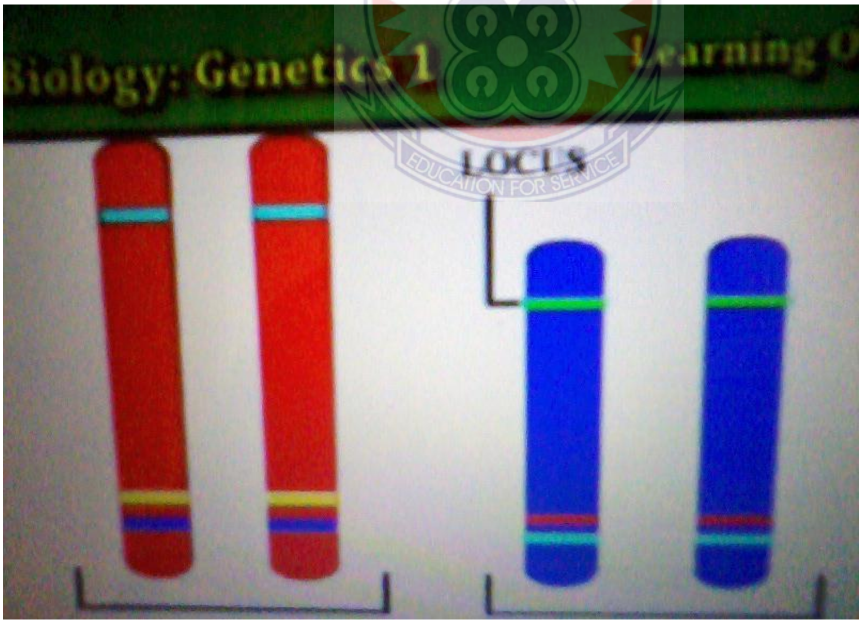

**Scene Captured Picture of structure of CBM (streamed video) of a DNA strand**

## Appendix E3



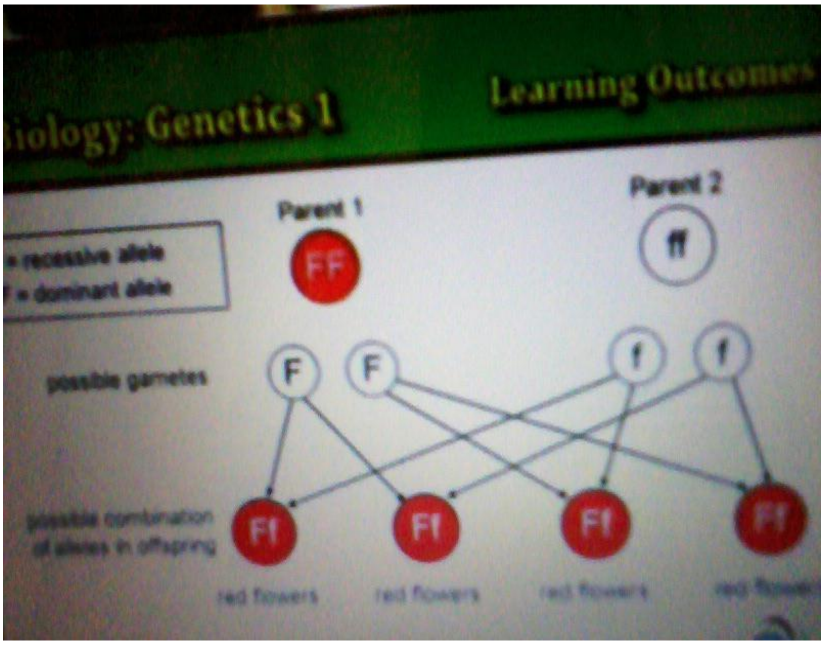
**Scene Captured Picture of structure of CBM (streamed video) of an allele**

## Appendix E4



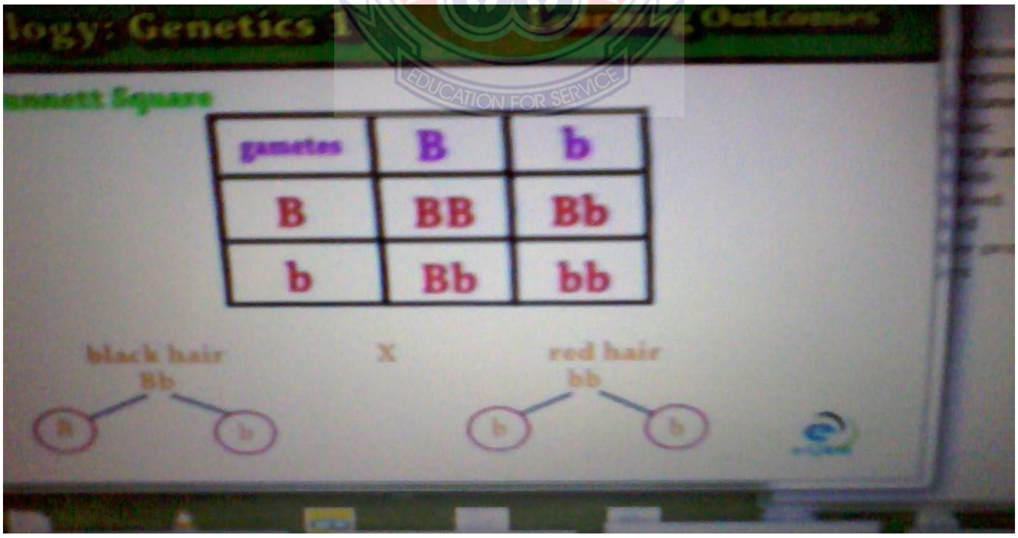

**Scene Captured Picture of structure of CBM (streamed video) of a locus**

## Appendix E5




**Scene Captured Picture of structure of CBM (streamed video) on monohybrid crosses**

## Appendix E6




**Scene Captured Picture of structure of CBM (streamed video) of punnette square of monohybrid crosses**

# APPENDIX F

## Reliability of questionnaire items

**Scale: All Variables**

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 50 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 50 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .782 | 28 |

# APPENDIX G

## Reliability of observation schedule

### Crosstabs

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| ratera * raterb | 10 | 100.0% | 0 | 0.0% | 10 | 100.0% |

**Symmetric Measures**

| | | Value | Asymp. Std. Error[a] | Approx. T[b] | Approx. Sig. |
|---|---|---|---|---|---|
| Measure of Agreement | Kappa | 0.733 | 0.88 | 8.882 | .000 |
| N of Valid Cases | | 10 | | | |