FACTORS THAT IMPEDE THE FORMATION OF BASIC SCIENTIFIC CONCEPTS DURING TEACHER TRAINING IN GHANA

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I declare that **FACTORS THAT IMPEDE THE FORMATION OF BASIC SCIENTIFIC CONCEPTS DURING TEACHER TRAINING IN GHANA** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE   DATE

(MR S SARFO)

DEDICATION

This thesis is dedicated to the memory of my late mother Grace Sarfo

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ABSTRACT:

The investigation aimed at identifying the factors that accounted for the teacher trainees' low understanding of basic scientific concepts and the appropriate strategies needed to rectify these obstacles.

In this investigation thirty open ended questions were administered to test three hundred teacher trainees' understanding of science concepts. Also, observations were conducted during science lessons to monitor the participation of trainees.

The teacher trainees' poor background in science was identified.
Inflexible teaching methods such as lecturing and provision of pointers to correct answers by teachers contributed.

Teacher trainees lacked the necessary conceptual, logical and linguistic background, and the vocabulary to express themselves in English.

Most science lessons did not consider media integration, but were conducted through verbal communication. Teacher trainees employed ineffective study techniques in learning science. Recommendations included reading assignments, laboratory work, media integration and the employment of effective study techniques in the teaching and learning of science.

Key terms

Concept formation, Development of conceptual change, Misconception, Problem Solving Skills, Types of concepts, First-Year Teacher Trainees, Qualitative and Quantitative Research, Free Response Items, Test-Retest Reliability, Single Frequency Statistical Analysis

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CHAPTER ONE

ORIENTATION TO THE RESEARCH

Introduction

This chapter gives insight to the background information which provides an explanation on the conception of basic schools in Ghana, the scope of Integrated Science in the basic schools, the meaning of teacher training and teacher trainees in Ghana, the comments made by the Chief Examiner for Science at the Institute of Education, University of Cape Coast, and the concerns expressed by the President of the Republic of Ghana on the teaching and learning of Science in the country.

The chapter also describes the nature of the problem as to what aspects of Science learning constitute the problem and how the researcher identified the problem. The main objectives of the research are outlined in this chapter and seek to identify the obstacles that prevent the teacher trainee from forming basic scientific concepts, identifying appropriate teaching strategies that need to be employed and effective learning techniques that can be employed by the teacher trainees to overcome their learning difficulties.

The significance of the research which talks about how the findings of this research are going to be of benefit to the educational systems in the country is also highlighted in this chapter.

Finally, the chapter throws light on the delimitations of the study, which focus on the areas from where the samples were drawn and the origin of the questions used in the survey.

Background Information

The research focused on the foundation studies at Teacher Training Colleges. The students who have successfully completed the course at the Teacher Training Colleges are expected to teach science at basic schools.

The basic schools in Ghana comprise Primary schools and Junior Secondary Schools. The Primary schools are made up of lower Primary, which comprises Primary one (1) to Primary three (3). The minimum age of a pupil to begin Primary one (1) is six years. Though, pupils in the lower Primary do not learn science as a subject, a teacher needs to have a strong foundation in science in order to teach them environmental studies which contain topics that are included in the Integrated Science syllabus. Since the lower Primary is the formation and foundation stage of the pupils, it is imperative that the teachers have firm knowledge of their subject matter. The upper Primary is from Primary four (4) to Primary six (6). The pupils' age is between eight (8) to eleven (11) years. The teachers handling pupils at this level teach all the subjects. Integrated Science forms part of the subjects taught in the upper Primary.

Science at the Primary schools covers the following

- Living environment of animals and plants
- Energy and Force
- Matter and change of state
- The human body
- Non-living environment of living organisms

Science at the Primary school is called Integrated Science because it is the fusion of the major branches of science. Its study at upper Primary level is to equip pupils with the necessary process skills and attitudes that will provide a strong foundation for further study in science at the Junior Secondary school level and beyond and also provide the child with the interest and inclination towards the pursuit of scientific work.

To this end, all the prospective teacher trainees are expected to pass Integrated Science at Senior Secondary School Certificate Examinations in order to be eligible to enrol at any Teacher Training College in Ghana. Teacher training means the academic and professional training given to students at Teacher Training Colleges in Ghana, which provides them with skills and knowledge to qualify as teachers in basic schools. Teacher Trainees are the students who are undergoing academic and professional training in Teacher Training Colleges in Ghana to become teachers in basic schools.

These teacher trainees acquire the basic scientific skills that will help them to teach science to pupils in the basic schools throughout Ghana. The skills that the teacher trainees have to acquire in order to teach effectively at various levels at the basic schools include observation, measuring, calculating, classifying, experimenting, interpreting, drawing, devising and planning investigations, communicating effectively and using materials and scientific concepts to create materials and procedures for solving practical problems.

The Chief Examiner for Science Education at the Institute of Education at University of Cape Coast in his 2002 report of the Teacher Training Examinations in Science had this to say “Most of the candidates who wrote the part one Science Examinations in the year 2002 performed below average and lacked the background for the sciences since they could not answer most of the compulsory questions". He further commented that most candidates could not solve very simple mathematical problems and continued to spell very important scientific words wrongly. The chief examiner concluded that the sort of responses candidates produce gave indications that the teaching and learning of science in the Teacher Training Colleges has lost certain fundamental attributes. A situation which actually reduces science to rote learning and which causes candidates to operate mainly at the memorization level at the expense of the other more advanced ways of learning such as comprehension, application, analysis, synthesis and evaluation. Even at the memorization level, many candidates were found wanting since they could not remember definitions, formulae, spellings and chemical equations. Also, he added that the candidates lacked the skill of observation; most of the students could not produce any good diagrams, be it those of experimental set-ups, structures etc. They also did not conform to the laid down rules for making scientific drawing.

The President of Ghana, His Excellency John Agyekum Kufuor in his keynote address to members of Ghana Science Association in April 2004 challenged scientists to help the government of Ghana to demystify science and technology, and bring them into the public domain and infuse them into the psychology of all Ghanaians. He said scientist have over the years maintained an intimidating and mysterious image as a preserve of only the highly intellectually endowed individuals (Daily Graphic, April 18, 2004).

Statement of the problem

The majority of the teacher trainees were unable to answer science questions properly during the End of First Semester Examinations in Integrated Science in the first semester, 2005/2006 academic year examinations for Teacher Training Colleges in Ghana. Three thousand and eighty (3080) candidates out of eight thousand, seven hundred and twenty (8, 720) had to re-sit the Science paper (Institute of Education University of Cape Coast, End of First Year First Semester Diploma in Basic Education Examinations Results 2006).

The majority of the teacher trainees were unable to manipulate scientific equipment, solve problems in science, and apply scientific concepts in their day-to-day activities. They also found it extremely difficult to explain scientific concepts. In order to facilitate an understanding of the problem, it is imperative to take cognisance of the fact that the first year students of the Teacher Training Colleges in Ghana gain admission into these institutions based on the fact that they have passed Integrated Science in the Senior Secondary School Examinations and study Integrated Science in the Teacher Training College to consolidate their knowledge. It is therefore a source of concern to observe that quite a number of the first year Teacher Trainees had to re-sit the Integrated Science paper in their End of First Semester Examinations. The question to be asked here is why is it that so many first year teacher trainees performed poorly in Integrated Science, although these first year teacher trainees have studied the Integrated Science at Senior Secondary School and have received instructions at the Teacher Training College on the same topics?

Again, the ability of the teacher trainees to form science concepts depends on their own background in science and the conditions under which they are being taught

(Eugene, 1993). The implication is that the learning of Integrated Science in the Teacher Training Colleges will be successful if the teacher trainees are provided with enabling environment to develop positive learning principles such as having an awareness that whatever they learn they learn for themselves and with such a mentality they would be highly motivated to learn and have much retention. However, the 2005/2006 End of First Semester Diploma in Basic Education Examination Results in Integrated Science depicted a different picture which raises much concern. The question to be asked is how can the Teacher Trainees be helped to develop positive learning principles in Integrated Science?

It should also be noted that the effectiveness of the laboratory experience is directly related to the amount of teacher trainees' individual participation. Such participation means active involvement in the experiment with definite responsibilities for its progress and success. In theory, the ideal arrangement is to have each teacher trainee wholly responsible for conducting the experiment from start to finish. In this way planning, designing methods, collecting data and analysing results and drawing conclusions are unmistakably the work of the individual teacher trainee that will enable the teacher trainee to develop the ability to learn science. The implication is that when teacher trainees are given the opportunity to perform experiments, interact with teaching and learning materials, make observations, and draw conclusions during science learning they will be able to achieve a maximum level of learning science. However, some factors may impede the achievement of a maximum level of learning science. Some of these factors may include teacher trainees' poor background in science, teacher trainees being fixated, teacher trainees' poor vocabulary and command over the English Language, and their negative attitude towards the learning of Integrated Science. The investigation was therefore focused on the possible causes of the poor performance in Integrated Science by teacher trainees.

Research questions

The following questions are therefore being asked;

- What factors account for the low understanding of basic scientific concepts by teacher trainees?

- What makes it difficult for the teacher trainees to understand basic concepts in science?

- How can teacher trainees be helped to overcome this difficulty?

The aims and the objectives of the research

The aim of this research is to identify the explicit learning obstacles of the teacher trainees in forming scientific concepts and to gain an insight into their knowledge and beliefs in relation to understanding basic concepts in Integrated Science.

The objectives of the research are as follows;

a. To find out the obstacles that impede the teacher trainees from forming the correct concepts in Integrated Science.

b. To find out why the teacher trainees find it difficult to grasp science concepts clearly during teacher training.

c. To find out the appropriate teaching strategies that can be adopted by science tutors in the teacher training colleges that acknowledge, accommodate and provide for the student teachers' prior learning experiences.

Significance of the research

This investigation into the factors that impede the formation of basic scientific concepts by teacher trainees in Ghana will be beneficial in the following ways:

a. The findings can be used to develop teacher training programmes in Ghana that will help science tutors at teacher training colleges to have insight into the learning experiences of the teacher trainees so that effective science teaching takes place in the training colleges.

b. The findings will be of enormous help to the teacher trainees in the sense that they will be well equipped with the basic scientific concepts that will help them to increase their knowledge, prepare them for the task in the classroom, and also help them for further studies.

c. The findings will bring about improvements in science education in the teacher training colleges in Ghana and consequently improvement in science teaching in the basic schools.

Delimitation of the research

The research was conducted in selected Teacher Training Colleges in the Ashanti Region of Ghana. The participants comprised the first year students in four teacher training colleges in Ashanti Region. The first year students were chosen because in the first year the teacher trainees study Integrated Science and apply the concepts they have studied in the first year to learn methods of teaching science in the second year. Again in the second year the teacher trainees employ the knowledge they have acquired in methodology in science teaching for teaching practice which prepares them for one-year internship. In the third year the teacher trainees are posted to basic schools in rural areas for one year internship for their professional development. These Teacher Training Colleges in the Ashanti Region were used due to limitation on time, financial constraints coupled with the scattered locations of Teacher Training Colleges in Ghana.

Teacher Training Colleges in the Ashanti Region of Ghana were used in this research because Ashanti Region is centrally and strategically positioned in Ghana. It is easier to travel from all the other parts of the country to the Ashanti Region. In view of these factors, students from all the regions of Ghana study in the teachers training colleges in Ashanti Region. It is worthy of note that the training colleges in the Ashanti Region are multi-ethnic in character. In another development, the survey used the first year students because all the first year students study science as a compulsory subject. Samples of questions were taken from the foundation studies in Science for Teacher Training Colleges and the answers to these questions were analysed. The students whose answers represented misconceptions were selected and interviewed.

Chapter Summary

The research focused on the basic problem that accounted for the teacher trainees' inability to apply scientific concepts in their day-to-day activities, manipulate scientific equipment and solve problems in science. The main purpose of the research was to identify the explicit learning obstacles that impeded the formation of basic scientific concepts by teacher trainees and the appropriate strategies that can be employed to rectify these obstacles.

The findings will be significant in that it will bring about improvement in science education in teacher training colleges in Ghana. The participants comprised the first year students in four teacher training colleges in the Ashanti region of Ghana.

CHAPTER TWO

LITERATURE REVIEW

Introduction

In this chapter, various definitions of concepts given by different authors, the characteristics of concepts, various descriptions given to concept formation and the conditions under which learners form concepts are discussed. It also throws light on types of concept and the strategies that need to be followed by teachers in handling different types of concept. The chapter makes an attempt to explain conceptual change and the views of some educational philosophers on conceptual change, how learning should progress under conceptual change and the factors that can bring about conceptual change. Finally, the chapter discusses problem solving under the steps involved in problem solving and various definitions of problem solving.

The chapter is discussed under the following headings;

- Meaning of concepts
- Types of concepts
- Concept formation
- Factors affecting concept formation
- Conceptual change
- Problem solving

Meaning of concept

There are different definitions of concepts and what various authors have described as concepts are discussed below:

According to Roets (1995) people's opinions are articulated by way of words, images, signs, symbols, and concepts. He explains that science concepts are the symbols, impressions and knowledge representing concrete objects and abstract ideas in the field of the natural sciences.

Carey (2000) defines concepts as mental representations that, in their simplest form, can be expressed by a single word, such as plant or animal, alive or dead, table or chair, apple or orange. Carey further states that, two concepts could be combined to form a third representational structure. An example of the latter could be "density", which is the "matter per volume". This is an example of a concept that stands on itself but is a product of two other concepts. More complex concepts can describe a whole idea, for example "the theory of natural selection". In other words, within a particular representational structure, concepts help us to make deductions and explain even more complex ideas. Concepts can thus act like building blocks of more complex or even abstract representations. From the above discussion, it can be deduced that a concept is an idea of how something is or a principle involving how something should be done.

Bernard (1966) describes a concept as a person's impression of an object or situation he or she draws on his or her total knowledge in order to work out how the object or situation is constituted. On the other hand, Vrey (1979) defines concept as a symbolic image with a particular meaning, manipulable by means of linguistic symbol. Arends (1991) emphasizes that concepts are the basic building blocks for thinking particularly, higher-level thinking in any subject, and concepts allow individuals to classify objects and ideas and to derive rules and principles, in addition to providing foundations for the ideal networks that guide our thinking. In view of this it will be of interest for a research to be conducted to investigate the extent to which teacher trainees acquire appropriate scientific concepts, since the acquisition of appropriate scientific concepts enables teacher trainees to exhibit the necessary library skills as well as those needed for processing, organizing and integrating data. It therefore became imperative for the researcher to find out how the teacher trainees were able to summarise main ideas and illustrate them in diagrams, and their ability to consult the relevant worthwhile sources, with receptive and open minds.

Child (1981) is of the opinion that concepts can be best defined by their characteristics or attributes. He listed seven of these characteristics

a. "Concepts are generalizations, which are abstracting particular sensory events, and critical attributes. They are not the actual sensory events but merely representations of some aspects of these events in the mind".
b. "Concepts are dependent upon previous experience such as home background, educational opportunity, and emotional perceptional connections".
c. "Concepts are symbolic in human beings in form of words, numbers, chemical symbols and physical formulations".
d. Concepts can form 'horizontal' or 'vertical' organizations. For example, horizontal classification can be things such as reptiles (snakes, lizards and crocodiles) which belong to the same major group of animals simply because they posses attributes in common. Vertical classification can be due to the presence of hierarchies or categories, which increase in complexity as one,

proceed through the classification. For example cats, bears, panthers and seals, which are all flesh-eating mammals.

e. "Concepts are terms or abstract words emanating sub-consciously by extension or intention. These are concepts, which have common agreement and acceptance or having special significance with no universal acceptance. For example concepts which have extensional use are those words whose meanings have widely acknowledged meanings. Concepts with intentional use are those concepts, which vary from person to person due to personal or subjective experience of an individual. In view of this it will be prudent for a research to investigate how concepts that have intentional use impede the formation of basic scientific concepts by teacher trainees".

f. "Concepts may be irrational, because their origins are obscure and based on unusual methods of concept formation from reality".

g. "Concepts formed without conscious awareness; these are values established by our culture, which in one way or the other influence our daily conduct of life formed as habits from childhood without our realizing it. For example, prejudices, dislike for certain foods, attitudes towards religion may be implanted in a person for life".

It will therefore be imperative for a research to be conducted to investigate the factors that influence the thinking and actions of the teacher trainees with the view to finding out the extent to which these actions and thinking affect the formation of science concepts.

Arends (1991) again indicates that science concepts are mental organizations about the world that are based on similarities among objects or events. They are ideas generalized from particular instances. In forming concepts, we are noting that even though items in a set may have differences, they also have certain aspects that are similar. These similar aspects form the basis for grouping the things together into concepts. From the above discussions one can define a concept as an idea of how something is or a principle involving how something should be done.

Types of Concepts

According to Sternberge & Ben-Zeev (2001) there are at least five forms of expressing concepts. These forms are:

- Concrete concepts
- Abstract concepts
- Verbal concepts
- Non-verbal concepts
- Process concepts

They explained that concrete concepts can be seen, touched, or heard. In other words they have some direct sensory input. Examples of concrete concepts include furniture, computer hardware and dog. In contrast, abstract concepts are thought to have no direct sensory input unless by metaphor or analogy. The concepts of metaphor and analogy can be thought of as abstract concepts while verbal concepts are often thought of as classes of ideas or objects that are best understood and used using language. Examples include friendship and irony. These examples may also be classified as abstract concepts. Therefore, types of concepts may overlap. Non-verbal concepts are often thought to be best understood; making mental pictures to represent their critical attributes. The process of painting mental pictures to aid learning and production is often referred to as visualization. Examples of non-verbal concepts include perimeter, area, volume, and mass. Process concepts represent mechanisms such as photosynthesis or an atomic reaction.

In Science, Abdullahi (1982) contends that concepts exist in two kinds, empirical and theoretical. Empirical concepts are observable or demonstrable and may be defined operationally. They can be measured relatively, for example diffusion, freezing, volume, pressure, density, speed, velocity, acceleration, potential energy, etc. Theoretical concepts are non-observable and do not lend themselves easily to perception and are not measurable directly. For example, atoms, cell, genes, protons etc. It was therefore imperative that the researcher investigated the obstacles that prevented the teacher trainees from grasping and applying concepts that were either empirical or theoretical and devise strategies that can be employed to help the teacher trainees to grasp theoretical and empirical concepts.

Abdullahi (1982) continues to emphasise that every individual builds his or her world on concepts. They come in all types and some are much more significant than others. As one learns and experiences new things, he or she draws upon and increases his or her conceptual “store houses”. Therefore it is recommended that an investigation aimed at finding out scientific concepts that are more significant to the teacher trainees during their course could be conducted.

Concept Formation

Human Beings constantly put old concepts to use and in the process, frequently extend them and acquire new, related ones. It is good to know that concept acquisition, formation or development have no end. This is so because at any time in the person’s life a new concept can be acquired provided the person is psychologically tuned. The chain of concept usage, enlargement and revision is continuous for as long as we are able to think. Everyone learns concepts, whether they like to or not. Concepts enrich, as well as, extend and order our psychological worlds. Many concepts, such as table are, acquired because they have functional value; useful for something we need or want to do. The process of acquiring and using new concept is described as concept formation.

Roets (1995) observes that the formation of concepts in the cognitive structure is not purely a result of direct observation and past experience, but cognitive process such as organization; interpretation and combination of thoughts play major part. Therefore concept formation and the development of thought go hand in hand, and there is gradual progress from naïve egocentrism to adult logic and objectivity. The implication is that the way a person thinks invariably affects the way the person forms concepts. In view of this, the study focused on the factors that account for the teacher trainees' adherence to naïve egocentric ideas and find it difficult to progress to logical and objective standpoints.

Arends (1991) describes concept formation as the acquisition of conceptual skills in one's cognitive framework. This means that concept formation is an interpretation or understanding of what have been experienced. Individuals internalize their experience in a way which is partially their own. They construct their own meanings. These personal "ideas" influence the manner in which information is acquired.

From another perspective, a concept is formed when certain qualities and relationships are seen repeated in a number of successive experiences. Through several trials you can identify what qualities and relationships make a given concept (Arends, 1991). The implication is that students make observations of events and give their interpretations for such observations and the strategies used to acquire new information. All these help the students to form concepts. In view of this it became expedient to investigate the observational skills of the teacher trainees with the view of finding out how these skills affect the way they form concepts in Science.

According to Arends (1991) the formation of concepts follows a developmental pattern. In a young child concepts are usually vague and inexact. As one grows, the concept he builds up comes through experience. Without experience, a concept has no meaning for an individual. Ausubel (1968) asserts that concepts can be formed with or without verbal presentations. To Ausubel, concepts are learned in two stages. The child learns the representative image of the concept, and then later learns the verbal representative. In view of the above, it is imperative that the teacher trainees in the teacher training colleges make the correct impressions of the concepts. Therefore the researcher investigated factors that prevent the teacher trainees from grasping the correct impression of concepts.

Concept formation is the process of integrating a series of features that group together to form a class of ideas or objects. Developmentally, a younger child might define a bird as any object that flies in the air. The first time this child sees an airplane in flight, he may point to the sky and say, “Bird!” The observant parent or caregiver might correct the child by saying, “No that’s an airplane. Birds fly but they have feathers. Airplanes fly but they don’t have feathers.”

Possibly the most important role of concepts is cognitive economy (Rosch, 1978). Imagine if there were no concepts we would have to learn and recall the word that represents each individual entity in our world. For example, each type of table, automobile, or tree would need its own name in order for us to learn and communicate about it in any meaningful way. The size of our mental vocabulary would be so large that communication would be nearly, if not outright, impossible (Smith, 1988).

Sternberg et al (2001) intimated that one way to promote concept formation is to preview the different concepts students will encounter during the school year or school day or a lesson. They suggested the following strategies;

a. Teachers are to present learners with the definition of the different types of concepts, telling them which type they will see most and least often in class.
b. Teachers are to provide learners with examples of important concepts of each type taken directly from their textbooks, class syllabi, and/or outlines.
c. Teachers are to help students to develop a firm sense of the critical attributes that define individual concepts, making clear that each concept (i.e., separate) may share some critical attributes with other concepts. Writing the critical attributes on one side of a flash card and the concept on the other side may help them to collaborate with others or go off by themselves to learn the attributes. The concept flashcards may also help students to retrieve the concept from memory.

According to Treaqust, Duit and Fraser (1996) concept maps are considered to be an invaluable aid to concept formation. They contend that concept maps (sometimes referred to as concept webs or semantic maps) are diagrams that illustrate the critical attributes of concepts. For example, the name of a concept could be written in the centre of a blank page with a circle around it. The five critical attributes of that concept could each be written in smaller circles around the concept, connected by a line. Students would then have a mental image of that concept that will help them to carry out discussions with the view to grasping and assimilating the concept.

Treaqust et al (1996) furthermore suggested other strategies for enhancing concept formation. These strategies include;

- Providing students with concrete experiences,
- Using metaphors or analogies, or
- Using multiple pathways to learn concepts such as videos, audiotapes, hands-on experiences.

Zirbel (2001) contends that learning is a mental process that depends on perception and awareness, on how addition stimuli and new ideas get integrated into the old knowledge database (a process Piaget called ‘assimilation’), and on how, through reasoning (a previously acquired mental mechanism), the entire database gets re-organized which results in alternations of the mental structures and the creation of new ones (a process called ‘accommodation’). Zirbel (2001) continues that adding new information is the first part of learning and so the whole leaning process involves the integration, re-organization and creation of new mental structures. This implies that, whenever one refers to an object that is not present or an activity that is not going on; the impression of these must be created in the mind of the person.

Arends (1991) describes concept learning as the process of constructing knowledge and information into comprehensive cognitive structures.

Grotzer (1999) stated that in the cognitive sciences the term “deep understanding” generally refers to how concepts are “represented” in the student’s mind and most importantly how they are “connected” with each other. Representations are generally made in the form of images in simple cases, and in the forms of models in more abstract situations. Deep understanding then means that the concepts are well represented and well connected. As such deep understanding of a subject involves the ability to recall many connected concepts at once, where every single concept has a deep meaning in itself. Zirbel (2001) stated that deep thinking involves the construction of new concepts and is almost always based on what the student already knows. When a learner “makes sense” of new material he is able to make the connections between different concepts.

Ausubel (1963) asserts that language adds additional meaning to an already acquired concept. His focus is on both images and language. Ausubel (1963) also recognizes that the two stages, imaging and verbalizing, may occur simultaneously, especially in older children. As children learn to increase their verbal conceptual bases, their ability to comprehend written material also increases. In view of this, it would be useful for a research to be conducted to investigate the extent to which the vocabulary in science makes the formation of science concepts by the teacher trainees difficult.

All concepts have names or labels and more or less precise definitions. Labels and definitions permit mutual understanding and communication with others using concepts. They are prerequisites for concept teaching and learning. Labels, however, are human inventions and in some ways are arbitrary. Knowing the label does not mean a student understands the concept and this is what makes teaching concepts difficult (Arends, 1991). It was therefore worthy of note that the researcher investigated the difficulties the teacher trainees' encounter with regards to understanding science concepts.

A single concept (e.g. dog, table, democracy, due process, energy) is a grouping of facts, attributes, or steps in a process (Levine, 1999; Smith, 1988; Sternberg & Ben-Zeev, 2001). For example, the following critical attributes group together to define the concept bird:

- A bird is an animal that has feathers,
- A bird is an animal that flies,
- A bird is an animal that eats insects,
- A bird is an animal that perches in trees.

Every concept possesses critical attributes and it is very important for teacher trainees to grasp the critical attributes of any concepts they learn in science.

Pinker (2003) reported that students do not enter the classroom as a "blank slate", but come to class with already formed ideas on many topics. Students have their own individual present knowledge, beliefs, and ways of thinking (Novak, 1987; Helm & Novak, 1983; Smith Disessa & Rochelle, 1994). Sometimes these views may be rather strange, even elaborate, but regardless of their content, these views tend to be highly resistant to change. The views can change but what has to happen at the neural level is to establish new dendric connections, eliminate others and tweak the wrights of the signals that determine whether or not particular neurons will fire. While "learning the unfamiliar" and "conceptually understanding" the subject-matter already provides a large challenge and involves much neural activity, unlearning misconceptions is significantly more difficult.

According to Zirbel (2001) a person has a set of intellectual abilities and has developed specific ways of thinking and of surviving in general, and has learned a variety of skills during his lifetime, including how to speak and how to read. The person has a certain database of knowledge that he has acquired over the years. How much of this material is really accessible or there on recall is another issue.

Zirbel further contends that, human beings will have developed specific personality traits and skills, and will have learned specific ways of thinking, developed special talents and ways of thinking which they are more at ease than with others. In other words, our experiences have determined how our brain got hardwired, what types of specific skills and intelligences we possess and how we think in general. If new information is fed into the student's brain and a thinking network already exists, the student will feel more at ease and will more readily be able to follow certain arguments. This is more difficult if the student is challenged to think in an unfamiliar fashion. This then requires changing the original hardwiring. But with a lot of training, and a lot of effort from the students' side this can be done – but the point is the student has to do all the thinking, or in other words, construct knowledge. So, if we teach new materials in a yet foreign fashion we have to consider having to reconfigure or even create some of the thinking networks and thus the hardwiring.

LeDoux (1999) in his contribution emphasizes that whenever we experience something new, the brain searches for an existing network into which to fit that information, and if that network exists, we can process and evaluate the information relatively quickly and at ease. But if we are asked to learn a new skill, additional connections among the neurons have to be made – which almost always takes some time and experience. Thus thinking in ways we have already learned to think will be much easier than being challenged to think in new ways.

From the above it can be deduced that the ability to form science concepts depends upon the learner's own background and the conditions under which the learners learn. In a well-organized course of study, concepts formed early in the year are used to develop new concepts that occur later. Concepts are most easily acquired when familiar and concrete perceptual materials are used. To this end, the researcher investigated the influence of the conditions under which the teacher trainees learn on the formation of science concepts.

Factors affecting concept formation

Learners have difficulty understanding scientific concepts because they do not have the necessary conceptual, logical and linguistic background (Gaghardi, 1997). Other environmental factors that determine who the student has become are his socio-emotional learning and upbringing. The language and culture certainly affects his characteristics, personal habits, and preset ways of thinking. The parents, specific mentors, relatives and peer opinions and interactions also affect his character and might influence personal his beliefs. For example, various cultures provide culturally specific explanations for particular phenomenon. Samaragungaven, Vosiadou and Brewer (1996) found that some Indian children's conceptions of the universe are intertwined with elements of theology and mythology that were passed on to them by adults – even well educated adults – as a way of presenting cultural traditions. Cobern (1996) and Lalik (1993) acknowledge various modes of social and cultural interactions are present during concept formation. The implication of the above is that socio-cultural interactions may affect the formation of scientific concepts by teacher trainees undergoing training in teacher training colleges.

Fraser, Meir and Le Roux (2000) reported that poor vocabulary and command of the English Language made the majority of learners to find it difficult and even impossible to express themselves in terms of their own experiences and capacities.
The issue of language also impacts on the formation of concepts. To cite word for nature in Japanese and the word with which nature is translated, "Schizen", has a very different culturally based connotation (Cobern, 1996).

It has been argued that the formation of all concepts is determined by the cultural, religious and language background of the learner (Mensah, 2002). It could therefore be hypothesized that the cultural, religious and language background of the learners, in part, determine the formation of all concepts – regardless of the learning area to which they apply. However, Cobern (1966) asserts that the complexity of the composition of the learner corps needs to be recognized and that a socio-cultural matrix needs to be adopted in terms of teacher and student beliefs about the teaching and learning and modes of forming concepts in science. It was therefore, imperative for the researcher to investigate the extent to which language impacted on the formation of science concepts by teacher trainees. This is very important because the medium of instruction in the Teacher Training Colleges in Ghana is English language which is not the mother tongue of the teacher trainees and yet they need to have a firm control over English language in order to express their views and grasp the basic scientific concepts which are all in English language.

Looking at it from another perspective, Lycan (1999) asserts that thoughts and ideas are associated with words. Different languages promote different ways of thinking. Language does not completely determine thought but does influence it. Language is important in many cognitive activities, such as memory and thinking. Cognitive activities also influence language. Thinking involves mentally manipulating information, as when we form concepts, solve problems, reason and make decisions. Regardless of the kind of thinking a person engages in, thinking is fuelled by concepts. Human beings have special ability for creating categories to help them make sense of information in their environment (Sentrock, 1999).

Rosch (1973) believes that in considering how people think about concepts, prototypes often are involved. In prototype matching, people decide whether an item is a member of a category by comparing it with the most typical items of the category. The more similar the item is to the prototype, the more likely the person will judge that it belongs to the category.

In a study conducted in the Republic of South Africa, students displayed poor competency in concept formation and thinking skills in Mathematics and Science, and were weak in fundamental processes and awareness of number of sense (Gray, 1997). Students exhibit misconceptions or deviations from universally accepted concepts in physical sciences. Constructivists trace these misconceptions back to the unique conceptual frames of reference of students. The strategies used to provide a more concrete base for concept formation. An empirical investigation launched to determine whether media use in science lessons could lead to the formation of misconceptions revealed that the use of two dimensional representations of atoms, molecules and ion lattices lead to misconceptions (Swanepoel, 1992). A research into the effect of media on the formation of concepts and misconceptions by teacher trainees during teacher training should be carried out.

In another development, Sirestarajah (1995) has reported that practical work forms an integral part of physical science. In his work in the Republic of South Africa, he reported that most schools in Venda have no laboratories for practical work. Teachers use the telling method. Students learn by rote. They learn without understanding scientific concepts. They cannot apply their knowledge to real-life situations. He further on suggested that when science is taught through experiments with improvised apparatus, students' learning occur in various domains of science education. Meaningful learning leads to the understanding of scientific concepts, and students construct their own knowledge, apply it to any situation and enjoy learning the subject. The researcher therefore made the attempt to investigate the frequency with which practical work is utilized in the teacher training colleges in Ghana and to what extent the teacher trainees enjoyed their science lessons; and if they do not enjoy sought to investigate the reasons why they do not enjoy their science lessons.

Taylor, Tobin and Cobern (1996) argue that the complexity of the composition of the learner corps in multi-ethic schools needs to be recognized and that a socio-cultural matrix needs to be adopted in terms of teacher and student beliefs about teaching and learning and modes of forming concepts in science. Social class, gender and ethnicity are additional factors associated with concept formation and learning. Kuhn (1993) reported that there is considerable diversity in student's current knowledge and that the diversity contradicts accepted views, and that much of this diversity seems to be unresponsive to instruction. The intellectual activity of the student is greatly affected by the student's current knowledge. From these findings, one can deduce that the early environment of children appears to be in sowing and nurturing the seeds of science and that the early environment of the teacher trainees was taken into consideration by the researcher. In doing so, however, they must recognize that there might be different views of the same and that those views must be respected. When different views are expressed, students must listen to and understand these views, and negotiate common meanings.

Eugene (1995) explains that much of the concept learning in schools is based on the curriculum of the school programme. Each day, students face a wide range of problems to be solved and not all problems are found in the science textbook. Younger children face word decoding and science calculating problems, early adolescents stare down growing time and materials management problems, and adolescents confront complex social situations and important decisions about what to do after high school. Solving problems such as these will require using the products of other areas of higher order cognition such as concepts, creativity, and critical thinking.

Duit and Treaquest (1995) in their contribution explain that learners' naïve concepts show a marked resistance to change. Thus the naïve concept that the trainees have may pose as obstacle to their understanding and formation of concepts of science. An effort was made in this research to identify some of the naïve conceptions that the teacher trainees possess. Sangstad and Raaheim (in Gorman 1947) maintain that cognitive errors may be eliminated by identifying, evaluating, and carefully classifying appropriate and relevant information. An adequate amount of recent information is needed to provide a complete background to the problem. Moreover, Qualter (1996) asserts that social class, gender and ethnicity are some of the factors that affect concept formation and learning. It was therefore, imperative that the researcher investigated the teacher trainees' background in Integrated Science and how it affected the formation of concepts in science.

Based on the literature, the factors that influence children's concepts formation include age of the child or stage of cognitive development, genetics, peer groups, learning environment, language of teaching, the learning material, the child's experiences, previous knowledge, reinforcement and motivation and teaching methods. It was imperative for the researcher to find out how the language of teaching science impeded the formation of science concepts during teacher training.

Conceptual Change

Hewson (1982) describes conceptual change as the process in which the person changes his or her conceptions by capturing new conceptions, restructuring existing conceptions or exchanging existing conceptions for new conceptions, (that is a process of conceptual change).

When children reach school age and are given formal instructions, the previous concept retained in their minds may be naïve, incomplete, tentative or incorrect, and may interfere strongly with what the teacher is trying to convey (Victor and Lerner, 1971). They explained that most of the time teachers present information in science classes in an expository manner. Additional information will come from textbooks, films, videotapes and other sources. A small fraction of class time will be devoted to laboratory work. This state of affairs is not conducive to overcome the misconceptions. Conceptual change is the process of overcoming ones' misconceptions and adopting the correct concepts (Victor and Lerner, 1971).

In the constructivists view, knowledge is a dynamic conceptual means of making sense of experience rather than a passive representation of an extant world. They stress that each person must individually construct meanings of words and ideas if they are to be truly useful (Treagust et al 1996).

The key features in the constructivists' view of learning are:

a. The student's head is not empty
b. There are interactions between pre-existing ideas and new experiences and phenomena
c. Learners attempt to make sense of new experiences and phenomena by constructing meanings
d. This is a continuous and active process

Learners do not therefore, have to only assimilate new concepts but also develop, modify and change existing ones. The constructivists' view of learning can therefore be summarized as follows:

a. Learning outcomes depend not only on the learning environment but also on the knowledge that the learners possess.
b. Learning involves the construction of meanings. Meanings constructed by learners from what they see or hear may not be those intended. Construction of meaning is influenced to a large extent by the existing knowledge.
c. Construction of meaning is a continuous and active process.
d. Meaning, once constructed, is evaluated and can be accepted or rejected.
e. learners have the final responsibility for their learning
f. There are patterns in the types of meanings learners construct due to shared experiences with the physical world and through natural language.

g. The essence of one person's knowledge is the result of a personal interpretation of experience that is influenced by such factors as the learners' age, gender, race, ethnic background and knowledge (Treagust et al 1996).

Lumps and Staver (1995) argue that the degree to which a learner will be prepared to consider and modify an existing concept will depend solely on how plausible the new concept is and how the learner is dissatisfied with the existing concept. This state of affairs is commensurate with the notion held by constructivist that all learning is a process of personal construction so that learners can construct scientific concepts if they are given the opportunity and also if they find out that the scientific concept is superior to the previously held concepts.

Learning is generally understood to entail changes in a learner's knowledge where such changes are attributed to experience (Lump & Staver, 1995). Brown and Palinesar (1986) describe conceptual change as learning characterized by dramatic restructuring of the existing knowledge base. It is therefore worthy of note that, for a learner to be able to undergo conceptual change or a restructuring of the existing knowledge base, it is presupposed that prior concepts must be held. These prior concepts held by the learners may be alternative understanding about phenomena or they may be scientifically incorrect interpretation that the learners believe or an error in the explanations of phenomena constructed by the learners in response to the learner's prior knowledge and experience. This constitute misconception, and it can be due to the fact that the learners received insufficient or incomplete explanations and experiences about the phenomena or learners being exposed to misconceived meanings of phenomena or from the information handed on to the learners from the society. All these point to the fact that the learners have their own ideas that convey personal constructions and these ideas may be incomplete or contradictory and these ideas are often very stable and highly resistant to change. For such learners, who hold misconceptions, conceptual change is most likely to occur when and only when the new concept is intelligible and appear to be coherent and intellectually consistent, plausible and appear to be reconcilable with other aspects of the learners' view of the world (Treagust et al 1996).

Johnstone and Qualter (1996) stated that children develop intuitive or informal conceptions about the world through experience and interaction with the natural and social environment. Often these conceptions, (also referred to as misconceptions, alternative concepts and alternative frameworks) are in contrast to prevailing scientific views.

Abimbola (1988) has documented that naïve conceptions held by learners show a marked resistance to change. This issue constitutes one of the main learning obstacles in relation to learning areas in which the learning and understanding of concepts form an essential component. Cobern (1996) contends that a concept has an influence if it is central in an individual's prevailing worldview and scope if it has relevance for the individual over a wide range context. This view consequently makes provision for a variety of cultural connotations in relation to concept formation and adherence to concepts. In view of this, a research to investigate the teacher trainees prevailing worldview vis-à-vis the relevance of the concepts in science they learn will be of immense interest to the development of science education. This is in line with the constructivist notion that learners will construct scientifically orthodox concepts of natural and physical phenomena if given the opportunity and if they see that the scientific concept is superior to their pre-instructional conception.

When learners are given formal instruction, the previous concepts retained in their minds may be naïve, incomplete, tentative or incorrect, and may interfere strongly with what the teacher is trying to convey. Such misconceptions are amazing, tenacious and difficult to change.

As children construct their world from observation, trial and error, experiences, instruction from classroom teachers, words of wisdom from their parents, and numerous other sources, they form concepts of how the world works and behaves. Being pragmatics, children use the knowledge they have gained to explain the unfamiliar things they encounter. If the information seems to offer satisfactory explanation and it appears to work for them, it becomes ingrained in their behaviour.

It can therefore be concluded that through formal and informal experiences learners develop ideas about events, objects and organisms. This implies that:

i. Learners have explanations about their world
ii. Learners' current concept of their natural world influence what and how they learn science
iii. The concepts that the learners hold may be inadequate when compared to scientific explanations

From the above implications, it is important to note that the most important single factor that influences the learning of science is what the learners already know. It was therefore very important for the researcher to investigate the level of scientific facts, information and concepts that were held by the teacher trainees. Also the investigation was conducted to discover the level of involvement of the teacher trainees during science lessons.

The researcher had to conduct this investigation due to the fact that the teacher trainees have already studied science at the senior secondary school level and also have learned some facts from their environment. The knowledge they might have acquired might be inaccurate, naïve and resistant to change. This state of affairs might be a factor that could impede the formation of basic scientific concepts.

Zirbel (2001) however, argued that whether or not a student is going to undergo a conceptual change depends not only on the complexity of the concept itself, but also on the character and upbringing of the student, that is, it involves his entire personality, his general cultural and personal belief systems, his acquires and inherited intellect, his ability to follow and think through arguments and his personal attitude towards undergoing conceptual change.

To form new concepts or change old inadequate ones the student has to be led through several processes. First, he has to consciously notice and understand what the problem is; second, he has to assimilate more information and try it into already existing neutral networks; third, he has to critically think through all the argumentation in his own words and reorganize this thoughts- he has to accommodate the knowledge and evaluate against his prior beliefs; and finally, he has to work towards obtaining fluency in the newly acquired and understood concept so that this concept itself has then becomes a mere building block for future, more advanced concepts. The claim here is that during the process of conceptual change what happens in the student's mind is a reorganization of his thoughts, the creation of new neural network, and the rewiring of old ones. This process is difficult to provoke and requires the student to work hard at this. If we wish the student to go beyond conceptual change then we are requiring the student not only to willingly change his opinion, but also to integrate the newly acquired knowledge into his neural thinking network to the degree that it can readily be used to construct further concepts upon that whole knowledge.

The development of conceptual change has been outlined (Zirbel 2001)

Step 1**:** acknowledging the new information

Let us assume new material is presented. What will register with the student? If the student has an already existing network he might pick up on a certain thought pattern, similarly to how, for example, we might pick up on a certain sound we might like to hear. If the "sound" is somewhat unusual, chances are that we will notice it. If the sound is familiar we will only notice it if we pay particular attention to it, otherwise it might be heard with the unconscious and might not get officially registered. This same is true with particular ideas that the student might encounter – if the idea does not stand out on its own, it might go undetected and become unintelligible.

Step 2: filing and assimilating the new information

This is the point where the student will have to do some real thinking. Clearly, this depends also on how the student has previously learned to think through problems. What he has to do in his brain is to make some minor adjustments to the already existing networks and try to fit in the new information. At this stage the student is still assimilating the knowledge.

Step 3: evaluating and accommodating the new information

At this state the student will be challenged profoundly. How, will he defend his beliefs? How strongly rooted are those beliefs? How many networks are activated while the student thinks through the problem? What methods does the student use to argue his way through the problems – this too requires the usage of already existing networks of "how" the student thinks, so it is both, his knowledge and his methods of thinking that are being challenged. Ultimately, what will have to happen is that the old and the new information have to be combined and critically evaluated. The new information has to be logically integrated into student's prior knowledge database. During this process new neural circuits are being created and old circuits have to be rewired – after all, the prior beliefs do no longer fit together into the newly created networks. This might be a little different to forming new concepts – they involve the creating of new network, and perhaps tweaking the existing ones, conceptual change, however, involves all, creating new networks, tweaking existing ones, and disconnecting and disposing of no longer correct information and methods of thinking. In other words, to some degree, it involves almost complete rewiring and reorganizing thoughts and the neural networks.

Step 4: enhancing the fluency

At this stage, the newly established circuits will be ready to be used by the student at ease and without much effort – in other works the new knowledge and newly acquired way of thinking has become part of the students' foundation of robustly wired circuits. In fact, this circuit now has become a building block for further concepts.

Steps to facilitate the process of conceptual change

Zirbel (2001) further mentions how a good teacher can help facilitate the process of conceptual change in the following steps.

Step 1: hooking the student (acknowledging information)

From an educational perspective, it is the task of the educator to ensure that the particular idea does get noticed efficiently. In terms of teaching, this might mean that if a new idea is presented the student might need to be told explicitly to pay attention, or is somehow forced into consciously noticing the particular idea that is being presented. In other words, the new idea has to be dressed up enough so that it gets noticed and preferably also so that the student is initially intrigued by it enough to want to know more.

Step 2: suggesting bridges (assimilating information)

Again, this might be the place where a good educator can help the student. Although the student himself has to do the job of assimilating the new knowledge, a good educator might help with meaningful analogies that the student is already familiar with. This might help the student organize his ideas and help activate (hopefully) those networks that will be used later to help solve the problem.

Step 3: querying and confronting the student (accommodating information)

The step of thinking through the problem, understanding it, and more importantly evaluating it, is the hardest part for the student. It requires the reorganization of knowledge, the creating of new neural circuits, and the rewiring of old ones. This is something a teacher cannot do for the student, and his help can only be relatively limited. The student has to be on his own. A good teacher comes in with two things, first he can guide him through the new explanations so that they really do make sense, and second he can help him reject prior beliefs by having the student explain to him why they no longer work. Finding out exactly where the prior theory is defective might help the student – but unfortunately only if the student really is also willing to let go of his prior beliefs. Furthermore, what a good instructor can do at this stage is to continually challenge the student – provided the student is willing to be challenged.

Step 4: practicing and constructing (familiarizing information)

The work of the teacher certainly does not finish with helping the student understand why his prior theory is not appropriate and why the new theory is so much better. Maybe the student even ends up agreeing and accepts the conceptual change, but this still does not mean that the student can readily apply his newly acquired skills. The student needs to practice, and this is a point where the teacher definitely can help again. He needs to provide the student with meaningful examples and other problems that involve the newly acquired concept. The idea is to make the student feel at ease with the new concept. In fact further challenges might be appropriate here – examples that go beyond just regurgitating the problem, examples that go beyond, examples that involve applying the new knowledge and testing it.

According to Akpan (1992) the interaction between the child's different ideas and the manner in which these ideas are used depends on effective teaching. Akpan asserted that cognitive scientists have proposed a model which is based on the hypothesis that information is stored in memory in various forms called "schemes".

A scheme denoted the diverse things or ideas that are stored and interrelated in memory. These 'schemes' also influence the way a person may behave and interact with the environment, and in turn may be influenced by feedback from the environment. This model of organisation of schemes integrated with mental structures can be used to describe the acquisition of a new piece of knowledge or concept.

The way a new piece of information is assimilated depends both on the nature of the information and the structure of the learner's schemes. Thus the same experience provided for students in their science lessons may be assimilated differently by each individual. These images of the organisation of schemes, and the acquisition of new schemes, according to Akpan, may account for the existence of personal contradictory and stable ideas.

The implication of the above is that when a student states several contradictory ideas, different schemes are brought into play. Therefore in learning science, a student may note an event that is contrary to his or her expectations, and does not fit in his scheme. However, the student may not be able to restructure his ideas immediately.

To help the student to accomplish such reorganisation in their thinking about natural phenomena, the following strategies have been suggested;

- The science teacher should give a wide range of experiences relating to the key ideas to be restructured.
- Teachers need to be aware that each student in his class may form a different concept from the same teaching. Some may form meaningful concepts and others may form inadequate or erroneous concepts. The teacher should use

evaluation techniques to help find out which students need to repeat the same experience.

- The teacher must take time to help students to understand the meaning of a concept or word as it is used in a particular situation or context.
- Every teacher should have a repertoire of illustrations that indicate the importance of developing a meaningful vocabulary as part of the learning process.
- An important part of the child's science education is learning how to express his ideas in words that are meaningful not only to children but also to other people in the community.

Problem Solving

Ausubel (1968) defines problem solving as an operation in which both cognitive representation of past experience and the components of the current problem situation have to be reorganized in order to attain a particular objective. Problem solving, therefore, is an attempt to find an appropriate way of attaining a goal when the goal is not readily available, in this case, forming the right concept. The steps in solving problems are:

- Find and frame problems,
- Develop good problem-solving strategies,
- Evaluate solution and rethink
- Redefine problems and solutions overtime.

The ability to solve problems depends on the extent to which a person undergoes a conceptual change and this leads to concept formation, which is a prerequisite for problem solving.

The ability to form concepts correctly, therefore, reflects the extent to which a person is able to employ effective strategies to solve problems (Darko, 2004). It is therefore important for science teachers to guide students to find solutions to problems by following the principles that are outlined below:

- students should make use of all available alternatives;
- Students should discover a system of relations underlying solutions and promote their own principles.

The above suggest that, students are inhibited from thinking independently if teachers supply too many pointers to the correct solutions. This is because the students will be prevented from using their own reasoning faculties. In view of this, students should be allowed to perform a series of activities designed to discover a meaningful means-results relationship, which is basic to problem solving. In view of this the researcher investigated the problem-solving abilities of the teacher trainees during teacher training.

Levine (1999) has stated that obstacles to solving problems include being fixated and not being adequately initiated. Being fixated means focusing on prior strategies and failing to look at a problem from fresh, new perspective. Functional tiredness is a type of fixation in which an individual tries to solve a problem in a particular way that has worked in the past. It was therefore imperative that the researcher investigated some of the past cognition of the students that impede the formation of new science concepts.

Levine continues to emphasise that problem solving is the systematic use of a stepwise approach to answering complex questions or addressing difficult issues. He listed the following as the critical steps in problem solving:

- Recognizing a problem when you see a problem
- Stating exactly what the problem is
- Searching memory to see if a similar problem has been dealt with in the past
- Searching and using prior knowledge and experience to solve the problem
- Preview the desired outcome
- Decide if the problem can be solved
- Break the process of attaining the desired outcome into a series of steps
- Conduct research
- Consider alternative strategies for solving the problem
- Select the best strategy
- Talk oneself through the task
- Pace yourself
- Monitor progress
- Manage difficulties
- Stop when the problem is solved and
- Reflect on the effectiveness of the problem solving process and store it away in long term memory for later use (Levine 1999).

To this end it is imperative that teacher trainees develop their own personal cognitive toolbox full of problems that will work for them. Therefore the researcher investigated the extent to which the teacher trainees have developed their own problem solving strategies, which is an ingredient for concept formation in science.

Chapter Summary

This chapter discusses the various definitions of concepts, types of concepts, concept formation, and factors affecting concept formation, conceptual change, and problem solving.

A concept is an idea or principle relating to something abstract. It is a person's impression of an object or situation with a particular meaning that can be expressed by means of linguistic symbols. Concepts are formed with or without verbal presentations. However, the formation of concepts in the cognitive structure is not purely a result of direct observations and past experience, but cognitive process like organisation and interpretation. Cultural religious and language background of learners affect the formation of all concepts.

There are different types of concepts that learner encounter in their day-to-day activities. These include concrete concepts that can be observed, verbal concepts that are ideas or objects represented by language, non-verbal concepts that are understood by making mental pictures, empirical concepts that can be observed and demonstrated and theoretical concepts that are neither observable nor measurable.

Conceptual change is the process by which a person captures new concepts by restructuring and exchanging existing concepts. The main obstacle towards conceptual change is the old and existing concepts held by a person. The process of making frantic attempts to form the right concepts and the ability of using the correct strategies to solve problems is called problem solving. Fixation, which is the inability of a person to look at a problem from a fresh new perspective but focusing on prior strategies, is an obstacle to problem solving. Lack of conceptual logical and linguistic backgrounds is also an obstacle to problem solving.

CHAPTER THREE

EMPIRICAL RESEARCH

Introduction

This chapter contains the research questions which describe the extent of the problem under investigation, the research design; which focuses on the plan and sampling procedure, the research method; which describes the way the subjects were selected and the type of information obtained from them, types of instruments used to gather information and how the data was analysed and the design of the interview guide.

Research Questions

This research was conducted to find answers to the following questions;

- What factors account for the low understanding of basic scientific concepts by teacher trainees?
- What makes it difficult for the teacher trainees to understand basic concepts in science?
- How can the teacher trainees be helped to overcome this difficulty?

Research Design

A research design is the plan, which specifies how the research participants (samples) are going to be obtained and what is going to be done with them with the view to reaching conclusions about the research problem (Huysamen 1994).

The research design therefore specifies

- The number of groups that were used
- Whether these groups were drawn randomly from the populations involved or whether they were drawn randomly and also assigned randomly; and
- Exactly what was done to the sample chosen?

Research Method

Educational research can be classified using purpose, method or whether as quantitative or qualitative (Amedahe and Gyimah 2002). While quantitative research tends to emphasise numbers, measurement, experiment, numerical relationships and description, qualitative research focuses on understanding and meaning through verbal narrations and observations. Moreover, quantitative research involves measuring of variables, assessing the relationships or impact of variables, testing hypothesis and applying results to a large number of people, qualitative research on the other hand, involves learning about the views of individuals, assessing a process over time, generating theories based on participants' perspectives and obtaining detailed information about a few people or research sites (Amedahe and Gyimah, 2002).

Population

The research was aimed at obtaining detailed information about the factors that impede the formation of basic scientific concepts by teacher trainees in Ghana. The participants were drawn from four out of the seven Teacher Training Colleges in Ashanti Region of Ghana. There are thirty eight Teacher Training Colleges in Ghana with a population of over eight thousand first year teacher trainees (Ghana Education

Service, Teacher Education Division, 2005). The participants were first year teacher trainees, since the first year teacher trainees study Integrated Science concepts during their first year and have to apply the concepts in the second year when they study science methodology which they apply during their professional development in third year when they undertake a one year internship in basic schools in rural areas. The first year teacher trainees who were involved in the study were assured of confidentiality. Since there was no intervention about teaching, other teacher trainees were not missing out by not taking part in the survey and therefore confidentiality was sufficient to address ethical issues.

Sample

The sample was chosen from the first year teacher trainees of four out of the seven Teacher Training Colleges in Ashanti Region, one female teacher training college, one male teacher training college and two mixed teacher training colleges. Three hundred students were selected at random from the four teacher training colleges as follows;

- The number of classes in each of the four teacher training colleges was written on paper and the paper folded and the paper put in a box.
- The papers were then shaken together in the box and randomly selected.
- Three classes were selected from the female teacher training college, two classes were selected from the male teacher training college and two classes were selected from one mixed teacher training college.
- All the teacher trainees in the selected classes were involved in the investigation.
- Each class consisted of forty teacher trainees.

The reason for selecting three hundred (300) teacher trainees from Ashanti

Region out of the eight thousand and forty (8,040) teacher trainees country wide was to enable the researcher to employ various data collecting instruments to vary the data. Also, the small size sample enabled the researcher to use less time to collect data and organized detailed study on the sample.

Sampling Procedure

In the first place, I asked permission from the Principals and the heads of Science Department of four teacher training colleges where the research was conducted. In the letter for the permission, I explained the objectives of the research clearly and the teacher trainees who will be involved.

Secondly, the heads of Science Departments of the four teacher training colleges were informed about the objectives of the research and their cooperation was solicited.

As mentioned, the participants were first year teacher trainees of the four Teacher Training Colleges. The questions were distributed to the teacher trainees and administered by the researcher and the teacher trainees were required to supply their answers and their responses were collected after the test.

Ethical Issues

The ethical measures that were undertaken included consent from the heads of science departments and the first year teacher trainees who were purposefully sampled. A letter for the consent can be found in Appendix IV. They were assured of anonymity and confidentiality and their agreement to audiotape their science lessons was obtained.

Instrument

The data gathering instrument used in this research was thirty open-ended test items or free responses items to test the teacher trainees' conceptions in science. It consisted of thirty open-ended questions aimed at testing the teacher trainees' conceptions and understanding of science concepts. Open-ended questions found in Appendix I were used in order to identify the Teacher Trainees' ability to spell science vocabulary correctly, to explain scientific phenomena clearly, do calculations involving science problems and relate science concepts to real life situations.

The researcher also sat in the science classes and took notes regarding the extent to which the teacher trainees participated in science lessons, the way scientific ideas were generated in science lessons, the use of diagrams and illustrations to explain science concepts, the observational skills, the drawing skills, the listening skills of the teacher trainees, problem solving abilities of the teacher trainees and the general teaching methods adopted by science teachers. Moreover, the participants were given questionnaire found in Appendix II to answer with the view to establishing their background in science, their attitude and interest in science. Also ,the questionnaires sought to find out the teacher trainees involvement in the use of teaching and learning materials, reference text books and assignments in the learning of Integrated Science.

Observations and interviews were conducted in a naturally occurring situation, that is, during science lessons in the college premises. There was neither measurement of variables nor experimentations, therefore, the qualitative research method was employed where the participants were interviewed and observed in their classrooms.

Visits were made to some first year teacher trainees during the science lessons to find out what makes it difficult for the teacher trainees to understand basic concepts in science and they were observed on their participation in the learning activities, and investigated how closely they were following the lessons. The observational schedule is found in Appendix III. The way the teacher trainees responded to questions and the type of questions they asked were also observed. Each class in the female teacher training college under investigation was visited twice because the researcher is a tutor in this college and so the teacher trainees and the science tutors cooperated. Also, the researcher had easy access to the teacher trainees. On the other hand ,each class in the other teacher training colleges was visited only once since the researcher found it difficult to obtain the cooperation of the science tutors and teacher trainees and more importantly to meet the selected classes during science lessons was a bit of a problem.

Overview of the research instrument

Methods for investigating teacher trainees' understanding of science concepts include naturalistic settings, interviews, conceptual relationships, diagnostic test items and computerized diagnosis.

Most research into teacher trainees understanding in science used interviews; less attention has been paid to conventional test item However, researchers have used pencil and paper measures, such as free responses items, to examine a range of ideas held by large numbers of teacher trainees either following in-depth clinical interviews with other teacher trainees or as a broad investigative measure. The items are designed to address known areas of teacher trainees' conceptions and are similar to those given in interviews about instances and interviews about events.

A major limitation of this type of item is the difficulty in interpreting teacher trainees' responses. Generally speaking, if the items have not been thought out carefully and have not been field tested, the results can be very difficult to interpret. In view of the above, it was most appropriate to use open-ended test items, interview and observations in this investigation.

Treaqust (1995) describes an approach using two tiers of multiple-choice distracters per item to diagnose student's conceptual understanding of specified content areas in science. An essential aspect of this method is the necessity to field-test items so that as far as possible, they are representative of the range of students' responses to the concept being investigated. However, this method could not be used because of the strong and negative association between behaviourism and multiple-choice items, and also the items seemed not to investigate conceptual understanding.

The data-gathering instrument used in this research was thirty open-ended questions aimed at testing the students' conceptions in science. Open-ended questions were used to find out the students' ability to understand the questions, provide accurate answers to the questions, to check the students' spellings of scientific vocabulary and finally to check the students command over the English Language.

The questions covered some areas in the physical science that the teacher trainees are supposed to have firm understanding. These areas include:

- Energy
- Force
- Momentum
- Work
- Electricity

- Magnetism
- Light

These areas form part of the basic school science curriculum and it is a core component in the foundation course in the teacher training college Integrated Science course.

Validation of the Instrument

The instrument used in the investigation was sent to the supervisor who has scholarly opinion about the formation of concepts in science and the factors that impede the formation of concepts. The supervisor carefully scrutinized the test items, discarded the invalid ones and suggested correct ones. Also, Dr. Godfred Darko of Chemistry Department in the Faculty of Physical Sciences at the Kwame Nkrumah University of Science and Technology provided some valuable assistance in the organisation of the test items.

Pilot Study

The thirty open-ended test items were first given to eighty teacher trainees from the Female Teacher Training College, that is ,two classes and forty teacher trainees from one Mixed Teacher Training College, that is, one class. These two Teacher Training Colleges were chosen because the researcher could get easy access to the teacher trainees since they were all in the city where the researcher teaches. The members of the Science Department in the various Teacher Training Colleges were present to help in the supervision of the teacher trainees. The same test was conducted again after two weeks to the same group of teacher trainees of eighty and forty respectively from the two Teacher Training Colleges. After the pilot study, it was realised that the time for the administration of the test items should be two hours and answer booklets needed to be provided for each test. Also, the science tutors in the teacher training colleges where the test was administered were to be invigilators.

The test items were intended to find out the following;

- Problem solving skills of the teacher trainees.(Q.2,3b,6a and 6b)
- Teacher trainees' ability to explain everyday observations based on scientific phenomena (Q7c, d and e, Q5a and c, Q6e).
- Teacher trainees understanding of basic scientific concepts (Q3, Q7f, Q6g).
- Application of science concepts (Q5b).

The test items can be found in appendix 1

Reliability of the Test

Reliability refers to the accuracy of measurement by test. If an instrument consistently yields the same results when it is used to measure the same thing, the instrument is reliable. According to (Amedahe and Gyimah 2002), reliability is generally expressed in a reliability coefficient which falls between 0.00 and 1.00. A perfectly reliable test will have a reliability coefficient of 1.00. There are three techniques for estimating the reliability of a test; these are parallel forms, test-retest and split- half reliability test.

- Parallel Forms Reliability. Theoretically, there are many ways to measure a given property. A person could measure the width of a residential sidewalk with different yardsticks, metre sticks or tape measures. Each measuring device is a parallel form of the other measuring device.

- Test –retest Reliability; Is correlating the scores for the first administration with the scores from the second administration.

- Split-half Reliabilit;. Is the technique used to estimate the reliability of a one time teacher- made test. (Amedahe and Gyimah 2002)

The reliability of the test was estimated by using the reliability coefficient (the test-retest reliability) to find out how reliable the test items were. The test items were found to be reliable because the participants provided almost the same answers and there were similarities in the errors that were made in the two pilot studies. After the pilot study, the questions were re-grouped under seven main questions, each question consisting of two or more sub-questions that required free responses and administered to the participants in the four teacher training colleges.

Main Survey

The main survey was conducted using the test items that had been field tested in the two Teacher Training Colleges. The survey was conducted in four Teacher Training Colleges in Ashanti Region of Ghana. One hundred and twenty students from St. Louis Teacher Training College and eighty students from Wesley Teacher Training College, fifty students each from Mampong Technical Teachers Training College and Offinso Teacher Training College. These four teacher training colleges were used for the investigation because they were easily accessible to the researcher.

After the answers of all the three hundred teacher trainees had been analysed, it was discovered that ninety of the participants; sixty from St Louis Teacher Training

College and thirty from Wesley Teacher Training College gave answers that were incorrect and represented misconceptions and so fifty from St Louis Teacher Training College and thirty from Wesley Teacher Training College were selected purposively and interviewed by means of questionnaire. The questionnaire sought to discover the background of the teacher trainees in science, the attitude of the teacher trainees towards science learning, the teacher trainees' involvement and interaction with teaching and learning materials, the teacher trainees' view on assignments in Integrated Science and their recommendations for instructional method for science learning. (See the questionnaire in appendix II)

The researcher also visited each class that was involved in the investigation at St Louis Training College and Wesley Teacher Training College once to observe one science lesson. The observations of science lessons were conducted in these two Teacher Training Colleges because the teacher trainees who took part in the investigation in these colleges displayed some errors that required the observation as a follow up. Also, the researcher received better cooperation from both the science tutors and the teacher trainees from these two colleges. During the observations, some audio recordings were made on the science tutors' lesson delivery and the teacher trainees' participation in science lessons. In all, five observations were made. The observation instrument that was used can be found in appendix III.

The investigations were conducted in the second semester after the release of the end of first semester examination results between March 25th and April 30th 2006.

Problems encountered

The problems that emerged during the research were as follows:

- Out of the three hundred participants, thirty-five could not complete the work.
- Eighteen of the respondents' answers were copy work from their colleagues and so these were rejected and not included in the data analysis.
- Ninety of the teacher trainees could not complete the questions in the stipulated time because the questions were too many for them.
- The researcher could not visit the other training colleges because of time constraint and the difficulties in getting the teacher trainees from the other teacher training colleges as a result of the tight nature of their programmes

Data Analysis

In conducting research to investigate the teacher trainees' understanding of science concepts, raw data such as student's answers in interviews or free responses on pencil and paper tests, are organized by a set of categories that are developed in the spiral interpretation process. The final interpretation has to be made on the basis of the categories and the original transcript so that responses that have been put into a particular category are interpreted in the context. Such a contextual interpretation is necessary because the same set of words can have totally different meanings in different contexts

Procedure and Rationale for Data Analysis

The procedure for data analysis was based on the nature of responses to the items. The single frequency count statistical analysis was used to compile the recurrence of the respondents to the test items. The responses were analysed using qualitative strategies such as categorization, interpretation, noting patterns or themes and clustering of beliefs and values (Gerber 1996). The researcher sought to find out the following;

- Establish the teacher trainees' level of comprehension in the areas covered in the test items.
- Identify the questions that were not adequately answered by the teacher trainees.

Also, quantitative analysis was done where tables were drawn from the participants' responses and percentages calculated and discussed using a comparison of the percentages. It became necessary to use the quantitative analysis since constructing tables and plotting graphs from the teacher trainees' responses made it easier to make a comparison of the percentages that were calculated. In view of this both qualitative data analysis and quantitative data analysis were used.

Qualitative data analysis

The thirty open-ended test items were grouped into four main categories. These categories were;

I. Problem-solving questions involving calculations where the respondents were expected to solve problems by showing working in stating formulae, substituting values in formulae, and writing the correct units for their answers.
II. Explanations to everyday observations that are based on scientific phenomena
III. Questions probing the respondents understanding of basic scientific concepts

IV. Questions on Application of science concept in some appliances and equipment

The participants' responses were analysed by interpretation and noting of patterns. How the participants solved problems, explained scientific concepts and their level of understanding basic scientific concepts were taken note of.

Quantitative data analysis

The responses that were given by the participants were categorised and put on tables and the frequency of correct answers and percentage of correct answers were calculated for each question. Also, the frequency of wrong answers and percentages of wrong answers were calculated for each question. These made it possible for the researchers to identify the specific questions which more of the participants obtained wrong answers or correct answers so as to find out the possible causes. Moreover, the frequencies and percentages of the various responses given to the interview questionnaires were calculated and a discussion was done using a comparison of the percentages. Graphs were also constructed to highlight the percentages of correct and wrong answers to the test items and the various responses to the interview questionnaires to make analysis quite easier.

Chapter Summary

The research questions were, 'what factors account for the low understanding of basic scientific concept by teacher trainees? What makes it difficult for the teacher trainees to understand basic concept in science? What teaching strategies can be adopted to help the teacher trainees to over come these difficulties?'

Both qualitative and quantitative research methods were used to obtain some answers to these questions. After permission had been sought from the heads of science departments of teacher training colleges, thirty open-ended questions were administered to three hundred teacher trainees. Also, visits were made to science lessons and observations were made. The responses of the teacher trainees and the observations from the visits were analysed and contextual interpretations were made. The data-gathering instrument was carefully scrutinised by the supervisor and a fieldwork was done to determine the reliability of the test items. After using the reliability coefficient the test items were found to be reliable and so the main survey was conducted in four Teacher Training Colleges in the Ashanti Region of Ghana.

The results were collected and the responses put on tables and graphs to make analysis easier.

CHAPTER FOUR

DISCUSSION OF RESULTS

Introduction

This chapter contains the results from the responses given by the participants to the questions in both the interview and the test on applying science concepts. Tables showing the frequency and the responses of the participants are discussed in this chapter. The implications and conclusions from these results are also discussed. Observation made from science lessons and their implications are also discussed in this chapter. Finally, an analysis of the answers to the questions on applying science concept is captured in this chapter.

Table of Results

The tables below indicate the responses given by eighty (80) teacher trainees who responded to the questionnaires (Appendix I) in the interview.

Table 1: Grade in Integrated Science in Senior Secondary School Certificate Examination (Q 1. State your grade in Integrated Science in the senior secondary school exams)

Grade	Frequency	Percentage
A	0	0%
B	0	0%
C	2	2.5%
D	18	22.5%
E	60	77%
TOTAL	80	100%

From table 1, majority of the teacher trainees scored lower grades in Integrated Science at the senior secondary school examination. This indicates that the teacher trainees have poor background in science that may contribute to their holding of naïve and inaccurate knowledge in science which is resistant to change and may impede the formation of science concept.

Table 2: Teacher Trainees should learn Integrated Science as a foundation course (Q2. All teacher trainees should learn Integrated Science, do you agree?)

Responses	Frequency	Percentage
1. Disagree completely	26	32.5%
2. Agree partially	22	27.5%
3. Agree	14	17.5%
4. Agree completely	18	22.5%
Total	80	100%

Table 3: Reasons given for Respondents' stance on Integrated Science (Q2b)

Reasons	Frequency	Percentage
1. Not all the teacher trainees specialized in Science at Senior Secondary School	46	57.5%
2. Teacher Trainees should not be forced to study Integrated Science if they are not science-biased	22	27.5%
3. The Teacher Trainees may not study Science for further studies	18	22.5%
Total	80	100%

From tables 2 and 3 majority of the teacher trainees disagree that all the teacher trainees should learn Integrated Science during teacher training. Also, majority of them explained that only a few of the teacher trainees specialized at the senior secondary school and also few may study science for further studies. This stand by the teacher trainees indicate that they had negative attitude towards the teaching and learning of Integrated Science and since their background knowledge in science is poor, it stands to reason that they will disagree that science should be a compulsory subject during teacher training.

Table 4: How much Time Teacher Trainees study Science at their private study time (Q6. How much time do you spend studying Integrated Science during your private study time?)

Responses	Frequency	Percentage
1. less than 1 hour	0	0%
2. between 1and 2 hours	70	87.5%
3. between 2 and 3 hours	10	12.5%
Total	80	100%

Table 5a**:** Integrated Science requires study techniques

(Q9. Integrated Science as a subject requires the employment of study techniques)

Responses	Frequency	Percentage
1. I learn Integrated Science when I am going to write a quiz	53	66.3%
2. I join other students for discussion	10	12.5%
3. I read my notes before I attend Integrated Science lessons	17	21.2%
Total	80	100%

Table 5b: How teacher trainees study science at their private study time.

Responses	Frequency	Percentage
Always	17	21.2%
Sometimes	39	48.8%
Not at all	24	30%
Total	80	100%

From tables 4 and 5, majority of the teacher trainees learn Integrated Science when they are going to either write a quiz or preparing for an examination. This simply reveals that the teacher trainees are not motivated to learn Integrated Science and so this has contributed to inadequate library and research skills. Also, majority of the teacher trainees spent insufficient time in studying Integrated Science and the conclusion that can be drawn from this is that because of their poor background in science they are not motivated to learn science and spend less time in learning science.

Table 6: If given the option will you avoid Integrated Science? (Q7)

	Frequency	Percentage
Yes	65	81.25%
No	15	8.75%
Total	80	100%

Table 7: What is your level of interest in Integrated Science? (Q4.)

Interest in Integrated Science	Frequency	Percentage
Very strong	0	0%
Strong	12	15%
Low	68	85%
Very low	0	0%
Total	80	100%

From table 7, 85% of the teacher trainees are not interested in Integrated Science

It can therefore be deduced that since they have poor background knowledge in science they will develop a strong negative attitude towards science and may find the learning of science not attractive.

Table 8: Continuous Assessment in Integrated Science

(Q21. How often are you given the following assessment in Integrated Science?)

Assessment in science	Very often	Often	Sometimes	Never	Total
Home work	0	10	70	0	80
Class exercise	0	5	75	0	80
Quiz	0	10	70	0	80

From table 8, it is evident that assessment in Integrated Science is insufficient and so the teacher trainees do not receive adequate practice in problem solving, research and drawing of diagrams. In effect the teacher trainees do not acquire proper problem solving skills, drawing skills and research skills. These deficiencies may hinder their formation of basic scientific concepts.

Table 9: Use of Teaching and Learning Materials in science teaching **(**17. what quantity of teaching and learning materials are available in your college?)

Use of teaching and learning materials	Frequency	Percentage
Very adequate	0	0%
Adequate	12	15%
Less adequate	68	85%
Not available	0	0%
Total	80	100%

Table 10: Suggestions made by students for the improvement of the teaching and learning of Integrated Science in Teacher Training Colleges.

(Q22. Can you suggest any way by which the teaching and learning of Integrated Science can be improved in colleges?)

Ways to improve Science teaching and learning	Frequency	Percentage
1. Science Tutors should try to explain concepts using simple English Language or in vernacular	27	33.7%
2. Integrated Science lessons must be held always in the Science laboratory so that the students get the exposure to scientific equipment.	28	35%
3. Integrated Science lessons should be tailored for only Teacher Trainees who would like to teach science at the Primary Schools.	25	31.3%
Total	80	100%

Table 11: Table of Results for the answers to the thirty open ended test items on applying scientific concepts (Appendix I).

Question	Frequency of correct answers	Percentage correct answers	Frequency of wrong answers	Percentage of Wrong answers
1	0	0%	192	64%
2(a)	72	24%	228	76%
2(b)	72	24%	228	76%
3(a)	120	40%	180	60%
3(b)	90	30%	210	70%
3(c)	60	20%	240	80%
3(d)	72	24%	228	76%
4(a)	60	20%	240	80%
4(b)	60	20%	240	80%
4(c)	180	60%	120	40%
4(d)	210	70%	90	30%
4(e)	210	70%	90	30%
5(a)	60	20%	240	80%
5(b)	60	20%	240	80%
5(c)	60	20%	240	80%
6(a)	60	20%	240	80%
6(b)	60	20%	240	80%
6(c)	60	20%	240	80%
6(d)	60	20%	240	80%
6(e)	60	20%	240	80%
6(f)	60	20%	240	80%
6(g)	120	40%	180	60%

7(a)	60	20%	240	80%
7(b)	60	20%	240	80%
7(c)	60	20%	240	80%
7(d)	60	20%	240	80%
7(e)	90	30%	210	70%
7(f)	192	70%	108	36%

Graphs illustrating these results are in appendix VI.

Discussion of Results

a. Perception of teacher trainees on Integrated Science

Fifty seven point five percent (57.5% (table 3)) of the teacher trainees explained that science should not be a foundation course at the teacher training colleges because not all the teacher trainees specialized in science at the senior secondary schools. This shows that quite a number of the teacher trainees believe that if one does not do elective science at senior secondary school level, that person should not be compelled to study Integrated Science. Twenty two percent (22.5% (table 3)) also explained that, if after completing teacher training they will not teach science then, it is not advisable for the teacher trainees to learn science during teacher training. This shows that over 20% of the teacher trainees were not in favour of making science a foundation course since they were not sure of when they were going to apply the knowledge in science in future. The implication is that majority of the teacher trainees had a wrong perception about Integrated Science. This perception is illustrated by the responses on table 2 which showed that 32.5% of the teacher trainees disagreed completely that Integrated Science should be a foundation course at teacher training colleges. This shows that over 32% of the teacher trainees are not interested in science. Further more, from table 7, 85% of the teacher trainees expressed low interest in science, while only 15% expressed strong interest in science. Thus majority of the teacher trainees were not interested in science. It can therefore be concluded that majority of the teacher trainees have negative attitude towards Integrated Science and so exhibited low interest in studying in the subject. Thus one can infer that the inability of the teacher trainees to form basic scientific concepts might be attributable to their poor attitude towards Integrated Science. The responses on table six (6) showed that 81.25%, that is over 81% of the teacher trainees would avoid Integrated Science if given the option while just over 8% of the teacher trainees would not avoid Integrated Science.

Moreover the teacher trainees considered science as a difficult subject that has no immediate benefit for them and so there is no need wasting their time in studying the subject.

b. Behaviour of teacher trainees which inhibited their learning of Integrated Science

- Poor class participation

Observations made from science lessons revealed that majority of the teacher trainees did not actively participate in science lessons. The teacher trainees remained passive and only participated in notes taking. They seldom asked questions during science lessons and gave totally wrong answers to some basic questions; for example, some were not particularly interested in grasping the fact that cell wall was a plant cell inclusion, and so emphatically asserted that cell walls are found in animals cells.

Secondly, most of the teacher trainees seemed not to concentrate in science lessons. This was obvious when the science tutors frequently reminded these teacher trainees that they should not put the head on the table. Some of them were also found either trying to refer from some prepared notes to give the impression that they had grasped a concept, whereas they were contributing by reading from prepared notes. The students lacked the appropriate observational skills, recording skills and communication skills. In one of the science lessons observed, the teacher trainees displayed poor observational skills when they described the two conditions available in the experiment to find out the necessity of carbon dioxide in the process of photosynthesis. They could not describe the conditions created in the two conical flasks, one that contained soda lime, which absorbs carbon dioxide. They were able to confirm that soda lime absorbs carbon dioxide but they failed to describe the consequences that were created in the flasks.

When the teacher trainees were given assignments on ‘Elements’, they failed to produce correct answers. In fact, some of them came out with answers that suggested that, they were only guessing. For instance, some teacher trainees gave bronze as an example of an element; this clearly indicated that the teacher trainees did not do assignments. Although the students have well equipped library where they can make research, they never go there to read. The implication is that they lacked the appropriate library skills as well as research skills. The teacher trainees did not actively participate in the lessons. The teacher trainees did not concentrate in the science lessons. The teacher trainees were not able to observe science phenomena correctly, i.e. they lacked observational skills.

Another predominant feature in science lessons was that almost all the lessons were teacher-dominated lessons. The teacher trainees were seldom provided with the opportunities to physically interact with instructional materials and also were not given the opportunity to engage themselves in varied kinds of activities.

- Inadequate Research Skills

The teacher trainees displayed a lack of research skills. This was revealed in one of the lessons when the teacher trainees were expected to give a report on a reading assignment on the topic land breeze and sea breeze. Most of the students could not explain the concepts in their own words and some even copied the entire page and read it out to class. This revealed that the teacher trainees did not have adequate research skills, reading skills and verbal skills. These inadequate research and reading skills are illustrated by the responses on table 8 which showed that the teacher trainees were sometimes given home work or class exercises and quizzes. This indicated that the teacher trainees were not assessed continuously. The teacher trainees were also not provided with guidelines as to what was expected of them when they were given assignments. The point here is that when the teacher trainees are given assignments, they are not adequately guided and also these teacher trainees are left to guess and more often than not they do trial and error.

- Poor study skills

The responses in table 5 showed that, 66.3% of the teacher trainees do not learn science and they only learn science when they are going to write a quiz, while only 21.2% read their notes before they attend science lessons. This shows that, the teacher trainees do not have private study schedules for science. Sixty-six point three percent (66.3%) of the teacher trainees study science when they are going to write examination, twenty-one point two percent (21.2%) read the notes before they attend Integrated Science lessons while twelve percent (12%) join their friends for discussions. This implies that, most of the teacher trainees do not employ any study technique when studying science (Table 5).

The responses in table four (4) showed that 87.5% of the teacher trainees study science for between one and two hours at their private study time while only 12.5% study science between two and three hours. This showed that majority of the teacher trainees spend less time to study science. Thirty (30%) of the teacher trainees do not study science at all during their private study time, forty-eight point eight percent (48.8%) study science at times while twenty-one point two percent (21.2%) always study science. This implies that thirty percent (30%) of the teacher trainees lacked the motivation to learn science during their study time (Table 5b).

Moreover, most of the teacher trainees could not provide correct answers to questions posed by the science tutors at the beginning of science lessons, and could not describe their observations correctly. For instance most of the teacher trainees described convection in liquid using potassium permanganate as movement of the permanganate in water from hot region to cold region. The above observations reveal that the teacher trainees did not prepare for science lessons. The implication is that these teacher trainees do not use any appropriate study techniques for learning science.

From the above, it can be concluded that, the teacher trainees lack the techniques of studying Integrated Science and do not think that studying Integrated Science need any special techniques.

- Teacher trainees' over-estimation of their ability

In the classroom observations, it was realized that the teacher trainees, most of the time, seemed to have some knowledge on the topic under discussion, so they did not actually bother to fully participate in the activities taking place in the classroom. In one of such classes where the topic under discussion was heat transfer, most of the teacher trainees appeared to have knowledge about the concept conduction. However, when the teacher trainees were asked to describe the process of conduction, they agreed with one of their colleagues that the process of conduction is the transmission of heat through materials usually solid ones without the movement of the material itself. The teacher trainees held to this view because it seemed easier for them to remember and they did not seem to accept the teachers' explanations. This situation where the teacher trainees seemed to exhibit the notion of "I know it already" prevailed in all the science classes and this state of affairs did not encourage the teacher trainees to concentrate during science lessons. It was observed that the learners stuck to most of their prior conceptions and expected the teachers to tell and explain new concepts to them. This did not help the teacher trainees because they were still holding to their beliefs.

c. Understanding of concepts by teacher trainees

- Incorrect application of formula

The respondents were asked to perform simple calculations on speed, force, potential and kinetic energy, and ohms law. Majority of the respondents could not write the correct formulae for the questions asked. Formulae such as;

$\text{Work} = \dfrac{\text{Force applied}}{\text{Distance}}$ instead of work done = Force x displacement

$\text{Speed} = \dfrac{\text{Velocity}}{\text{Time}}$ instead of $\text{Speed} = \dfrac{\text{Distance}}{\text{Time}}$

$\text{Mass} = \frac{\text{Dis tan ce}}{\text{Speed}}$ instead of $\text{Mass} = \frac{\text{Force}}{\text{Acceleration}}$

$\text{Re sis tan ce} = \frac{\text{Current}}{\text{Voltage}}$ instead of $\text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$

V = RA instead of V = IR

Work done = Mass × Height instead of work done = Force x displacement

$\text{Potential Energy} = \frac{\text{Mass}}{\text{Velocity}}$ instead of PE = Mgh

$\text{Power} = \frac{\text{Re sis tan ce}}{\text{Current}}$ instead of $\text{Power} = \frac{\text{Work done}}{\text{Time}}$

$\text{Speed} = \frac{\text{Work done}}{\text{Time taken}}$ instead of $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

Speed = Distance taken x Time taken

Resistance = Voltage x Current

One hundred and eighty (180) teacher trainees out of the three hundred (300) teacher trainees who were tested were able to write the correct formula for kinetic energy. Two hundred and thirty (230) teacher trainees out of the three hundred (300) could not write the correct formula for speed, potential energy and the relationship between voltage, current and resistance, they could not solve the problems involving these concepts. As an example they wrote the following incorrect formulae;

Speed **=** distance **x** time, instead of speed **=** distance/time

Potential energy **=** mass **/** velocity, instead of potential energy **=** mass **x** acceleration due to gravity **x** height

Resistance **=** voltage **x** current, instead of resistance **=** voltage /current.

This suggests that the teacher trainees were not able to apply formulae to solve problems.

In another development, only one hundred and twenty (120) of the teacher trainees were able to write the correct formula and did the correct substitution, but when they arrived at the correct answer they could not write the SI units for the quantities. For example, in calculating the speed of a sprinter some of the teacher trainees approached the problem as follows;

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{200}{21.45} \text{ Instead of } \frac{200m}{21.45s} = 9.32 \text{ ms}^{-1}$$

$\therefore$ Speed of the sprinter = $\underline{\underline{9.32}}$

In this state of affairs, it is observed that the teacher trainees did not find it necessary to write the units for distance and time and that affected their final answers.

Secondly, in calculating the potential energy for the book hundred and thirty (130) students approached the problem as follows;

$PE = mgh = 2 \times 10 \times 2$

PE = <u>40N</u> Instead of 40J

$F = ma = 18N = m \times 3 = 3m = 18N$

$$\therefore 10m = \frac{10m}{3} \times 18N = \underline{\underline{60Nm}} \text{ Instead of } F = ma = 18N = 3kg \text{ x } a = \frac{18N}{3kg} = 6ms^{-2}$$

Though the teacher trainees were able to write the correct formula and obtained the correct numerical answer, they were not able to write the correct units for their answers. This suggests that teacher trainees did not appreciate the importance of the answers written correctly with their units.

The teacher trainees' displayed poor problem solving skills, which suggests that, they are unable to exhibit independent thinking. Also, the teacher trainees lacked the ability to follow instructions and so they were not able to develop their personal problem solving strategies. The crux of the matter is that the teacher trainees are not allowed to perform series of activities to find their own strategies in solving problems. The science tutors supply too many pointers to the correct solutions through notes given. This kind of teaching strategy does not encourage understanding of science concepts and may lead to misconceptions.

- Misconceptions on science held by teacher trainees

  This is how the teacher trainees answered the questions on the thirty open ended test items on applying science concepts. The explanations given by the teacher trainees on everyday observations that are based on scientific phenomena are discussed below.

  The questions to uncover misconceptions included the following.

  - Explain why the sky appears blue when the sun is high in the sky?
  - The object at the bottom of a clean pool of water appears to be shallower, explain; why does a highway sometimes appear wet when on a hot day when it is not wet?
  - Explain why most materials become less dense as their temperature is increased?
  - Explain why a glass filled with a cold beverage seems to "sweat"?
  - Explain why the electricity company increases the voltage of electricity for long distance transmission?

Most of the teacher trainees provided unscientific explanations to the observations. Some of the answers are as follows;

Question 7(d): The object at the bottom of a clean pool of water appears to be shallower. Explain?

- “An object at the bottom of a clean pool of water appears to be shallower because the object at the bottom of the clean pool may be heavy and it cause by a force being apply to it to reach the bottom of the object”. “The object at the bottom of a clean pool of water appears to be shallower because the pool is clean which seem to have no particle and it will be still so when you are looking at it would seem the thing is so near”.
- “Because water does not have colour it normally takes the colour of the container in which it is in and pools which are clean if even you looking inside you will see your face do the same thing apply to the object in the pool you will see it clearly”.
- “An object which has been put in a clean pool of water at the bottom can get to shallower when the load of the object is not heavy”.

This question sought to find out the students’ understanding of the consequences of refraction which explains the bending light rays from one medium to another. However the answer did not indicate any idea of refraction.

Question 7 (e): Why does a highway sometimes appear wet on a hot summer day, when it is not wet?

- “Because during the hot summer the sun scourcthing is very high so the waves of the sun appear to wet the ground”. “Highway sometimes appears wet on a hot summer day when it is not wet due to the sunshines. When the sun shine too much there will be swear and thus cause the highway to be wet".

- "On a hot summer day seas and rivers breeze in the air so the air becomes moisture and thus makes the highway wet".
- "A highway sometimes appears wet on a hot summer day because of geothermal energy that is the hot rocks found under the earth surface".
- "Highway sometimes appears wet on a hot summer day because when it shines it expanse from it normal sizes and when the sun goes it form. It normal size and because of the heat it makes it wet".

This question sought to find out the students understanding of mirage, but some of the answers above described mirage as scorching of the sun which indicated that the students do not have firm understanding of science concepts. Also they displayed poor spelling of the word scorching as "scourcthing"

Question 7 (c): Explain why the sky appears blue when the sun is high in the sky?

- "Sky appears blue when the sun is hot because the temperature up there will be very high and because the sun is hot it makes the clouds becomes denser as the temperature increases, i.e. the molecules". This question was aimed at finding out how the students could relate the abundance of nitrogen in the atmosphere and the scattering of blue light by nitrogen to make the sky appear blue, but the student attributed the blue to high temperature forming dense clouds.
- "This is because when the sun shines high the colour of the sea through electromagnetic waves reflects to the sky and it appears blue as the colour

of the sea. The material becomes dense due to the free movement of the molecules".

- "The sky appears blue when the sun is high in the sky because when the sun shines brightly it you can't look at it straight in the sky so when you look at another place your eyes will be blear and you will see the sky as blue".
- "The sky appears blue when the atmosphere becomes cool in the air. the atmosphere comes together when it becomes blue it reduces the temperature in the air so that the weather become cool".
- "The sun makes the clouds that is if there sun in the sky, the sun absorbs the clouds and the sky becomes blue".
- "Because when the sun shines hot the moisture on the road come into contact with the sun this bring about the road becoming wet".

Question 5 (a) Explain why most materials become less dense as their temperature is increased?

- "Most materials become less dense as temperature increases because as temperature increases it tends to withdraw some energy materials possess, therefore making less dense".

This question was trying to find out relationship between thermal expansion and density. That is as temperature increases materials expand and become less dense. But the student attributed the material becoming less dense to removal of energy.

- “Most materials become less dense as their temperature is increased because of temperature change. Example if water is put in the refrigerator and it becomes an ice block it becomes lighter because of the temperature difference”.
- “Most materials become less dense as their temperature is increased. When we take fat for instance. When the temperature is moderate or ids normal is it solid but when the it increases is melt. That is it change from solid to liquid thereby making it less dense and the same applies to other materials”.

Question 5(c) Explain why a glass filled with a cool beverage seems to “sweat”. Would you expect more sweating inside a house during the cold or hot season. Explain?

- “The glass filled with cold beverage seem to “sweat” because of evaporation. Since cold water evaporises faster than warm water, the water rises and some settle around the glass.

  The question was testing the concept of condensation of water vapour as it comes into contact with a cold object; however, the student was talking about evaporation of cold and warm water.

Question 6(e): Explain why the Electricity Company increases the voltage of electricity for long distance transmission.

- “The electricity company increases the voltage of electricity for long distance transmission due to the used power at a particular place. When the enough power is used, these would be increment of voltage”.

- “The electricity company increases the voltage for long distance transmission because if the voltage is low the light will not be bright. It will rather be dim”.
- “The electricity company increases the voltage of electricity for long distance transmission because more cabbles are use for the long distance transmission and it takes longer period to reach the place so if the voltage is small it will delay more time before it gets there”.
- “Electricity is increased in along distance because as light travels, the light rays decreases”.

  This question was trying to find out the students’ understanding of the conversion some of the electric current into heat that is lost and hence, increase the voltage for long distance transmission.

Only thirty percent (30%) of the teacher trainees could explain why the highway sometimes appears wet on a hot summer day when it is not wet. These teacher trainees agreed that it is due to mirage caused by hot air near the ground reflecting light rays upwards into the eyes of a distant observer. Only sixteen percent (16%) of the teacher trainees could explain that an object at the bottom of a clean pool of water appears to be shallower due to refraction of light.

Eighty-four percent (84%) of the teacher trainees could neither explain why the sky appears blue when the sun is high in the sky nor explain why most materials become less dense as their temperatures is increased.

Eighty percent (80) of the teacher trainees failed to provide scientific explanations to the following;

- Why glass filled with cold beverage seems to “sweat”?

- Why electricity company increases the voltage of electricity for long distance transmission?

The above analysis of the teacher trainees' answers to the questions that required them to give scientific explanations to everyday observations has revealed the following;

- The teacher trainees have difficulty in understanding scientific vocabulary.
- The teacher trainees could not relate the scientific concepts to everyday life.

- Questions Probing the Teacher trainees' understanding of basic scientific concepts

The teacher trainees were expected to answer questions that test their knowledge and understanding of the following concepts; potential energy, magnetism, work and energy, luminous and non-luminous objects, and the relationship between force and acceleration, and momentum.

The following examples indicate the poor understanding exhibited by the teacher trainees;

Question 3(a): Is it possible for a small car to have the same momentum as a larger truck? Explain.

- "No because the momentum of the larger one can weigh more mass than the smaller one"
- "No it is not possible for a small car to have the same momentum as a larger truck because since the small car would not be having much load, the speed or its momentum will be faster as compared to the larger truck that do not have heavy load on it.

Momentum is product of the mass of an object and velocity. This question was testing the students' ability to apply their knowledge in the definition of momentum which is the product of mass and velocity, but they were looking at the load, the size and the mass of the two vehicles.

Question 7(f): Distinguish between luminous and non-luminous objects and give two (2) examples of each.

- "Luminous are objects which allow light to pass through e.g. transparent object, while non-luminous objects do not allow light to pass through".

Question 7(a): A permanent magnet has magnetic properties. Why?

- "A permanent magnet has magnetic properties which helps to protect the magnetic".
- "A permanent magnet has magnetic properties because the magnet is able to resist heat. Also the magnet is capable of resisting any change of temperature that might occur. A magnet is a best conductor of heat".

Questions 6(g): Why does the north pole of a magnet point to the geographic North Pole if like poles repel?

- "North pole of a magnet points to the geographic north pole of like pole repel because the poles are the same and they are from different area since they are not the same they will repel"

Majority of the teacher trainees displayed poor knowledge and understanding in the concepts. This is illustrated by the responses on table one which showed that 77% of the teacher trainees obtained grade E while 22.5% and 2.5% obtained grade D and C respectively. This showed that majority of the teacher trainees had poor background in science which might be a factor that impeded the teacher trainees from understanding basic scientific concepts.

- Questions on Application of science concepts in appliances and equipments

Question 5(b): A true vacuum flask has a double-walled, silvered bottle with the air removed from the space between the walls. Describe how this design keeps food hot or cold by dealing with conduction, convection and radiation.

- "Since the vacuum flask has double- wall silvered and there is no air the food in the vacuum flask becomes hot when molecular particles collides and transfers heat to around and since the air inn the doubled walled is removed it keeps it hot. The food, likewise becomes cold due to radiation because is involved the transfer of micromagnetic waves from one object to another. With conduction since the molecules are far apart therefore molecules take more time to heat".
- "Since silver is a metal, and metals are good conductors of heat and the silver is double-walled which allows the molecules to move to causing collision that generates heat and therefore keeps the food's temperature at a stable rate".
- "When food is put into vacuum flask the hotness or the coldness of it turns it into small droplets of water. So as these droplets collides with one another it condenses. Heat then travels from it (first side) to external or several vacuums. This side keeps the food warm or cold since it does not give way to evaporation".
- "The silvered line helps the food to become hot or cold if it is hot or cold food. The vacuum prevents heat lost by radiation. The silvered

line also prevent lost by conduction and the space between the walls prevent heat lost by convection".

- "The vacuum flask has a double-walled to avoid heat loose by conduction. Silvered bottle is prevent hot loose by conduction and convection. Vacuum is to prevent heat loose by radiation".
- "There is no space in it therefore the heat is able to transfer the heat to other parts of the vacuum flask thereby keeping the food hot".
- "The vacuum flask has food in it and due to the vibration of silvered bottle in the hot food transfers heat molecules to the silvered bottle in it".

From table 11, it is observed that the percentage of correct answers ranges from 0% to 70% while the percentage of wrong answers ranges from 30% to 80%. This suggests that majority of the teacher trainees provided wrong answers to the questions. Nobody got question one correct while seventy percent (70%) got question four (4) correct. Apart from question three (3) and questions six (6) where there were forty percent (40%) correct answers, all the other questions that is question two (2), question three (3) and question five (5), teacher trainees scored only twenty percent (20%) correct answers. The questions in which teacher trainees scored twenty percent (20%) or below correct answers were questions that involved calculations and application of scientific concepts. This implies that, the teacher trainees have poor problem solving skills, inappropriate analytical skills and poor understanding of science concepts.

They displayed lack of logic in their answers, for example, they simplified how convection currents bring about sea breeze and land breeze.

In another development, it was observed that the teacher trainees could not use the beam balance to measure the mass of a stone after following the instructions given by their teacher. Always the teacher trainees read the scale when the pan had tilted instead of the two pans being at equilibrium. This state of affairs revealed that the teacher trainees had a different meaning for the word ‘balance’. In fact, they argued that the word balance as used in everyday discussion means that an object has been tilted.

- The teacher trainees lacked the vocabulary and could not express themselves well in English
- The teacher trainees were using everyday knowledge in science which made it difficult for most of the teacher trainees to grasp scientific concepts
- Inflexible teaching methods, for example, lecturing, reading from textbooks and tutors providing too many pointers to correct answers were used in the teaching of science. In this way, the teacher trainees were inhibited to think productively and thus they have poor analytical abilities
- The science tutors did not motivate the teacher trainees, in that the teacher trainees were not given effective counselling as to how to study science. Also, the attitude of some of the science tutors in science lessons was not encouraging therefore the teacher trainees had negative attitude towards the learning of science
- The teaching of science did not take into consideration the integration of different teaching and learning materials; model, real objects, charts and pictures were seldom used to explain concepts. The only medium employed frequently was verbal communication.

The samples of the teacher trainees’ answers to the test questions is found at Appendix IV.

Conceptual difficulties were also uncovered during interviews with the teacher trainees.

SOME EXCERPTS FROM INTERVIEW WITH TEACHER TRAINEES

Question: Name examples of elements.

Answer; bronze

Question: How is work related to energy?

Answer; work is when a force is moved in the direction of an object. Energy is the ability to do work, therefore work is the force needed to transfer a form of energy to another.

Question: Explain why most materials become less dense as their temperature increases.

Answer; they become less dense as their temperature increase because the higher it goes the cooler it becomes and so as the temperature rise the material becomes lighter.

Question; Explain why a glass filled with cold beverage seems to “sweat”

Answer; a glass with cold beverage seems to sweat because glass is not a good conductor of heat so cold beverage in a glass cannot sweat inside but outside the glass

Question: Explain why the sky appears blue when the sun is high in the sky.

Answer; the sky appears blue when the sun is high in the sky because during the day the temperature will increase and the hotness of the temperature will evaporate and make the sky to become blue.

In response to a question on the differences in heat between steam and boiling water in one of the science lessons, many of the teacher trainees responded by saying that it is obvious that boiling water contains more heat energy than steam, since the steam has not come into contact with any source of heat .When they were asked to explain their responses, they explained that as for boiling it is already on fire, having contact with heat but steam the object used to attract metals will always be at room temperature.

In another development, the teacher trainees displayed inadequate knowledge about digestion in human beings. Digestion is among the process concepts which require the teacher trainees to follow instructions. However, the teacher trainees could not describe the process adequately. For instance, majority of the teacher trainees held the belief that digestion of food begins in the stomach and that there is no digestion in the mouth. The teacher trainees in describing the role the mouth plays in digestion, said food is chewed and swallowed. The teacher trainees with this poor explanation to digestion displayed inadequacies in their understanding of the process concepts. This observation revealed that the teacher trainees do not follow simple instructions and they draw conclusions without adequately finding out the connections between the parts. The interviews truly confirmed those test results and indicated that the teacher trainees experienced difficulties in understanding science concepts.

d. Suggestions for improvement of teaching of science

Table 10 shows that a large number of teacher trainees have different ways of improving the teaching and learning of Integrated Science in teacher training colleges. The teacher trainees therefore suggested different ways like clear explanation of science concepts during science lessons and conducting science lessons in science laboratories where teacher trainees interact with science equipment. This shows that there are deficiencies in the teaching and learning of science in the teacher training colleges and these deficiencies need to be rectified.

Fifty-seven point five (57.5%) of the teacher trainees (table 3) suggested that the teaching of Integrated Science should be limited to only teacher trainees who have already specialized in science at the Senior Secondary School. The implication is that science should be a specialised subject, which should be selected by only the teacher trainees who studied science as elective in Senior Secondary School.

Twenty-Seven point five percent (27.5%) of the teacher trainees suggested that the students should not be compelled to study Integrated Science if they are not Science biased (table 2). This shows that some of the teacher trainees feel compelled to study science and do not show any commitment into the study of science.

Thirty-two point five percent (32.5%) of the teacher trainees disagreed completely while twenty-seven point five percent (27.5%) agreed partially to the notion that teacher trainees should learn Integrated Science (table 2). The implication is that, the teacher trainees felt that there is no need to make science a compulsory subject at the teacher training colleges.

Thirty-three point seven percent (33.7%) of the teacher trainees suggested that science concepts should be explained in vernacular. Thirty-five percent (35%) suggested that science lessons should be held in laboratories while thirty-one point three percent (31.3%) suggested science teaching at the teacher training colleges should be given to only the students who would be teaching science at the basic schools. The implication is that, the teaching of science in the teacher training colleges does not employ appropriate teaching techniques and moreover, the teacher trainees are not exposed to experimental procedures in the laboratories. Also, the teacher trainees wanted scientific concepts to be explained using vernacular and science teaching should be limited to only teacher trainees who specialised in science at secondary school.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter is designed to give an insight into the major findings of the research under the topic "the factors that impede the formation of science concept during teacher training in Ghana". The main factors that were identified during the research as contributors to the teacher trainees' poor understanding of basic scientific concepts included teacher trainees' poor background in science, inability to communicate effectively in the English language, inflexible teaching methods, poor attitude towards science learning and poor problem solving skills.

Recommendations on strategies to be employed to rectify the problems included laboratory work in science learning, encouraging teacher trainees to do science assignments, science teachers explaining science concepts clearly and teacher trainees being provided with instructions on how to study effectively.

The major findings on factors that impede the formation of science concepts during teacher training in Ghana are as follows;

(a) Teacher Trainees' Poor Background in Science

Every educational programme has a baseline and a ceiling. This baseline is a starting point which in most instances assumes that learners entering into a programme have already acquired basic knowledge and skills relevant to their understanding of the new content.

However, the majority of the teacher trainees' performance in the Senior Secondary School Certificate Examination was just average, that is Grade E which is interpreted as a pass. This weak foundation is traceable to their junior high school days. This indicated that what majority of the teacher trainees ought to know in science already to assist them to understand science concepts was inadequate. The implication is that the Teacher Trainees who had poor knowledge in science had difficulties in comprehending science concepts. This is supported by the constructivists view on learning which says that learning outcomes depend on the knowledge that the learners posses, and the construction of meaning is influenced to a large extent by the existing knowledge. Therefore, if the existing knowledge in science is poor then it will impact negatively on the way the teacher trainees learn science during their training.

This assertion is further buttressed by the fact that the teacher trainees' poor background in science resulted in their holding to naïve conceptions about science which further resulted in marked resistance to change. The teacher trainees' previous incomplete and incorrect knowledge in science might have interfered strongly with what their teachers conveyed in class. It therefore stands to reason that the teacher trainees' poor background in science contributed to their low understanding of science concepts.

(b) Teacher Trainees' inability to communicate effectively in English language.

Science teaching in the Teacher Training Colleges in Ghana is done in English language since it is a second language and the medium of instructions in schools. The Teacher Trainees found it difficult to understand scientific concepts because they had poor command over the English language. The genesis of the problem is as usual traceable to the poor foundation in English language exhibited by the teacher trainees. The teacher trainees found it difficult to understand most of the things their teachers said during science lessons and also could not express themselves in English language and so they were unable to ask pertinent questions in class to solicit for clarification.

As a result, when they did not grasp the meaning of any concepts, they had a tough time formulating the language to express their views in asking the relevant questions to address their shortcomings in science lessons.

Coupled with their poor spoken English language ability, they also had difficulties in expressing themselves clearly in writing. This tendency further frustrated their understanding of instructions and examinations questions. The teacher trainees' inability to communicate effectively in the English language contributed to their poor understanding and prevented them from thinking through concepts in their own words. Therefore, the teacher trainees' poor command over English language contributed to their low understanding of science concepts.

(c) Inflexible teaching methods

A good teacher is supposed to guide students through any new concept and also to help students to reject prior beliefs. The good teacher does this by trying to provide students with exactly the defects regarding the beliefs they hold and continuously challenge the students and also providing the students with meaningful examples and other problems that involve the newly- acquired concepts. The essence of education is the teacher teaching so that the learners learn. Therefore it is imperative that the science teachers convey their instructions in class in such a way that the learners will be helped to develop positive learning principles, for example whatever they learn for themselves, they are highly motivated to learn and they have much retention.

However Inflexible teaching methods, for example, lecturing, reading from text books and science tutors providing too many pointers to correct answers were used in the teaching of science. The science tutors did not motivate the students. Also, the competence of some of the science tutors during science lessons was not encouraging, therefore the teacher trainees have negative attitude towards the learning of science. The teaching of science did not take into consideration the integration of different media. Models, charts, pictures and real objects were seldom used to explain concepts. The only medium employed frequently was verbal communication. This inflexible teaching method inhibits the teacher trainees to think productively, makes it difficult for them to understand scientific concepts and make the teacher trainees have poor analytical abilities.

(d) Teacher trainees' poor attitude towards science learning

Teacher Trainees are supposed to learn science concepts, remember what they have learnt and then apply the knowledge in unfamiliar situations to solve problems. In this way, they will be developing skills in the areas of understanding, evaluating, synthesising, and drawing conclusions, seeing cause and effect, mastering technique of notes taking and research. This required the employment of appropriate study skills to learn science concepts and developing positive attitudes towards the learning of science. However, basic and elementary scientific phenomena and explanation were beyond the reach of the teacher trainees. They were not familiar with common concepts such as electrostatics, magnetism, refraction, momentum, speed, acceleration, work and energy and force in the physical sciences. They displayed poor mastery of these science concepts and understanding and that their understanding was limited to their own experience, social knowledge and prior learning experiences.

This state of affairs was due to the fact that the teacher trainees employed inappropriate study techniques, such as refusal to do assignments, not doing any supplementary reading and research which contributed to their poor understanding of basic scientific concepts. It is therefore obvious that when teacher trainees exhibit negative attitude towards the learning of a subject they are more likely to experience profound problems in understanding the subject. Hence the teacher trainees' poor attitude towards studying science on their own was due to the fact that they had negative perceptions about science and this impeded their understanding of science concepts.

(e) Teacher trainees' poor problem-solving skills

The ability to form concepts, and for that matter, science concepts reflects the extent to which a person is able to employ effective strategies to solve problems. Obstacles to solving problems include being fixated and focusing on prior strategies and failing to look at a problem from fresh and new perspective. There is therefore the need for the teacher trainees to develop their own problem solving strategies which is sine qua non for concepts formation. However, the teacher trainees were supplied with too many pointers to correct solutions by their teachers and were prevented from performing series of activities in science lessons. This state of affairs resulted in the teacher trainees exhibiting poor problem - solving skills which in effect impeded the formation of basic scientific concepts. It stands to reason that for learners to be able to form concepts in science they must have appropriate problem solving skills, hence the poor problem solving skills exhibited by the teacher trainees was a factor that impeded the formation of science concepts.

(f) Insufficient use of media integration in science lessons

It has often been said that science is not really science unless it is accompanied by experimentation and laboratory work. This can lead to skill development since the learners learn by doing and are involved in activities that provide them with desired skills. Effectiveness of the laboratory experience is directly related to the amount of students' individual participation. When learners are given the opportunity to perform experiments, they experience the sense of joy and develop positive attitudes towards science learning. This enables the students to understand basic scientific concepts. On the contrary, most of the science teachers conducted their lessons by means of the lecture method. Other media were not used and the lesson phases did not take media integration into consideration. The teacher trainees were therefore copying notes most of the times during science lessons. The use of only lecture or verbal communication did not stimulate both hemispheres of the brain and also did not allow the teacher trainees to get a first hand experience with the learning materials. The teaching of science without adequate use of teaching and learning materials did not help the teacher trainees to understand the basic scientific concepts. Therefore the absence of laboratory work, experimentation and adequate use of teaching and learning materials during science lessons impacted negatively on the teacher trainees understanding of basic scientific concepts. Hence science lessons that were held frequently without laboratory experiments were one of the factors that impeded the formation of basic scientific concepts by the teacher trainees.

RECOMMENDATIONS

Strategies to be employed to find solutions that will help the teacher trainees to understand basic scientific concepts.

a. The science tutors in teacher training colleges in Ghana should teach the teacher trainees the way they should study science and guide them to prepare their own private study schedule. For example it is suggested that the science teachers should tell the teacher trainees what they need to do before they attend lessons. For instance, the teacher trainees should be encouraged to do all assignments before they attend lessons and bring into class all the materials they will need in their science lessons.

b. The science tutors at the teacher training colleges must endeavour to help the teacher trainees to undergo appropriate conceptual change and form basic scientific concepts by following the principles underlined below:

    i. The teacher trainees must be made to pay attention when a new idea or new concept is being presented and the new idea should be presented clearly in a language that the teacher trainees will understand.

    ii. The new ideas must be presented in a simplified fashion so that the teacher trainees can follow every part of the argument clearly.

    iii. The teacher trainees must be guided by the science tutors by providing them with plausible explanations of concepts and also providing evidence that will enable the teacher trainees to reject their prior misconceptions. This can be done by asking the teacher trainees to provide their views on concepts and challenging them to justify their explanations.

    iv. The teacher trainees must be guided to relate the new concepts to their real life situations. The science tutors in teacher training colleges must endeavour to help the teacher trainees to put into practice what they have learnt by providing the teacher trainees with meaningful examples and other problems that involve the newly acquired concept.

c. It is suggested that the science tutors at the Teacher Training College can help with the process of conceptual change by confronting the teacher trainees with the problems so that the teacher trainees become dissatisfied with their prior beliefs; prompting the teacher trainees not to only regurgitate new concepts in their own words; providing further examples of where to apply the new concepts and providing support to the teacher trainees. This can be done by the science tutors by adopting the strategy below;

   When new concepts are being introduced, the science tutors must observe what the teacher trainees notice, what the teacher trainees recall from memory; how the teacher trainees combine the new and old information and which strategies the teacher trainees employ to learn the new concepts.

d. The science tutors should employ different media in their lessons and ensure that the media used at each stage of the lessons should be commensurate with the desired objectives of the lesson. Also, integration of the media should coincide with planned learning activities. For example models, charts, drawings, specimens and real objects should be used at different stages during science lessons.

e. The teacher trainees should be given the opportunity to express their views on concepts so that the science tutors rectify any misconceptions by providing explanation. Also, the teacher trainees must be allowed to have personal involvement with the material s and make their own observations.

f. The teacher trainees should be given more reading assignments so that they improve upon their vocabulary and also develop effective problem solving skills.

g. Clear and concise explanation should be given to scientific vocabulary and the attention of the teacher trainees must be drawn to the correct spellings of science vocabulary.

h. Concepts must be clearly explained by science tutors and the teacher trainees should be allowed to perform experiments when new concepts are introduced. In view of this it is imperative that all science laboratories in the teacher training colleges must be well equipped to enable experimental work take place.

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Appendix I

Sample of Questionnaire

Applying Scientific Concepts

Rules Time 1hr.45mins

Some questions need calculation, show your calculations whenever you calculate.

1. Are there any unbalanced forces acting on an object?
    a. That falls a short distance?
    b. That falls a long distance? Explain.

2. A sprinter runs 200m dash in 21.45s,
    a. What was the sprinters speed in m/s?
    b. If the sprinter were able to maintain this pace, how much time (in hours) would be needed to run the 420km distance?

3 (a) Is it possible for a small car to have the same momentum as a larger truck? Explain.

(b) Is a constant force necessary for a constant acceleration? Explain.

(c) Is an unbalanced force necessary to maintain a constant speed? Explain.

(d) An unbalanced for of 18N is needed to give an object an acceleration

of $3m/s^2$. What force is needed to give this very same object an acceleration of $10m/s^2$

4. (a) How is work related to energy?

(b) Does a person standing motionless in the aisle of a moving bus have kinetic energy? Explain.

(c) A spring clamp exerts a force on a stack of papers it is holding together. Is the spring clamp doing work on the papers? Explain.

(d) A 2.0kg book is moved to a position 2.0m above the ground.

i. What is the potential energy of the book as a result?

ii. The book is now released. How much kinetic energy will the book have as it hits the ground?

(e) A rock on the ground is considered to have a zero potential energy. Is statement true or false? Explain.

5. (a) Explain why most materials become less dense as their temperature is increased.

(b) A true vacuum flask has a double-walled, silvered bottle with the air removed from the space between the walls. Describe how this design keeps food hot or cold by dealing with conduction, convection and radiation.

(c) Explain why a glass filled with a cold beverage seems to “sweat”. Would you expect more sweating inside a house during the cold or hot season? Explain.

6. (a) A current of 4A flows through a toaster connected to a 120V circuit. What is the resistance of the toaster?

(b) A light bulb with a resistance of 10n allows a 1.2A current to flow when connected to a battery.

i. What is the voltage of the battery?

ii. What is the power of the bulb?

(c) Explain why a balloon that has been rubbed stick to a wall for a while.

(d) Explain what is happening when you walk across a carpet and receive a shock when you touch a metal object.

(e) Explain why the electricity company increases voltage of electricity for a long distance transmission.

(f) How is an unmagnetized piece of iron different from the same piece of iron when it is magnetized?

(g) Why does the north pole of a magnet point to the geographic north pole of like poles repel?

7. (a) A permanent magnet has magnetic properties. Why?

(b) A current carrying wire has a magnetic field around it. True or False? Explain your answer.

(c) Explain why the sky appears blue when the sun is high in the sky?

(d) The object at the bottom of a clean pool of water appears to be shallower. Explain.

(e) Why does a highway sometimes appear wet on a hot summer day when it is not wet?

(f) Distinguish between luminous and non-luminous objects and give two examples of each.

APPENDIX II

QUESTIONNAIRE TO TEACHER TRAINEES TO FIND OUT THEIR VIEWS ON TEACHING STRATEGIES

Please tick or respond appropriately

Index number …………………

1.State your grade in Integrated Science in the Senior Secondary School Certificate Examinations.

A	B	C	D	E

2. All the Teacher Trainees should learn Integrated Science:-

☐ Disagree completely

☐ Agree partially

☐ Agree

☐ Agree completely

3. Can you state two ways by which Integrated Science can help you in your daily life?

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

4. .How is your interest in Integrated Science?

Very strong	Strong	Low	Very low

5. List about four topics that you think are relevant to your life?

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

6. How much time do you spend studying Integrated Science during your private study time during the week?

Less than 1 hour	Between 1 and 2	Between 2 and 3	More than 4 hours

	hours	hours	

7.If you were given the option will you avoid Integrated Science ?

Yes	No

8. Give reasons to your response in (7) above

…………………………………………………………………………………….

……………………………………………………………………………………..

9. Integrated Science as a subject requires the employment of study techniques?

☐ Disagree completely

☐ Agree completely

10. State any study techniques you used in studying Integrated Science.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

11.Is the number of Integrated Science tutors adequate for your college ?

Yes	No

12. How do you rate your Integrated Science teachers' performance in lessons in terms of the following?

a. Speaking ability

☐ V. Good

☐ Good

☐ Poor

☐ V. Poor

b. Ability to explain concepts

☐ V. Good

☐ Good

☐ Poor

☐ V. Poor

c. Organisation of lessons

☐ V. Good

☐ Good

☐ Poor

☐ V. Poor

d. Knowledge of subject matter

☐ V. Good

☐ Good

☐ Poor

☐ V. Poor

e. Attitude to subject

☐ V. Good

☐ Good

☐ Poor

☐ V. Poor

f. Attitude to students

☐ V. Good

☐ Good

☐ Poor

☐ V. Poor

13. What instructional style is used by science tutors

Lecture	Discussion	Activity	Combination of these

14. Do you like the style?

Yes	No

15. Give reasons to your answer in (14).

……………………………………………………………………………………………..

……………………………………………………………………………………………..

16.Do you have teaching and learning materials for Integrated Science in your college?

Yes	No

17. What quantity of teaching and learning materials is available in your college?

Very adequate	Adequate	Less adequate	Not available

18.Are there prescribed reference books for Integrated Science in your college?

Yes	No

19.If yes do you have enough copies available?

Yes	No

20.If no do you get appropriate Integrated Science text books to refer to?

………………………………………………………………………………………………..

21.How often are you given the following assessment in Integrated Science?

	Very often	Often	Sometimes	Never
Home work				
Class exercise				
quiz				

22. Can you suggest anyway by which the teaching and learning of Integrated Science can be improved in Colleges?

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

APPENDIX III

CLASS ROOM OBSERVATION SCHEDULE ON SCIENCE TEACHERS

	5	4	3	2	1	0	
1.Effective and relevant introduction linked with R.P.K. with teachers							
2.Sysmatic and sequential presentation adapted to the level of students							
3.Mastery of subject matter demonstrated through teaching							
4.Proper and effective use of language							
5.Use of varying feedback techniques							
6.Effective use of teaching/learning resources							
7.Clearly explained task settings							
8.Regular monitoring of individual/whole class performance							
9Adequate subject content coverage							
10.Active students participation and involvement							

KEY (5 excellent, 4 very good, 3 good, 2 fairly good, 1 poor, 0 absent)

OBSERVATION SCHEDULE ON STUDENTS DURING SCIENCE LESSONS

	5	4	3	2	1	0
1. Students participation in science lessons.						
2.Students problem solving skills						
3.Students listening skills						
4.Presentation of assignments for discussion and marking						
5.Student ability to ask relevant questions						
6. Students ability to provide correct explanation to questions in science lessons.						
7. Students level of concentration in science lessons.						
8. Opportunity available for students to use science equipments.						

Key (5 excellent, 4 very good, 3 good, 2 fairly good, 1 poor, 0 absent)

Appendix IV

Letters for Permission from the Heads of Science Departments

St. Louis Training College

P.O. Box 3041

Kumasi

18th November 2004

Head of Science Department

…………………………….

Dear Sir,

PERMISSION TO CONDUCT SURVEY WITH FIRST YEAR STUDENTS

I am currently a Graduate student in the Department of Educational Studies at the University of South Africa, and I am working with Dr. N. Nkopodi as my supervisor. The purpose of my study is to find out the factors that impede the formation of science concepts during teacher training in Ghana.

I am asking you to allow me to administer my questionnaires to your first year students and also humbly requesting the assistance of the Science Teachers in your Department.

I deeply appreciate your co-operation and support. Without you and the co-operation of the Science Teachers, I would not be able to conduct this research, which hopefully will shed light on the improvement of teaching and learning of science in teacher training colleges. When the research is completed, I will provide you with a description of the results.

Yours sincerely,

S.Sarfo

Appendix V

Samples of students' answers to the questions on applying scientific concepts

Candidate's number AMPONSAH ANTWI REBECA Page ....

Question No ..... INTEGRATED SCIENCE

Write on both sides of the paper

1. There are no unbalanced forces acting on an object that falls a short distance because there are no force of gravity acting on the object and it falls with a short range.

2. Speed = $\frac{\text{Displacement}}{\text{Time}}$

Displacement = 200

Time = 21.45s

$\therefore \frac{200}{21.45} = 9.32\,m/s$

b. If 200m = 9.32   1000m = 1km

$\therefore$ 420km = $\therefore$ 420 = $\frac{420 \times 1}{1000}$

$0.42 = \frac{0.42 \times 9.32}{200}$ = 0.42km

3. The momentum of a small car will not be the same as of the larger truck because the weight of the larger truck is higher than the small car.

4. A constant force is necessary for a constant acceleration because the rate of speed determines both force and acceleration.

Candidate's number .... Page ....

Question No ....

Write on both sides of the paper

7b) True because it can give you a shock.

7d) The object at the bottom of a clean pool of water appears shallower because objects on top of water appear shallower because of the thick-ness of water.

7e) Mirage

6e) To speed up the voltage, for free flow to the transformer

3b) Yes because small cars also have momentum.

3c) Yes because force is applied when work is done

Candidate's number .... Page ....

Question No ....

Write on both sides of the paper

3. An unbalanced force does not maintain a constant speed because the force acting being applied may not be of a stable state but may move within certain different rates which changes the speed.

d. Force = 18N

Acceleration = 3m/s²

∴ if 18N = 3m/s² $\frac{18N}{3m/s^2}$ = 6m/s²

? = 10m/s²

∴ $\frac{?N}{3m/s^2}$ × 10m/s² ->

3m/s² × 10m/s²   30m/s² × 10m/s²

× 10m/s²

= 60N

4a. Work is when a force of is moved in the direction of an object

Energy is the ability to do work.

∴ Work is the force needed to transfer a form of energy ~~from~~ to another.

b. A person standing ~~motionless~~ motionless in the aisle of a moving bus possess the energy in virtue of its motion.

c. Work is said to be done when a force is moved in the direction of an object, so the force exerted by

Candidate's number .... 3 .... Page ....

Question No ....

Write on both sides of the paper

k) Yes

A Small car will have the same momentum

as M

b) Yes

If the mass and velocity of the small car is equal to the mass and velocity of the larger truck.

Q) Unbalanced force = 18N

Acc = 3m/s²

force = ?

Acc. = 10m/s²

F = mass = 18 x 3 = 54 kg

Force = ~~mass x acceleration~~ acceleration

18 Force = 54 / 10

3

54

= 5.05N

≈ = 5N

a) Work is the energy possess by the body.

Work is equal to energy.

Work = energy

Candidate's number 4 Page

Question No

Write on both sides of the paper

(6) NO

~~Kinetic~~ Kinetic energy is the energy a body possess by ~~due~~ it position and motion.

(d) mass = 2.0kg
distance = 2.0m
Work = 2×2 = 4J

Potential energy = mgh
= 2×10×2
= 40J

Kinetic energy = ½mv²

5 Most materials become less dense as their temperature is increase because they have ~~less~~ small weight and ~~wet~~ small density.

(7f) Luminous objects are objects that can produce light by itself while non-luminous objects cannot produce light by itself.
Example of luminous objects are Sun, Star, Fireflies etc.

Candidate's number ______________________ Page ________

Question No. ______________________

Write on both sides of the paper

③ Force = mass × acceleration
= 10 × 18
= 180N

④ True, because an object possess potential energy when it is at work, but the rock is at rest which means there is no work done

⑤ Because when the temperature of most materials increases, they exert heat which makes the material more dense

⑥ Since silver is a metal, and metals ~~conduct heats~~ are good conductors of heat and the silver is double walled which allows the molecules to move ~~rath~~ causing collision that generates heat and therefore keeps the food's temperature at the ~~rate~~ stable rate

⑧ When glass comes into contact with the cold water, because it cools down in the glass and during that process it evaporates making the glass event.

Candidate's number .... Page ....

Question No ....

Write on both sides of the paper

9 (b) True

(c) Because of surface tension.

(f)

(i) Because of electric metals are good conductors of heat and also when metals get into contact with electric, ~~it transper~~ the electric transpore some of it's power to the metal, giving it a shock when it is touched.

(ii) Because when electricity travels a long distance the voltage reduces, so if more voltage is added before it will reach the ~~to~~ distance the electricity is been sent to, the voltage will reduce to normal, since during the long distance transmission, some power were been lost in the voltage

(iii) Because unlike poles attract whiles like poles repel.

(j)

1st

Candidate's number: Omone Roky Grace   Page:

Question No:

Write on both sides of the paper

5. a) When most materials becomes less dense as their temperature increase because when the material ~~get~~ there is change in temperature the material will expand ~~that~~ is, increase in size makes the material becomes lighter in weight eg is a dough ~~wheat~~ of bread when you put it in a ~~n~~ hot oven it will increase in size and will become a little bit to lighter.

7. c) Luminous objects are object which allows light to pass through whiles non-luminous objects are object which does not allow light to pass through.
Luminous eg is plane mirror and a pin whole

b) It is because the highway becomes heated it the heat will evaporate into the atmosphere in the form of mirage.

7d) The object at the bottom of a clean pool of water appears to be shallow

6 e) Because for electricity to travel for long distance, it requires high amount of energy to travel through a long distance before it rea-

Candidate's number .... Page ....

Question No ....

Write on both sides of the paper

Over the place.

4 b) No because kinetic energy is involve with a velocity ~~by~~ of the person but here being standing does not involve with velocity.

~~(c)~~. Yes because the height of the rock may be zero which when multiply with the mass and the gravity will give you zero

6a) $I = R \times V$

$R = \frac{V}{I} = \frac{\cancel{120}}{\cancel{4}}$ $\therefore R = 30\Omega$

2) Speed $= \frac{200}{21.45}$

3d) $F = 18N$

$\Rightarrow a = m \times$

4d) $W = m \times d$

$W = 2.0kg \times 2.0m = 4 kg/m$

$P.E = mv^2$

$= 2.0kg \times 2.0^2$

$= 8$

Candidate's number: Adu Benson Prince Page: 16

Question No. ....

Write on both sides of the paper

4a) Energy Possed by an object is equal to the work done by the Object. Because energy is the ability to do work and work is said to be done force is applied on an Object that moves in a distance.

7A) Luminous Objects produce light on their own
eg: Star and Sun

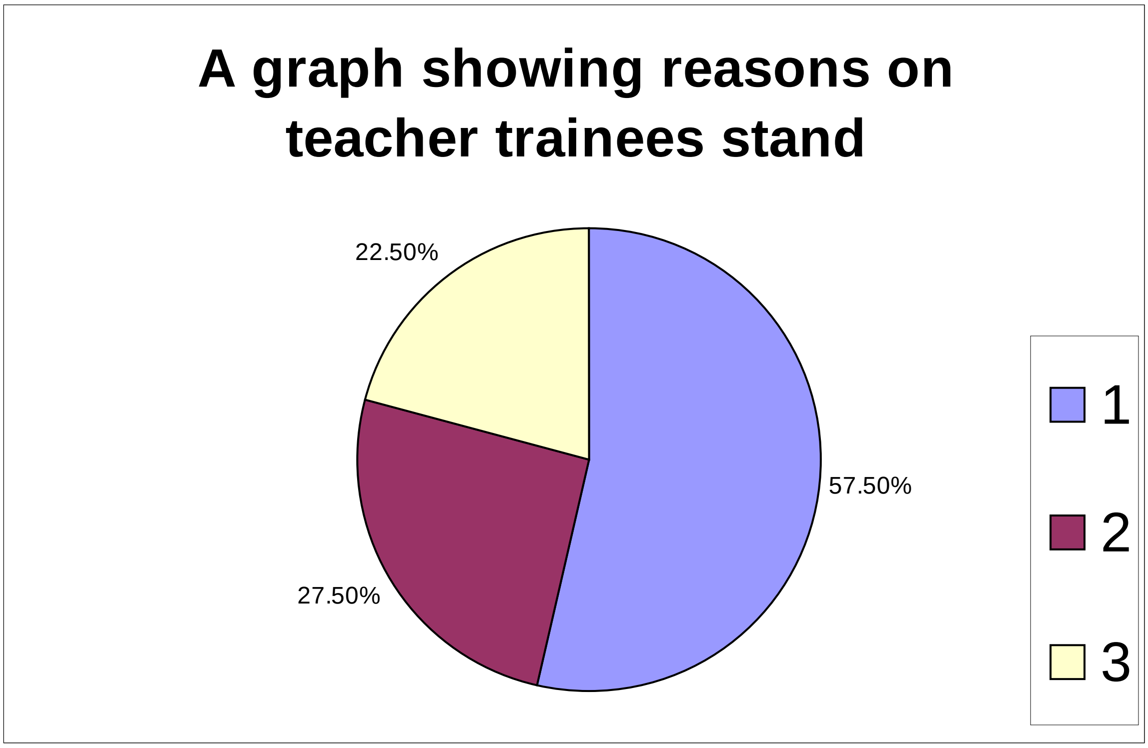
Non-luminous Objects cannot produce light on their own.
eg: Wood and Stones.

4c) No because the force is applied on the stuck papers.

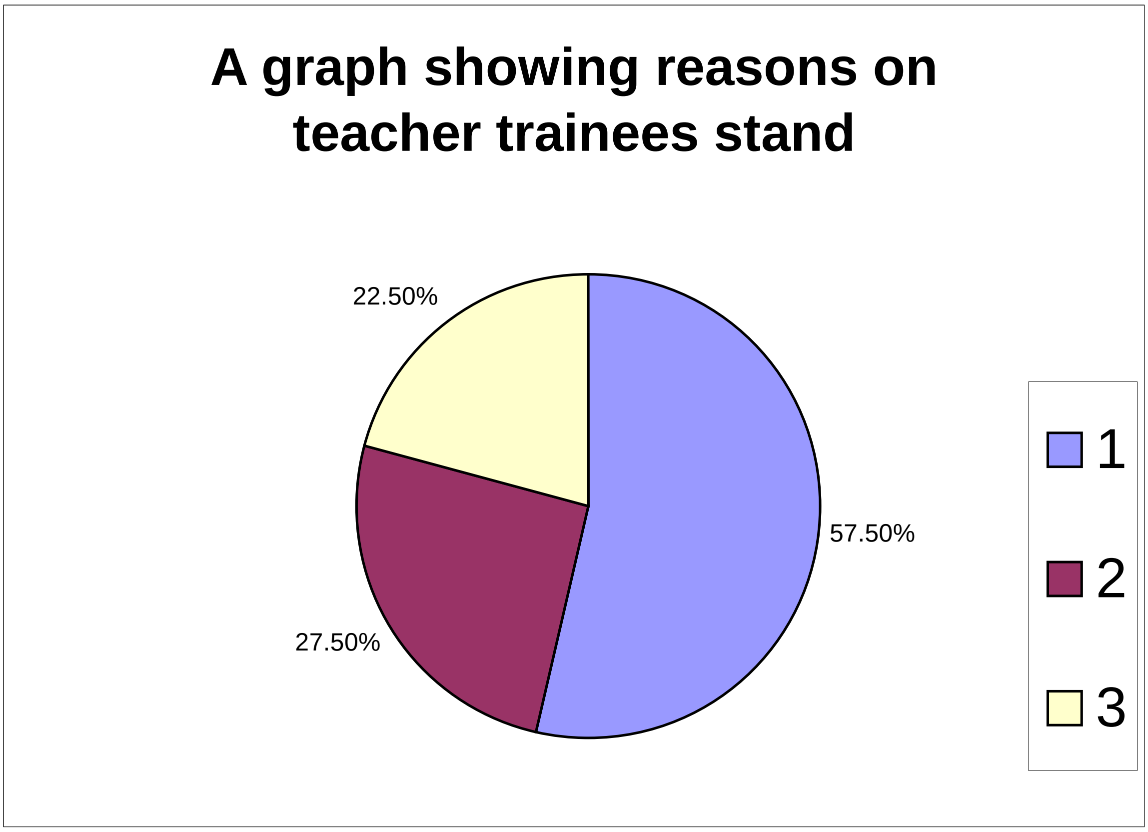
4d) Workdone = Force x Distance
Force = mass x acceleration due to gravity
Force = mass (2.0kg) x acceleration $10 ms^{-2}$
Force = 20 Newtons
∴ Work done = 20 x 2
= 40 Joules

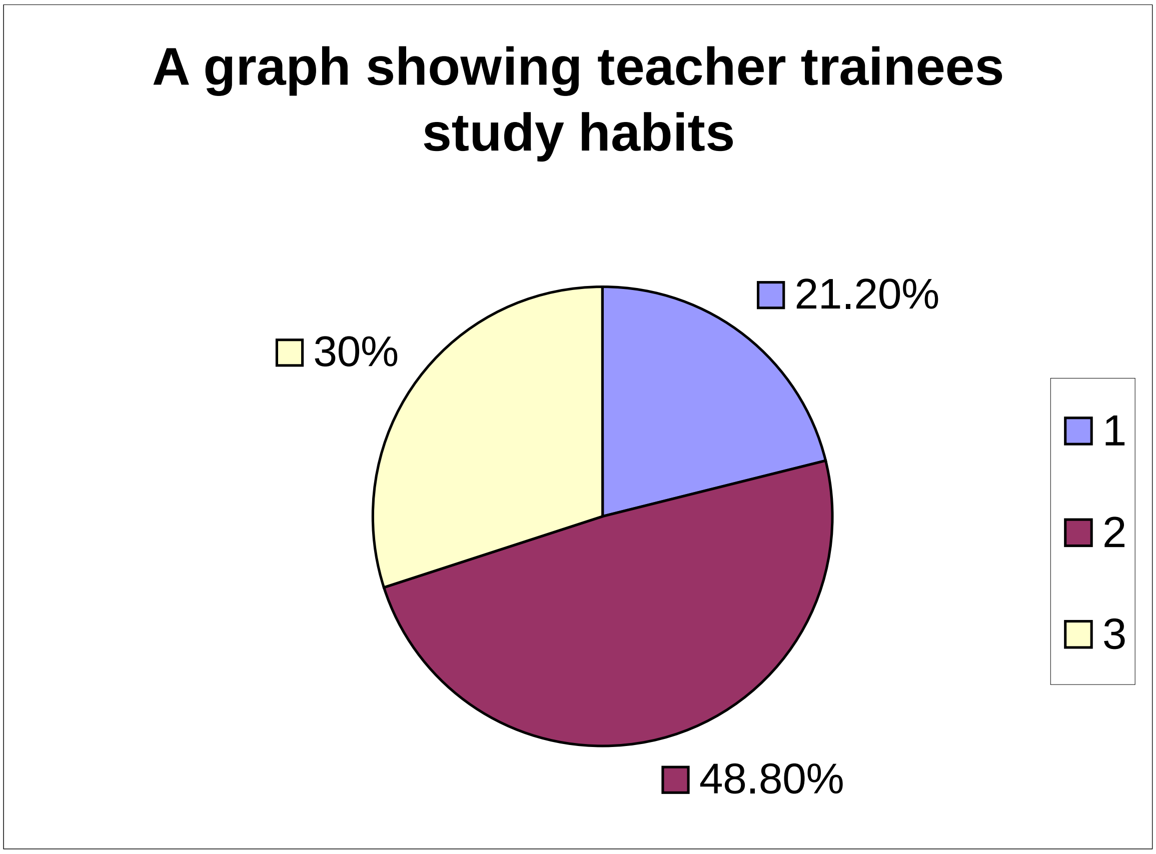
6i) They repel because they are like poles that is the law of magnetism states that like poles repels and unlike poles attract.

APPENDIX VI



A graph showing reasons on teacher trainees stand
22.50%
57.50%
27.50%
1
2
3


A graph showing reasons on teacher trainees stand
22.50%
57.50%
27.50%
1
2
3


A graph showing teacher trainees study habits
21.20%
30%
48.80%
1
2
3

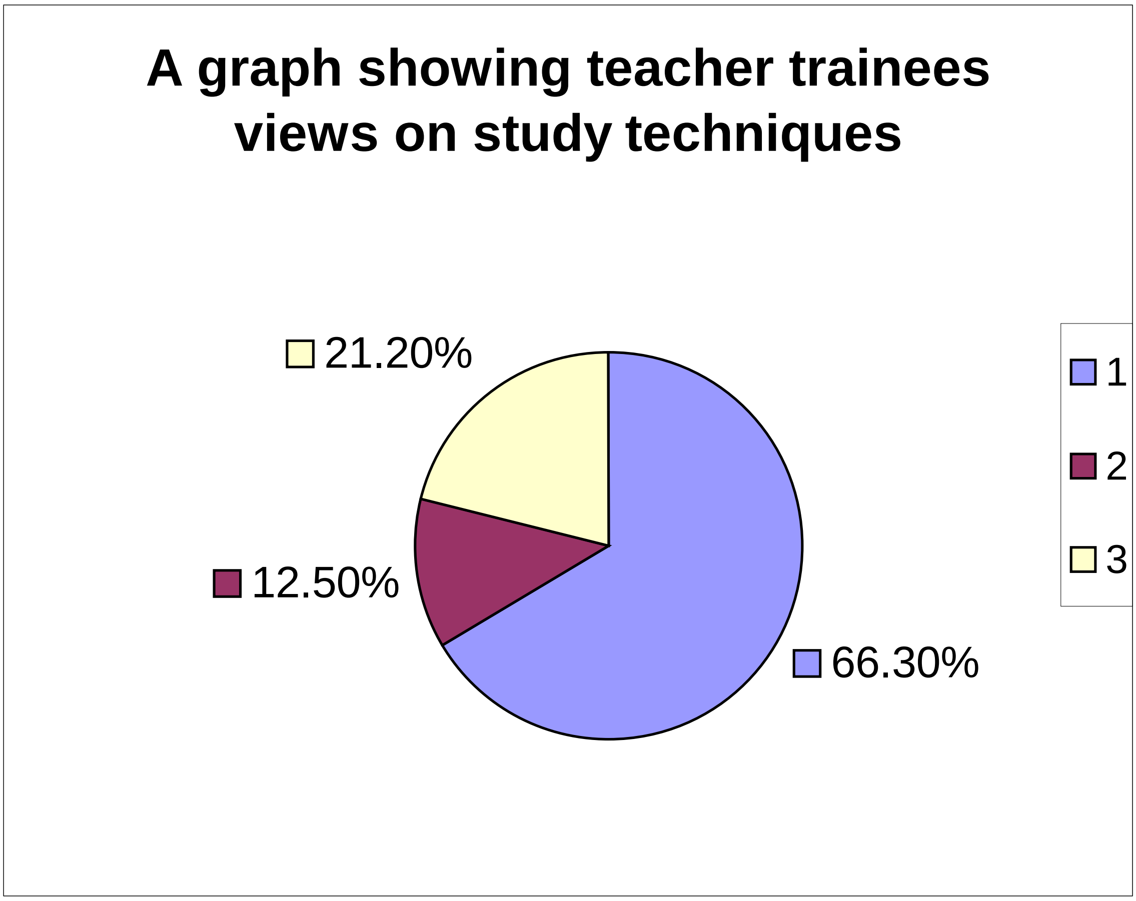
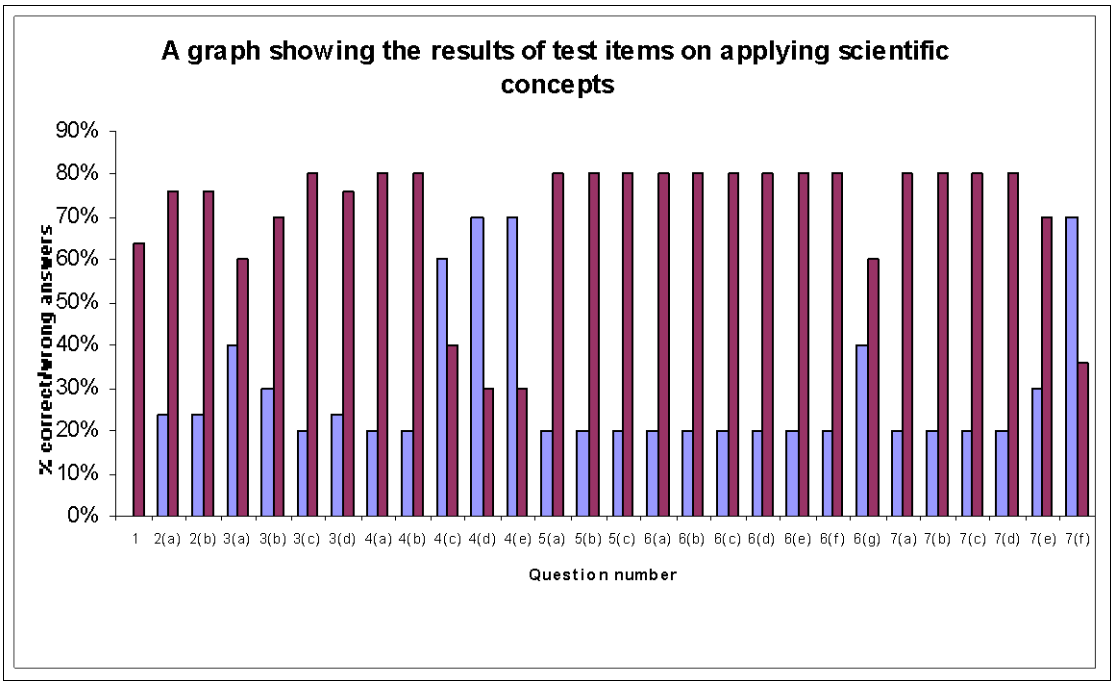
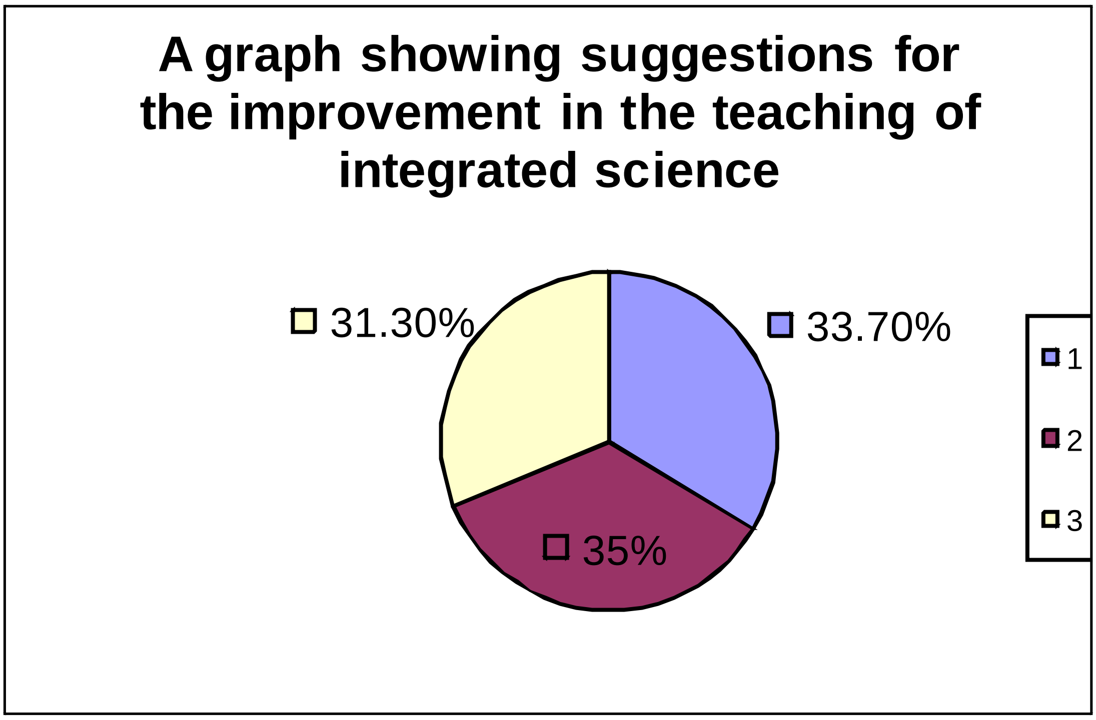

A graph showing teacher trainees views on study techniques
21.20%
12.50%
66.30%
1
2
3

Figure 6


A graph showing the results of test items on applying scientific concepts
% correct/wrong answers
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2(a) 2(b) 3(a) 3(b) 3(c) 3(d) 4(a) 4(b) 4(c) 4(d) 4(e) 5(a) 5(b) 5(c) 6(a) 6(b) 6(c) 6(d) 6(e) 6(f) 6(g) 7(a) 7(b) 7(c) 7(d) 7(e) 7(f)
Question number



Key

Blue colour - % correct answers

Brown colour - % wrong answers