UNIVERSITY OF EDUCATION, WINNEBA

THE EFFECTS OF STUDENT-CENTRED APPROACH ON BASIC PRACTICAL SKILLS OF PRE-SERVICE TEACHERS AT OLA COLLEGE OF EDUCATION, CAPE COAST

LAUD TEYE NARTEY

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LAUD TEYE NARTEY

A dissertation in the Department of Science Education, Faculty of Science Education submitted to the School of Graduates Studies, University of Education, Winneba, in partial fulfilment of the requirements for award of Master of Education (Science Education) degree.

APRIL, 2014

DECLARATION

CANDIDATE'S DECLARATION

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

SIGNATURE:……………………………………………..

DATE:……………………………………………………

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this research work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: Professor Mawuadem Koku Amedeker

SIGNATURE:……………………………………………..

DATE:……………………………………………………

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DEDICATION

I dedicate this study to my wife Priscilla and my children Laudlyn, Lamech and Larice. I also dedicate my work to my supervisor Professor M. K. Amedeker and my friend Humphrey Assem.

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CHAPTER FIVE: SUMMARY, CONCLUSIONS AND ECOMMENDATIONS

ABSTRACT

The study is an action research aimed at assessing the effects of student-centred approach on basic practical skills of pre-service teachers at OLA College of Education – Cape Coast in the Central Region of Ghana. A class of forty female pre-service teachers were used for the study. The main purpose of the study was to adopt the student-centred approach which is a teaching strategy that attempts to assist students to discover their own knowledge through an activity to acquire basic practical skills for teaching at the basic school level. Practical lessons and teacher-made test were the instruments used to assess the impact of the student-centred approach on the pre-service teachers after they had gone through five main lessons on basic practical skills in science. Data collected from the study was analysed qualitatively and conclusions were drawn. Notable among the findings of the study was that, the student centred approach allowed students to have equal opportunity to interact and manipulate teaching and learning materials. The students were able to cut, mount, draw and label given specimen among other practical skills. In view of the findings, it was concluded that it is possible to improve students' basic practical skills through the use of student-centred approach since it strengthens students' motivation. The recommendation made was that all pre-service science-teachers in all colleges of education be given a one semester course training on basic practical skills in science in order to equip them for the teaching of science.

CHAPTER ONE

INTRODUCTION

Overview

The quality of an educational system depends largely on the effectiveness of pre-service teacher education. In order to meet the needs of a growing student population in recent times, it is necessary to emphasize the importance of teacher education, as student teachers will eventually take responsibility for educating the country's students. There is a consensus that the main deficiency in teaching is the result of teachers' inability to adequately implement the teaching skills they have been taught, relying primarily on traditional teacher-centred instruction rather than utilizing the more effective model of student-centred learning (Bencze & Hodson, 1999). If teachers take will take the centre stage of learning in our classrooms, then the core business of the constructivism will be defeated.

Background to the Study

As technology continues to influence many aspects of our social and work lives, it is important that school experiences equip students with the skills and knowledge that will enable them to develop into effective independent, creative, and lifelong learners to cope with the influx of changes. Science student teachers in OLA College of Education have reported that, during the course of their practical field work, their mentors do not apply the techniques and professional skills they have learned during their coursework. This situation limits the ability of pre-service teachers to observe the practical application of professional skills that they have learnt in vocational education and training lessons, resulting in feelings of inadequacy, shyness and skepticism when they, in turn, are given the responsibility of leading a classroom (Blumberg, 2008). In order to ensure that OLA student teachers have the opportunity to apply newly-learned teaching strategies, methods and theories during their field experiences, the researcher decided to delve into this study in order to identify the key factors that bring about this problem and how they could be curbed. I believe that there is a need to adopt a student-centred learning framework to design science curriculum for all pre-service teachers. In this paper, the researcher presents a number of the findings of the effects of student-centred approach on basic practical skills of pre-service teachers at OLA College of Education – Cape Coast. The study is also aimed at providing some recommendations to the College and to a large extent other colleges of education that may be affected by the problem based on the results found.

Statement of the Problem

In the wake of the call for technological advancement to the approach of teaching science whereby teachers must teach science as a process and not a product, pre-service teachers of OLA College of Education are saddled with the problem of inability to use basic practical skills to handle science topics during their pre-service training. As a result of the above the teacher-trainees lack the requisite basic practical skills such as identification, manipulation of a simple apparatus, planning and performing of simple practical activities in science, a requirement necessary for the teaching and learning of Integrated

Science at the basic schools as implied in a paper delivered by Anamuah-Mensah, (1999) at the National education Forum on the theme: Towards Sustaining an Effective National Education System, held at the Accra International Conference Centre, Accra, 17-19th November.

The problem under investigation is that pre-service teachers cannot apply basic practical skills in their teaching and learning and hence, this affects their ability to teach integrated science in basic schools.

Purpose of the Study

The main purpose of the study was to adopt the student-centred approach as an intervention to help pre-service teachers in OLA College of Education to acquire basic practical skills for teaching at the basic school level. The study exposed trainees to the use of basic laboratory equipment so as to enable them acquire basic skills such as identification, manipulation of simple apparatus, planning and performing simple experiments.

Research Questions

The study was guided by the following research questions:

1. How will the student-centred approach affect the teacher-trainees' skills in planning laboratory practical skills?
2. How will the student-centred approach affect the teacher-trainees' skills of performing laboratory practical activities in science?
3. What effect will the student-centred approach have on the teacher-trainees' attitude towards laboratory work in science?

Significance of the Study

Science education at teacher training level in Ghana is to lay foundation for the future work in science and science-related field by equipping the student-teachers with scientific knowledge, basic/concepts and skills of manipulating and reasoning. The significance of this study to a large extent will among other things:

Help the teacher trainees to be equipped with the prerequisite teaching skills so that they will be functional in the science classroom in the area of basic skills in the teaching and learning of science. It will help policy makers and as well as the CRDD to formulate and design science curriculum which hinge around acquisition of scientific skills to enable basic school learners unearth their generic skills during integrated science lessons. It will also unearth the generic skills in pupils or students who would otherwise benefit from the instructions of the pre-service teachers. It will also serve as a measure for curriculum designers and the Institute of Education, Faculty of Education–University of Cape Coast to plan the course outline for Science such that, practical lessons will dominate all spheres of the science concepts that pre-service teachers will go through in the colleges of education. This will enhance the practical skills of pre-service teachers.

Delimitation of the Study

The study was restricted to OLA College of Education, a female College in the Central Region of Ghana. This was due to its proximity to the researcher and owing to available logistics. The study also covered only basic practical skills for pre-service teachers and hence findings could not be generalised to cover other areas such as integrated skills of students. Also the findings of this study span only the scope of OLA College of Education and as such could not be used as the case in other colleges.

Limitation of the Study

A study of this nature is likely to be bedevilled with many external factors. Notably amongst these was the accessibility of respondents. Respondents would be on the college internship program and thus, away from various college gatherings. Hitherto, the pre-service teachers run different academic calendar. The researcher intends to access the pre-service teachers by arranging with various headmasters to alert the researcher when basic school programs are in full section. This was well coordinated and hence guaranteed the accessibility a larger population of the pre-service teachers for the collection of data. It is also the intention of the researcher to reward a token some of money to respondents in order to aid their accessibility and willingness to provide the needed information. This was to address the reliability of data collected. It also foreseen that financial constraints may be a hindrance to the success of the study in the area of transportation and logistics. The researcher intends to limit the sample size for the study to proximity in order to cut down on the expenditure in terms of transportation.

Organisation of the Study

This dissertation is organised in five chapters. Chapter One deals with introduction of the study. It includes the background, statement of the problem, purpose of the study, research questions and significance of the study. It again covers delimitations, limitations and organisation of the study.

Chapter Two deals with the literature review. Chapter Three discusses the methodology. Chapter Four focuses on the analysis of the data with their findings discussed. Chapter Five covers the summary of findings, conclusion drawn from the findings, recommendations made and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

Overview

This chapter covers the review of related literature and other research works. It spans the concept of practical work in science, hands on activities and laboratory skills. The concept of science process skills have also been distinguished as well as theoretical base for teaching strategies and approaches. The literature also focuses on types of research designs and then supports the bid for the choice of action research while looking at types of population and sampling technique and dwelling on why choice of a particular sampling technique. The instrument for the study is also covered while juxtaposing it with other instruments used in other research jurisdictions.

The concept of practical skills

The concept of science practical skills as explained by SCORE (Science Community Representing Education, 2009) is a 'hands-on' experience which prompts thinking about the world in which we live. It is made up of a core of two activity types: Scientific techniques and procedures, both in the laboratory or the field, and; Scientific enquiries and investigations.

It was further explained that each of these core activities not only supports the physical development of skills but also helps to shape the understanding of scientific concepts and phenomena. The hands-on approach offered by practical work often challenges students' preconceived ideas and as a result deepens their scientific understanding.

Science practicals in the classroom should be activities that link students' theoretical learning in school with the practical application of science to the world at large and later at the workplace (SCORE, 2009).

Millar (2004) in its article added that, practical work in science education should build on the natural curiosity of children, enabling them to experience and explore the material and natural worlds. This process will continue in secondary schools, and later advanced by the development of discipline-specific skills and the use of specialist equipment enabling students to use a more abstract and measured approach. For brevity the article referred to these as 'laboratory skills'.

In addition to the above, many authors have also added their voice to the explanation of practical skills. Osman (1997) and Tobin (1984) indicated that the purpose of the laboratory is to afford experiences and challenges for students to solve problems, construct relevant science knowledge, undertake scientific investigations, promote inquiry and to verify known scientific concepts and laws. Thus, the main goal of the laboratory is to provide students with the opportunity to investigate by doing. The reason being that, science from the very beginning is an active process. It is not a fact or a product, but the process of problem identification, experimentation, data interpretation, hypothesizing and testing.

Ogunniyi (1983) asserted that there is a general consensus among science educators that laboratory skills occupy a central role in science instruction. It provides students with unique opportunities to study abstract concepts and generalizations through the medium of real materials. As students interact with the learning materials, and with their teachers and classmates, they gradually reinforce their knowledge and develop the basic manipulative skills and attitudes needed for future work in science. Since science emphasises on the learning of processes of science rather than the mere acquisition of knowledge, one should expect that the substantial part of the laboratory period would be devoted to investigate activities. The new approach towards science teaching and learning – activities approach – involves the reduction of teacher-student behaviour into interpretable categories. It is an attempt to obtain objective, detailed qualitative and quantitative description of interactions that occur during the teaching-learning process of science.

The Concept of Process Skills

According to Padilla, Okey and Dillashaw (1983) one of the most important and pervasive goals of schooling is to teach students to think. All school subjects should share in accomplishing this overall goal. Science contributes its unique skills, with its emphasis on hypothesizing, manipulating the physical world and reasoning from data.

The scientific method, scientific thinking and critical thinking have been terms used at various times to describe these science skills. Today the term "science process skills" is commonly used. Popularized by the curriculum project, Science – A Process Approach (SAPA), these skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists. SAPA grouped process skills into two types: basic and integrated. The basic which is the simpler process skills provide a foundation for learning the integrated (more complex) skills.

Thiel and George (1976) added that, Science process occurs naturally, spontaneously in our minds. By logically breaking down the steps in our thinking, we can use science process to find out how to answer our questions about how the world works. Science process is not just useful in science, but in any situation that requires critical thinking. Science process skills include observing qualities, measuring quantities, sorting/classifying, inferring, predicting, experimenting, and communicating.

The above definitions are in consonance with what Wideen (1975) propounded, that, the science process skills form the foundation for scientific methods. These basic skills according to Rezba and Payne (1995) are integrated together when scientists design and carry out experiments in everyday life and that all the basic skills are important individually as well as when they are integrated together.

Donnelly and Jenkins (1999) distinguished themselves from the others by ascertaining that science process skills are a means for learning and are essential to the conduct of science. They argued that the best way to teach process skills is to let students carry out scientific investigations and then to point out the process skills they used in the course of the investigations.

Padilla, Caronin and Twiest (1985) described the science process skills as; observing, communicating, measuring, comparing, contrasting, organizing, classifying, analyzing, inferring, hypothesizing, predicting,

Doran and Parkin (1993) also used a model of science laboratory activities which has three categories of planning, performing and reasoning. Hunt (1998) cited the case whereby the United Kingdom has been experimenting with science for all young people. The approach to practical and investigative science through performance has been marvelous and leads to high achievements by young people in international comparative studies. The general approach is to help students to discover and establish knowledge about the world and phenomena and then subsequently and systematically motivate them through performance to acquire skills and then (crucially) encourage them to apply these creatively to real problems.

Mehrens and Lehmann (1991) reiterated that there are many times we want to evaluate not only what a person knows but what a person can or will do. Performance is of interest because, so often, what a person knows is not a good prediction of what a person can do or will do. And measuring what a person can do or will do requires both an instrument that is performance and a procedure.

Meyer and Carlisle (1996) said that in science education, the nature and value of science laboratory activities are the subject of critical debate. They stated that in science teaching, laboratory work represents a diverse range of purposes and expectations. While some science educators emphasize students' development of technical skills in laboratory activities, others envision the laboratory as an environment where students acquire scientific knowledge of certain phenomena. They say other designated roles are students' development of processes of scientific inquiry and insights into students' understanding are also provided while purposefully engaged with materials. Gardner and Gauld (1990) also said, for students, laboratory work presents varied experiences with structured activities, school science equipment and science topics. Laboratory work also provides enhancement of scientific attitudes and the enjoyment of science.

The Concept of Practical Work

Millar (2004) defined practical work as any teaching and learning activity which involves at some point the students in observing or manipulating real objects and materials. Practical work enables the students to act in a scientific manner. According to Tamir and Lunetta (1981), laboratory work helps in inducing scientific attitude in students, develops problem-solving skills and improves conceptual understanding. Besides, developing critical thinking skills, it creates motivation and interest for learning.

However, where practical work is widely used, many educators express concern that it is not effective in promoting learning. Frequently practical work is carried out very rapidly, or with unreliable equipment, or with little time to practice the use of the equipment before making measurements – and these is often taken with insufficient attention to care and precision. As a result, students may fail even to produce the phenomenon they are supposed to observe, let alone be helped to appreciate patterns, trends or explanations. Even when they do make the measurements or observations the teacher intended conclusions which seem 'obvious' to the teacher can appear less so to the student. In view of this people often considered practical work to be humdrum and routine, rather than engaging or inspiring.

In a strong critique of current practices, Hodson (2001) writes:

> As practised in many schools, [practical work] is ill-conceived, confused and unproductive. For many children, what goes on in the laboratory contributes little to their learning of science or to their learning about science and its methods. Nor does it engage them in doing science in any meaningful sense. At the root of the problem is the unthinking use of laboratory work. (p. 176).

Some of the pre-service science teachers who are aware of these debates and discussions ask: is practical work effective? Is it a good way to teach science? In my view, practical work is an essential – indeed inevitable – aspect of teaching science – because of the subject matter of science. The aim of science is to gain an understanding of the material world – to be able to explain events and phenomena, and perhaps become able to control some of them in some ways. Indeed, we value science because it has been successful in this. The aim of science education is to pass on to young people some elements of this knowledge and understanding that we (as a society) feel are of value to them because science education is about trying to pass on knowledge and understanding about the physical world, it is natural that this will involve acts of 'showing' as well as 'telling'.

To conclude this section, there is one point that I think is very important to make about practical work that is intended to support the teaching and learning of scientific on a global perspective, science educators continue to convey the need for reforms in science education in an effort to promote a more critical scientific literacy (Bybee, 1997; Hodson, 1998). Such critical scientific literacy has been described as multidimensional and considered in terms of three major elements: learning science, learning about science and doing science.

On the other hand, Lawson (1995) stated that the major objectives of effective science teaching are to help students: develop creative and critical thinking skills, construct understanding of the major conceptual thought and develop the self-confidence to pose questions and problems to seek answers and solutions.

In an earlier study (Pedro, 1997), it was revealed that 74% - 100% of beginning and prospective teachers perceived lectures, exercises, discussion, problem solving, projects and homework as the most effective teaching methods in pre-service mathematics and science courses. Pedro also found that the 6-12 weeks period for the practicum was perceived as inadequate to improve the practicumer's teaching competencies. In student practicum, student teachers often adopt the classroom management style and attitudes of their cooperating teachers (Mellado, 1998). It was not surprising that Pedro (1997) likewise reported that beginning and prospective teachers claimed that they teach the way their college instructors taught them. It was noted however, that none of the strategies used indicated the emerging transformative role of teachers as learning facilitators or navigators rather than transmitters of knowledge (Shulman & Tamir 1973). Indeed it is a challenge for the college faculty, cooperating teachers and the practicumers to utilize the appropriate teaching and learning processes in order to produce quality educational outputs

Perceptions on Practical and Laboratory Work

From the foregoing discussion, there are evidences that the teaching processes and strategies employed by the faculty and cooperating teachers influence the learning processes and strategies of practicumers. This is manifested by their demonstrated teaching skills and values. Mellado (1998) investigated the relation between teaching and learning of science concepts and practice when teaching science. In his findings he deduced a general correspondence between the two. He explained the reason of the situations as the fact that the academic knowledge (static knowledge) they receive during teacher training process is not sufficient to know how to teach science. According to his findings, it is necessary to equipped trainees with the professional component (personal teaching experience and reflection, self-knowledge) named as dynamic knowledge. Self-efficacy in teaching science is considered as an important quality that pre-service teacher need to have and many problems in teaching science can be solved by investigating the relationship between self efficacy and science teaching behaviours.

Cantrell, Young and Moore (2003) examined the factors effecting the efficacy of the pre-service teacher in teaching science and stated that the efficacy would increase if teacher training classes are focused on Bandura's (1977) four strategy (providing opportunities for mastery experiences, physiological and emotional arousal, vicarious experiences and social persuasion).

The quality of the science methodology classes also has an important part in teaching better science. Brown, Okey and Brown (1982), concluded that methodology classes positively affect the self efficacy of the pre-service teacher and stated that this result is quite encouraging due to the fact that classroom experience is considered as more important compared to previous studies and that methodology classes do not bring an additional value.

Doyle (1997) investigated the effects of the beliefs of pre-service teacher about the teaching program and found out that the act of learning and teaching had turned from a passive form in which teacher transmitted the knowledge into an active process in which teacher is the guide and that this result is related with the pre-service teacher' gaining experience in teaching situations. According to Skamp (1997), pre-service teacher need to focus on a good primary school science teacher concept that develops during teacher training process. In fact, as they are the teachers of the future, knowing what they think about learning and teaching situations might be an important factor in the development of teacher training programs (Aguirre & Heggerty, 1995). According to Hodson (2001), investigating the knowledge of the pre-service teacher about teaching provides assistance for effective learning in teacher training programs. According to Plourde (2002), finding answer to the question ‘why the teachers cannot teach effective science’ will solve the problems related with this issue; because this is one of the major problems in science education.

In the last 20 years, the educators and programmers draw attention to the fact that how the pre-service teacher learn teaching and the conditions of better teaching (Minor et al., 2002). Educators need to know how teachers learn, what kind of knowledge they need to have in order to become effective teachers and the level of this information and they agree that knowledge and thoughts of the teacher are a critical factor in understanding how the teacher learns teaching and learning (Lowery, 2002).

However, according to Tosun (2000) the beliefs of the pre-service teacher about the education systems are related with the teacher education programs as well as their attitudes.

A fundamental shift towards student-centred/constructivist teaching and learning in classrooms is needed in order to fulfill the responsibility of producing members of society who will have the skills required to be effective citizens of the 21st century (Plourde & Alawiye, 2003).

Science process skills and their importance are considered in detail. Practicing scientific processes skills must be presented to the pre-service teachers. Because if educators do not change the way they come at the educational process, they will indeed maintain and support the status quo (Plourde &, Alawiye, 2003). Thus, pre-service teachers are provided with effective science teaching practice skills and knowledge. Effective science teaching gives the learners the opportunity to learn and considers how they learn.

In Doyle's (1997) study, four themes about learning and teaching are determined. Many pre-service teachers described the act of learning as receiving information whereas some of them described it as exploring, discovering and under-standing. Again, many pre-service teachers described the act of teaching as transmitting knowledge to the other party whereas some of them described it as making learning easier with the guidance of the teacher. The latter descriptions for both the act of learning and the act of teaching are in accordance with the findings of the present study. Lowery (2002) asked pre-service teachers about the most important aspects that the teacher should know while teaching science and received responses such as teachers should work with students using hands-on and real world situation, make lessons relevant and challenging, realize that abstracts concepts are hard and solve ample amount of problems. The responses are in accordance with the findings of the present study.

According to Vermunt (1998) pre-service teacher have positive thought about constructivism and think that they should develop their teaching activities based on this approach. In Edelson (2001) study, students prefer learner-centred approaches more than knowledge transfer. One of the results of Bybee (2000) study is that pre-service teacher prefer inquiry teaching method when teaching science for all. it is therefore evident that pre-service teacher prefer this certain method because many teachers avoid using inquiry teaching method due to the reasons such as it's being time-consuming, not being able to change learning habits easily, not being able to find suitable laboratory equipment, students' being immature, not being able to control the class properly Lawson (1995) and Damnjanovic (1999) compared the attitudes of pre-service teacher and in-service teachers towards inquiry based teaching and as a result indicated that teacher trainees do not make discrimination between contemporary and traditional methods; however, in-service teachers look more positive to using contemporary methods in science teaching.

Plourde & Alawiye (2003) investigated the relation between the beliefs of pre-service teacher on constructivist approach and what they do in practice and found out that there is a strong positive relation between the two. This result is another indicator of how important the quality and adequacy of the knowledge received during teacher training education on this issue are. One of the methods projected in the study is learning cycles. Learning cycles are consisted of constructivist, inquiry and cooperative methods. Doyle (1997) found out that pre-service teacher considered teaching as a passive act and that they would feel more successful when they employed active teaching techniques.

Mellado (1998) mentioned the presence of some studies which indicate that pre-service teacher bring the opinions, concepts and attitudes regarding learning and teaching with them when they start their university education and that these opinions, concepts and attitudes are strictly reserved and therefore would not change throughout their university education. Thus, based on this, as pre-service teacher come with such thoughts, the first thing that needs to be done regarding learning and teaching of science during their university education is to encourage them to find the best and the most suitable according to themselves. In fact, this seems to be the best solution. Because the education system in Turkey was teacher-centred until recently; the pre-service teachers in the present study were educated in such an education model. However, opposite of what is mentioned above, they are rejecting teacher-centred methods and support more effective and contemporary models.

According to Fraser & Walberg (1995), experiments play a key role in teaching and learning science in traditional and constructivist settings and research conducted by Bennett and Kennedy (2001) has attested to that.

Science Teaching Strategies and Approaches

According to Biggs (1991), the combination of a student's motive and approach to teaching applied to a specific educational experience is referred to as teaching strategy. Entwistle and Ramsden (1983) describe an approach to teaching and learning as being a student's response to an educational situation as opposed to a characteristic of the student.

Considerable research has been conducted on the teaching strategies and approaches that individual students use during learning experiences and various researchers have developed their own terminology describing similar concepts. Jarvis, Holford, and Griffin (2005), discuss the fact that people do not always learn from experience, but when they do they are largely categorized as either non-reflective learners or reflective learners. Non-reflective learners might be involved in developing specific skills or learning things by rote. Reflective learning is described as a more intellectual approach to learning involving contemplation and the development of hypotheses based on learning experiences. Biggs (1987) uses the terms deep and surface, where deep learners are those who focus on what is meant whilst surface learners concentrate on what is said. He also indicates that learning approaches are something that are relatively stable within individuals, but he argues that learners may modify their learning approach to best suit the assessment regime and subject area. The concept of students changing their approach to best suit the educational situation is also discussed by Gibbs (1992) who agrees that course design, teaching method and assessment determine whether students adopt surface or deep approaches to learning.

Another approach to teaching science is by constructivism. Constructivism has its roots in the psychology-based traditions going back to Dewey (1966), Bruner (1962; 1966) and Vygotsky (1978). However, more recently this is supported by biological science-based theory in neuroscience. There is a good discussion of this convergence of support for constructivism in the report by the Committee on Developments in the Science of Learning (2000). According to the book, ''what we now know result in in-depth learning. This new knowledge calls into question concepts and practices firmly entrenched in our current education system''.

There is no single definition of constructivism (Perkins, 1992; von Glasersfeld, 1992), According to him ‘Constructivism is an epistemological belief about what "knowing" is and how one "come to know." Constructivists believe in individual interpretations of the reality, i.e. the knower and the known are interactive and inseparable.

Constructivism rejects the notions that

1. Knowledge is an identifiable entity with absolute truth value
2. Meaning can be passed on to learners via symbols or transmission
3. Learners can incorporate exact copies of teacher's understanding for their own use
4. The whole concepts can be broken into discrete sub-skills, and that concepts can be taught out of context.

He asserts that the term is often not explicitly by the user of the term. However, there is a common element in the belief that knowledge is constructed out of personal sets of meanings or conceptual frameworks based on experiences encountered in relevant environments. Interacting with their environment and as a result develop conceptual frameworks to explain these interactions and assist in negotiating. Perkins (1992) opines that central to the vision of constructivism is the notion of the organism as ‘active’ – not just responding to stimuli, as in the behaviorist rubric, but engaging, grappling, and seeking to make sense of things”.

Neurologically, this is the result of complex sets of connections being formed between neurons, these connections being called dendrites (Committee on Developments in the Science of Learning, 2000).

Pines and West (1986) developed what they call a "sources-of-knowledge" model of learning based on constructivism, which the study finds most helpful. They discriminate between two sources of knowledge for school children: firstly, knowledge spontaneously acquired from interactions with the environment; and secondly, knowledge spontaneously acquired from interactions with the environment; and secondly, knowledge acquired formally through the intervention of school. These two sources of knowledge are represented as vines in a metaphor based on the writings of Vygotsky (1978). The former source originates from the learner and thus is known as the upward growing vine. The latter source is formal knowledge imposed on students and therefore is known as the downward growing vine. Therefore, education in schools is concerned with the meeting of these vines that Pines and West (1986) define as four possible paradigms (congruent, conflict, formal-symbolic, and spontaneous), based largely on the relative strengths of the existing and imposed frameworks and the degree to which the frameworks are different.

Further, it is usually also argued that science can assist students in engaging cognitively to a greater depth with knowledge domains. That is students are supported in employing the full range of thinking skills within authentic contexts. This is often discussed in terms of cognitive taxonomies such as that provided by Bloom (1964).

There is often the misguide belief among teachers that constructivism means that all learning must be entirely discovery and that the teacher and curriculum materials have no place. Perkins (1992) describes two constructivist positions on teaching/learning paradigms as without the information given (WIG) constructivism and beyond the information given (BIG) constructivism. It is advocated that a blend of both approaches is employed. DeCorte (1990) discusses this balance of approaches in the context of using computers in schools. According to him, a powerful computer learning environment is characterized by a good balance between discovery learning and personal exploration on one hand, and systematic instruction and guidance on the other, always taking into account the individual differences in abilities, needs, and motivation between students.

It is important not to equate particular sets of teaching strategies with constructivism. One teacher may choose to employ certain strategies in a manner consistent with her constructivist notions, while another may employ quite different strategies in a manner that is equally consistent with his constructivist notions. The educator who believes in constructivism should be concerned with personal conceptual frameworks, prior knowledge, students understandings, the relationship of formal knowledge to spontaneous frameworks, and the attitude of the learner to formal knowledge (Osborne & Wittrock, 1985; von Glasersfeld, 1992).

Student-Centred Approach in the Teaching and Learning of Science

The student-centred Approach is a teaching strategy that attempts to assist students to discover their own knowledge through an activity (Mensah, 1992). According to Mensah (1992), in addition to acquisition of knowledge, the approach also leads to acquisition of process skills such as measuring, recording, analyzing and interpretation of data. Student-centred approach is more of activity-based approach, as such; pupils may learn better and faster when they are taught through activities (Reisman & Payne, 1987). When a pupil performs an activity as an individual, the learner easily understands and never forgets (Jenkins, 1998).

According to Mensah (1992), the student-centred approach is used to teach science in which the pupil is placed at the centre of the learning process and made to manipulate materials and experience things for him or herself. In this method, the student discovers concepts and facts either unaided or with minimum teacher interference. The teacher is less active, a facilitator, co-learner and a guide. The student-centred approach takes full advantage of the learner's natural tendency to explore the familiar environment. The advantage of this approach is that pupils learn to use their hands and minds.

Again pupils learn to organize, observe and become more curious to manipulate and carefully handle equipment during practical lessons. The activity-based method of learning science is also related to the doing of experiments or practical exercises with scientific apparatus (Reisman & Payne, 1987). According to Reisman and Payne (1987), student-centred approach learning of science takes full advantage of the pupils' individual differences and abilities. However, the method is time consuming. It is also very expensive, since it involves the use of more materials. Erinosho (2008) identified other suitable approaches that can be used for the activities in teaching science at the basic school to include:

Inquiry based approach, Discussion approach, Demonstration approach, Questioning and Answer approach, Concept Maps, Field Trip and Simulation approach.

Inquiry Approach to Learning of Science

Despite the introduction of inquiry-based teaching as a significant tool to develop students‘ scientific knowledge and habits of mind, its implementation has not been well established in science classrooms in Ghana. To understand the challenges and difficulties of the practice of practical work, this study particularly aims to understand how pre-service teachers 'understandings of how the various ways of practical work have been shaped in educational and social contexts in OLA College of Education and later how their views and willingness could be developed through repackaging their thoughts.

To overcome the pitfalls of theory-focused and test-oriented science curricula such as lecture-based teaching and memorization of fragmented concepts, science as a process has been used to encourage students to think about science as inquiring and knowing about the world. Getting students involved in authentic experiences of inquiry-based learning, such as problem solving and investigations, can help them develop scientific knowledge, creativity, and habits of mind to question and learn about the life-world phenomena around them (Haigh, 2007). However, the ideas of inquiry-based approach are new to majority of science teachers in schools where the ways of teaching and assessing students' knowledge and settings of classroom environment are still traditional and outcome-based. Therefore, its practice is even a bigger struggle in their everyday teaching.

There are a significant number of studies that discuss the difficulties of scientific inquiry in elementary science classrooms in other countries. For instance, Lee, Tan, Goh, Chia, and Chin (2000) in Singapore contexts found that elementary science teachers encountered external (constraints with time, curriculum, students' abilities and classroom structure) and internal (lack of knowledge, beliefs and attitudes) difficulties in using the problem-solving teaching approach. Research in western countries also stated that many elementary science teachers lack the necessary background and experiences to teach science, and thus lack confidence in teaching the subject (Appleton, 2003; Appleton & Kindt, 1999; Gustafson, Guilbert, & MacDonald, 2002). Even for science teachers with science background knowledge, the implementation of inquiry teaching is challenging for various reasons, such as lack of administrative support and conflicts of personal experiences and beliefs in scientific inquiry (Anderson, 2007). Certainly, without external support of time, materials and laboratory assistance, conducting practical work and inquiry-based learning can be difficult and challenging. Another issue is that science is not a priority subject for elementary school teachers (Appleton & Kindt, 1999). Teachers strive to find a balance among various subject areas and from their perspective, practical work may not seem to be the most efficient way to teach science (Appleton, 2003).

Conducting practical work is challenging and cultivating students' inquiry skills through practical work can also be difficult to attain in basic school science classrooms.

Although these concerns are relevant to many countries, there are certain social contexts in Ghana that further hinder the implementation of inquiry-based teaching and learning. For example, pre-service and beginning teachers tend to depend heavily on curriculum materials such as textbooks and teachers' guidebooks (Rowell & Ebbers, 2004; Schwarz, Gunckel, Smith, Enfield, & Tsurusaki, 2008).

In OLA College of Education, this situation is more pronounced. This is because there are different authorized science textbooks based on a decentralized science curriculum and conventionally, teachers are expected by students, as well as parents, to teach all the content in the textbooks. In addition, national and local examinations and competitions are based on the curriculum and many Pre-service teachers rely on the content of textbooks as a base for learning (Rwell & Ebbers, 2004). With a focus on the text-book content and materials, science learning becomes univocal and less creative since there is not much flexibility. Also, due to the highly competitive examination systems throughout the school years, many Pre-service teachers study the subject matter content at private groups prior to school science classes (Lee, 2005). That means that they already know what the correct results are and they are expected to achieve these results in their practical work without performing any practical exercise (Bybee, 2000).

Because of content-oriented curriculum and assessment, Pre-service science teachers tend to focus on concepts, even in practical work, rather than on an understanding of the development of scientific knowledge, scientific process and enterprise, and the culture of laboratories practiced by scientists (Haigh, France, & Forret, 2005). Whereas scientists experiment, communicate, validate, and develop scientific knowledge through practical work, school practical work tends to test textbook knowledge, thus, recipe practical (Haigh, et al., 2005, p. 221). In this study, practical work in classrooms refers to students' hands-on experiments and this could be practiced in two ways. One is there are no certain, known answers to questions to students and they strive to find out results of their practical work and the other is teachers use practical work to teach textbook knowledge, thus students need to get correct answers through experiments. The latter practice is rather recipe-based practical work whereas the former encompasses an inquiry orientation. The latter is the common practice of practical work at schools since the teaching has been content knowledge-oriented. With this nature of recipe-based practical work is not sufficient to develop Pre-service teachers' habits of mind. When it is recipe-based approach, tutors tend to give Pre-service teachers step-by-step instruction to reach the certain knowledge. There is not much questioning and thinking involved in the process. When Pre-service teachers already know the outcomes or they must get the right answers from the work, they may find it uninteresting and discouraging when they do not get right results and some tutors find practical work ineffective and dilemmatic to teach scientific knowledge (Yoon & Kim, 2009). In this case, practical work cannot bring into much development of inquiry process in Pre-service teachers' learning. In this regard, practical work with inquiry orientation seems such a challenging task in Pre-service science Education in OLA college of Education. It is not simply doing but requires thinking through doing. Following instructions in the textbook activities is not sufficient to enhance inquiry skills and minds. There needs more thorough attention to conducting practical work with inquiry focus.

For this regard, this study attempts to encourage pre-service teachers to understand the need of inquiry orientation in practical work and other ways of improving their practical skills. Since science teaching heavily depends on textbooks in OLA College of Education.

Demonstration Approach to Learning of Science

The demonstration method as another type of pupil-centred lesson, involves the teacher doing or presenting something (a lesson) to the entire class or pupils in order to illustrate a principle to them or show pupils a procedure of accomplishing a task. The goal of this strategy is to help pupils acquire skills. In some cases, the teacher does it first and later asks pupils to try their hands on or perform another task. Some science educationists like Smith (1990) agreed to it that demonstration method is an essential aspect of science teaching. According to Gall, Borg & Gall (1996), once the concepts are firmly established, the other higher-order varieties of learning like problem solving can also take place.

Question and Answer Approach to Learning of Science

Question and Answer method of teaching science is also an important teaching strategy used to develop in pupils the essential attributes of scientific inquiry. Research finding by Walsh and Satters (2005), point to the positive effect of pupils-teacher classroom interaction through questioning. This means that questioning is the entry point to problem formulation in inquiry, promote participatory learning, good communication skills, and confidence building in pupils' learning process. One good strategy of engaging pupils in science lesson is by prompting them to answer questions or ask questions. This would then help the teacher to resolve misconceptions and check understanding. Questioning could arise as a spontaneous activity during instruction, or could be pre-planned.

Although questioning technique is a valuable instructional strategy, badly formed or faulty questions can impede learning. A faulty question is vague (difficult to pin down the answer); not logical (not asked to follow a sequence that helps to build up knowledge); unconnected with instructional materials (asked without reflection); confusing (unclear wording or one that entails multiple tasks); and not adequately challenging to provoke thinking (focus on recall).

Field Trip Approach to Learning of Science

Another strategy which his rarely used in science enhancing is the field trip or excursion (Akpan, 1992). It involves organizing a group of pupils to visit companies or industries where things taught in theory can be seen practically. According to Akpan (1992), field trip or excursion can be likened to a visit to another laboratory away from the school's premises, which is equipped with instruments and materials that the school's laboratory does not and cannot contain.

Those places they visit can serve as science resource centres, to allow the students to acquaint themselves with principles or phenomena which had been heitherto abstract to them. Field trip enables learner to see those things they have learn theoretical makes learning real (Reisman & Payne, 1987), it becomes very difficult for learns to forget what had been learnt and seen in field trip. This method is therefore recommended for students at the basic level since they easily remember things they have been taught and seen (Akpan, 1992).

Simulation Approach to Learning of Science

Simulation technique involves initiating activity that resembles real life situations in teaching certain science concepts and ideas. Simulation technique can take the form of a role-play, games, and models (Yardley-Matwiejczuc, 1997). According to Erinosho (2008), pupils could act as scientists in a situation that requires a decision or planning to solve problem through role-play and develop basic/generic skills in pupils. Yardley-Matwiejczuc (1997), has observed that games and role-play helps pupils to develop analytical, communication, and decision-making skills, as well as to build confidence in discussions on science issues.

According to Wadsworth (1989) people followed the theoretical approach due to limited knowledge of science that the pupils possessed. In modern times Wadsworth (1989) stated that science is seen more to be practically oriented or activity based. Students enjoy science lessons when they are involved in activities concerning the topic. There is therefore the need to adopt the activity-based and inquiry methods in the teaching of science especially at the basic and secondary levels (Reisman & Payne, 1987).

Action Research

Bassey (1995) distinguishes three categories of research: theoretical research, evaluative research and action research. For Bassey, action research is where researchers seek to describe, interpret and explain events whilst seeking to effect changes.

Whitehead (1995) adds to the above in his statement; "action research is distinguished from other forms of research by the fact that researchers are investigating their own practices" (p.114).

Altrichter (1993) endorses this by saying "Unlike many other research and development approaches, action research does not want to replace the practitioners' thinking by expert knowledge but rather aims to build on it and to support it" (p.48)Cohen and Manion (1980) indicate that:

Action Research as a method is most appropriate whenever specific knowledge is required for a specific problem in a specific situation, or when a new approach is to be grafted onto an existing system. More than this, however, suitable mechanisms must be available for monitoring progress and for translating feedback into the ongoing system.

According to Mills (2000), action research is a method within the qualitative inquiry tradition that seeks to improve professional practice through better understanding of a particular aspect of a situation. It is well-suited to the social science, particularly to educational issue where there can be ethical problems experimenting with treatments on students (Denzin & Lincoln, 2005). Again, Creswell (2008) states that action research is the most commonly applied practical research design in education today.

The goal of action research is to experiment with making a positive different in one's professional practice as the research is conducted. Creswell (2008), continued by saying that teachers reflect on what worked well and what did not, when needs adjustment, and what should be discarded altogether. He concluded that teachers also consider what new practices hold promise for the academic attainment of their students. Mills (2000), believes that the purpose for choosing action research is to effect positive educational change.

Elliott (1991) holds a similar view as he says; "action research is the study of a social situation with a view to improving the quality of action within it".

There has been much debate as to the appropriateness of traditional forms of research to the classroom teacher. This view has not always been commonplace however. Stenhouse (1975) suggested that teachers should possess a capacity for autonomous self-development through systematic self-study, through the work of other teachers and through the testing of ideas by classroom teachers. This view was a response to the fact that for many years teachers had been fed with findings from in-service courses which had little relevance to their everyday practice (Gurney, 1989).

Bassey (1981; 1983) adds weight to this concern. In his work, he draws a distinction between disciplinary research and pedagogic research. Disciplinary research is research carried out by psychologists, sociologists, historians, philosophers primarily for the development of their discipline, Bassey argues that such traditional research couched in the various jargon according to the discipline is alien to practicing teachers and has been rejected by them as being of little use in analyzing and devising solutions for classroom practice.

Pedagogic research however is research which directly affects the above. It is presented in a pragmatic style and is readily accessible to teachers. Its prime purpose is to find ways of improving pedagogic practice, and this is not deflected by other purposes. According to Bassey (1983) theory is created in pursuit of improvement and for the achievement of that improvement, not as the ultimate purpose of the research. Bassey is by no means unsupported in this view. The argument for teachers adopting the dual role of teachers as researchers has been made most persuasively and effectively by Elliot (1991, 1993).

Bassey (1981) draws the readers' attention to pedagogic research which he views as having valuable potential for teachers.

The educational research community should distinguish between pedagogic research and other forms of educational research and in relation to pedagogic research should eschew the pursuit of generalisations, unless their potential usefulness is apparent, and instead should actively encourage the descriptive and evaluative study of single pedagogic events. In this way pedagogic research will contribute effectively as the improvement of pedagogic practice.

It can be argued that the above process generations its' own body of knowledge. A main issue arising from this is that schools now have a far greater role in curriculum development and what is more the curriculum development is relevant to the individual's particular institution. In addition, because action research is such a personal form of learning, complemented by intense rigour and systematic reflection it could be argued that its effect on the individual is far greater than that which would be achieved through engaging with more traditional forms of research.

Summary of Related Literature Review

Practical skills which are widely used today provide students with unique opportunities to study abstract concepts and generations through the medium of real materials. It however depends largely on logical reasoning. Practical skills could range from simple such as identification of instruments to complex ones. The purpose of practical work is to enhance, understand and develop scientific concepts, processes and laboratory skills. Practical activities further evaluate what a person knows and can do which requires the use of instruments and procedures to follow.

Though practical skills are learned best through integration, it still cannot be learned within a relatively short time. It needs to be practiced overtime. Conducting practical work can be difficult, challenging and frustrating where students may not have the basic skills in performing the activities. In addition, it is evidently clear that every research employs specific research designs, specific instrument and also describes the type population and sampling technique suitable to help achieve the core objective of the study.

CHAPTER THREE

METHODOLOGY

Overview

This chapter presents the methodology employed for the study. It focuses on the design chosen for the study while discussing other types of design and why the need for this particular design for the study. The population drawn for the study was also discussed with much emphasis on how the sample size was obtained from the population and justifying the need to use the sample size. Test items on practical skills in science were employed as research instrument for the study. The study aims at finding the effects of student-centred approach on basic practical skills of pre-service teachers at OLA College of Education – Cape Coast. In an attempt to unraveling the hidden treasure, the chapter presents how the data gathered will be analyzed.

Design of the Study

There are various types of research designs in various jurisdiction of research work. In this study a review of some research design are enumerated. They include:

1. **Philosophical/Discursive**

This may cover a variety of approaches, but draws primarily on existing literature, rather than new empirical data. A discursive study could examine a particular issue, perhaps from an alternative perspective (e.g. feminist). Alternatively, it might put forward a particular argument or examine a methodological issue. Examples of topics that may fit into this category are:

- Davies (1999) ‘What is Evidence-Based Education?’ British Journal of Educational Studies, 47 (2), 108-121. [A discussion of the meaning of ‘evidence-based education’ and its relevance to research and policy]
- Pring (2000) ‘The ‘False Dualism’ of Educational Research’. Journal of Philosophy of Education, 34, 2, 247-260. [An argument against the idea that qualitative and quantitative research are from rigidly distinct paradigms]

2. Literature Review

This may be an attempt to summarize or comment on what is already known about a particular topic. By collecting different sources together, synthesizing and analyzing critically, it essentially creates new knowledge or perspectives. There are a number of different forms a literature review might take. These may include;

A ‘systematic’ review will generally go to great lengths to ensure that all relevant sources (whether published or not) have been included. Details of the search strategies used and the criteria for inclusion must be made clear. A systematic review will often make a quantitative synthesis of the results of all the studies, for example by meta-analysis.

Where a literature field is not sufficiently well conceptualized to allow this kind of synthesis, or where findings are largely qualitative (or inadequately quantified), it may not be appropriate to attempt a systematic review. In this case a literature review may help to clarify the key concepts without attempting to be systematic. It may also offer critical or alternative perspectives to those previously put forward. Examples:

- Adair, Sharpe and Huynh (1990) 'Hawthorne Control Procedures in Educational Experiments: A reconsideration of their use and effectiveness' *Review of Educational Research*, 59, 2, 215-228. [A systematic review and meta-analysis of studies that have tried to measure the 'Hawthorne Effect']

3. **Case Study**

This will involve collecting empirical data, generally from only one or a small number of cases. It usually provides rich detail about those cases, of a predominantly qualitative nature. There are a number of different approaches to case study work (e.g. ethnographic, hermeneutic, ethogenic, etc) and the principles and methods followed should be made clear.

A case study generally aims to provide insight into a particular situation and often stresses the experiences and interpretations of those involved. It may generate new understandings, explanations or hypotheses. However, it does not usually claim representativeness and should be careful not to over-generalise. Examples:

- Jimenez and Gersten (1999) 'Lessons and Dilemmas derived from the Literacy Instruction of two Latina/o Teachers'. American Educational Research Journal, 36, 2, 265-302. [A detailed study of the behaviour and experiences of two teachers of English to minority students]

4. **Survey**

Where an empirical study involves collecting information from a larger number of cases, perhaps using questionnaires, it is usually described as a survey. Alternatively, a survey might make use of already available data, collected for another purpose. A survey may be cross-sectional (data collected at one time) or longitudinal (collected over a period). Because of the larger number of cases, a survey will generally involve some quantitative analysis.

Issues of generalisablity are usually important in presenting survey results, so it is vital to report how samples were chosen, what response rates were achieved and to comment on the validity and reliability of any instruments used. Examples:

- Francis (2000) 'The Gendered Subject: students' subject preferences and discussions of gender and subject ability'. *Oxford Review of Education*, 26, 1, 35-48.
- Denscombe (2000) 'Social Conditions for Stress: young people's experience of doing GCSEs' *British Educational Research Journal*, 26,. 3, 359-374.

5. **Evaluation**

This might be an evaluation of a curriculum innovation or organizational change. An evaluation can be formative (designed to inform the process of development) or summative (to judge the effects). Often an evaluation will have elements of both. If an evaluation relates to a situation in which the researcher is also a participant it may be described as 'action research'. Evaluations will often make use of case study and survey methods and a summative evaluation will ideally also use experimental methods. Examples:

- Burden and Nichols (2000) 'Evaluating the process of introducing a thinking skills programme into the secondary school curriculum'. *Research Papers in Education*, 15, 3, 259-74.
- Ruddock, Berry, Brown and Frost (2000) 'Schools learning from other schools: cooperation in a climate of competition'. *Research Papers in Education*, 15, 3, 293-306.

6. **Action Research (*Experiment*)**

This involves the deliberate manipulation of an intervention in order to determine its effects. The intervention might involve individual pupils, teachers, schools or some other unit. Again, if the researcher is also a participant (e.g. a teacher) this could be described as 'action research'. An experiment may compare a number of interventions with each other, or may compare one (or more) to a control group. If allocation to these different 'treatment groups' is decided at random it may be called a true experiment; if allocation is on any other basis (eg using naturally arising or self-selected groups) it is usually called a 'quasi-experiment'.

Issues of generalisablity (often called 'external validity') are usually important in an experiment, so the same attention must be given to sampling, response rates and instrumentation as in a survey (see above). It is also important to establish causality ('internal validity') by demonstrating the initial equivalence of the groups (or attempting to make suitable allowances), presenting evidence about how the different interventions were actually implemented and attempting to rule out any other factors that might have influenced the result. Examples:

- Finn and Achilles (1990) 'Answers and questions about class size: A statewide experiment.' *American Educational Research Journal*, 27, 557-577. [A large-scale classic experiment to determine the effects of small classes on achievement]
- Slavin (1980) 'Effects of individual learning expectations on student achievement'. *Journal of Educational Psychology*, 72, 4, 520-4. [A smaller study which investigates how the kinds of feedback students are given affects their achievement]

Population and Sampling

Population

Monatte and Anderson (1994) suggests that population is all possible cases of what we are interested in studying. A target population will be all possible cases of whatever a unit of analysis is (Kish, 1985). A research population is generally a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population that researches are done.

Types of Research Population

There are usually two types of populations. These include target population and accessible population.

Target population refers to the entire group of individuals or objects to which researchers are interested in generalizing the conclusions. The target population usually has varying characteristics and it is also known as the theoretical population.

The accessible population is the population in research to which the researchers can apply their conclusions. This population is a subset of the target population and is also known as the study population. It is from the accessible population that researchers draw their samples.

The target population of the study was all final year students (pre-service teachers) of all special mathematics and science colleges of education. From the target population the researcher chose final year students of OLA College of Education numbering one hundred and twenty (120) females as the accessible population.

Sample and Sampling Technique

A sample size of 40 was drawn from the total population of 120 pre-service teachers using the random sampling technique. In this technique, each member of the population has an equal chance of being selected as subject. The entire process of sampling was done in a single step with each subject selected independently of the other members of the population.

Though there are many methods to proceed with simple random sampling, the most primitive and mechanical which is the lottery method was used in this study. Each member of the population was assigned a unique number. Each number was placed in a hat and mixed thoroughly. The researcher blind-folded himself and then picked numbered tags from the hat. All the pre-service teachers who bore the numbers picked by the researcher became the subjects for the study.

Instruments

Types of Instrument

According to a report by published by Yolanda (2011), one of the most important components of a research design is the research instruments because they gather or collect data or information. She asserted further that research instruments or tools are ways of gathering data. Without them, data would be impossible to put in hand. In her report, many research instruments were made mentioned of. These include;

1. **Questionnaire**

The most common instrument or tool of research for obtaining the data beyond the physical reach of the observer which, for ex. May be sent to human beings who are thousands of miles away or just around the corner. Two Forms of

Questionnaire; Closed form / Closed-ended and Open form / Open-ended exist. In this release some guidelines for constructing these types of questionnaire were given. Among these are:

- Clarity of language Singleness of purpose Relevant to the objective of the study correct grammar should be upheld.
- Define or qualify terms that could easily be misinterpreted. In this regard one should be careful in using descriptive adjectives and adverbs that have no agreed-upon meaning while regarding carefulness of inadequate alternatives. And shunning double negatives.
- Avoid the double-barreled questions
- Underline the word if you wish to indicate special emphasis.
- When asking for rating or comparisons a point of reference is necessary
- Avoid unwarranted assumptions.
- Phrase questions so that they are appropriate for all respondents
- Design question that will give a complete answer
- Provide for the systematic qualification of response
- Consider the possibility of classifying the respondents yourself rather than having the respondents choose categories.

Advantages of using questionnaire includes facilitating data gathering Is easy to test data for reliability and validity Is less time-consuming than interview and observation Preserves the anonymity and confidentiality of the respondents' reactions and answers. In spite of its advantage is saddled with

Printing and mailing which makes it costly Response rate may also be low and respondents may provide only socially acceptable answers. There is also less chance to clarify ambiguous answer, respondents must be literate and with no physical handicaps to answer and rate of retrieval can be low because retrieval itself is difficult

2. **Interview**

This is in a sense of an oral questionnaire. Instead of writing the response, the interviewee gives the needed information orally and face-to-face. With a skillful interviewer, the interview is often superior to other data-gathering device. The purposes of interview are among others to verify information gathered from written sources, to clarify points of information, to update information and to collect data the types of Interview may include structured or standardized and unstructured or unstandardized interview.

3. **Rating scale**

This involves qualitative description of a limited number of aspects of a thing or traits of a person. Forms of Rating Scale include; Thurstone Technique, Likert Method and Semantic Differential.

4. **Checklist**

The simplest of the devices, consists of a prepared list of items. The presence or absence of the item may be indicated by inserting the appropriate word or number. It is used in descriptive and historical researches

5. **Sociometry**

This is a technique for describing the social relationships among individuals in a group. In an indirect way it attempts to describe attractions or repulsions between individuals by asking them to indicate whom they would choose or reject in various situations

6. **Document or Content Analysis**

This is used as a main tool of research or a subsidiary tool Main tool in historical research but a subsidiary tool in descriptive research and less used in experimental research

7. **Scorecard**

This is a rating that may yield a total weighted score that can be used in evaluating communities, buildings, sites, schools, or textbooks. Similar in some respect to checklist and rating scale

8. **Teacher or Research-Made Tools**

This is very popular in research and usually part of the overall instruments used in research studies. It is combined with other standardized tests in the assessment of individuals' operations and situations

9. **Tape Recorded Data**

This is observed through the ear as well as through the eye. It also uses video tape recorder or radio cassette recorder

10. **Opinionative**

This is an information form that attempts to measure the attitude or belief of an individual it is also known as attitude scale

11. **Observation**

This involves perceiving data through the senses: sight, hearing, taste, touch and smell. It is mostly used in studying individual behaviour. Various types of observation exist. These may include; Participant and non-participant observation, structured and unstructured observation and controlled and uncontrolled observation.

12. **Psychological tests**

This is an instrument designed to describe and measure a sample of certain aspects of human behaviour i.e. performance test, paper and pencil test, achievement inventory, personality inventory and projective devices

13. **Ready-to-Use Instrument or Standardized Test**

This type of instrument is a product of long years of study which has tends to be highly reliable and cover a wide range of student performance level. E.g. the Basic Practical Skill Test (BPST). The BPST, which is a standardized test, was used to generate data for the study after pre-service teachers have been taken through five set of practical skill lessons on biology, physics and chemistry. The set of BPST were designed by experience tutors from the sixteen (16) Special Colleges of Education offering Mathematics and Science to reflect applications of what pre-service teachers have gone through.

Administration of the Instrument

The Experimental group was taken through some basic practical skills in science through the child centred approach of teaching. (Lesson note for lesson is at appendix A).

Data Analysis Procedure

The various lessons were analysed based on the progress of pre-service teachers from lesson to lesson as shown in chapter four.

The analysis and the results of this study were explained in three sections. The first section dealt with observations from lessons. The second section presented the findings from the five lessons and thence was followed by discussion of findings and research questions.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

Overview

This chapter presents the findings of the five week teachings. The reports have been presented in five different lessons and analysed. The discussions were based on the student-centred activities that went on in the classroom, the procedure as well as the observation made during the lessons.

Lesson One

Procedure and Student-Centred Activities

In lesson one the topic "*Identification of Specimens"* was treated. The teaching and learning objectives were that, by the end of the lesson, students should be able to identify the following specimens using their external features: Tridax fruit, Coconut fruit, Mango seed and Cotton seed. The lesson was based on students' relevant previous knowledge. Students described how seeds of pepper, mango, guava, cotton and coconut fruits are dispersed.

Students – Centred Activities

Activity 1

Students observed the following external features of specimen A using hand lens: Size of the specimen, surface of the specimen and nature of the specimen. The students recorded the following features of specimen A after observing closely with the hand lens: Specimen A was small in size, specimen A had large surface area and has parachute hairs. Students determined the weight of the specimen A by weighing it on a top pan balance and also by blowing to see if it could blow away. Students observed that the specimen was light in weight. Hence the students identified specimen A as tridax using the observed external features.

Activity 2

Students observed the following external features of specimen B; weight and nature of the specimen. The students determined mass of coconut and mass of water melon of the same size on a top pan balance. Students observed that the mass of coconut ranged from 1.8kilogram to 1.1 kilogram and that of water melon ranged from 1.2 kilogram to 1.6kilogram. student recorded that the coconut has light weight as compared to the water melon of the same size. Furthermore, the students dropped the coconut in a bucket of water to observe whether it sinks or floats (buoyancy). They observed that the coconut floats hence buoyant in nature. Also the students observed the external strands of the coconut's mesocarp using hand lens. They recorded that the strands of the coconut's mesocarp are fibrous in nature. Students identified the name of the specimen B as coconut.

Activity 3

Students observed the following external features of specimen C; adhesive structure and enzyme resistance. Students attempted to peel off the coat of specimen C with their fingers and compared with peeling off the coat of groundnuts. The students observed that peeling off specimen C was difficult because the cover was sticky, which was due to its adhesive nature. Also, students used the fingers to feel the seed of specimen C. They observed that the seed was very hard which makes it enzyme resistant. It means the seed does not easily get decomposed because of its hardness. Students identified specimen C as mango.

Activity 4

Students observed the following external features of specimen D using hand lens; size of specimen and nature of the specimen. The students recorded the following features after closely viewing the specimen using the hand lens. Specimen D was small in size and has parachute hairs. Students further determined the weight of the specimen D by weighing it on a top pan balance and by blowing to see if the specimen could blow away. They observed that specimen D was light in weight. Students determined the fluffy nature of the specimen by manipulating the specimen with the fingers. They observed that the specimen was light, soft and airy. Hence fluffy in nature. With the aid of a hand lens students observed that the colour of specimen was ash in colour when compared to a colour chart. Students explained that the colour may change depending on environmental factors and other conditions the seed might be exposed to. With the features identified above, students concluded that specimen D was a cotton seed.

Evaluation Questions and Students Responses

Students answered the following questions:

Question 1: If the tridax were mixed up with small torn pieces of paper and a fan used to blow over them, which one will fly off earlier and why?

Students Response: The tridax of the large surface area and the parachute – like wings.

Question 2: Explain why when the coconut and mango are dropped in a bucket full of water, the mango sinks and the coconut floats?

Students Response: This is because the coconut has fibrous tissues in its mesocarp. This contains air spaces and gives the coconut a density that is less than water or makes the coconut buoyant and so it floats in the water. The mango on the other hand has a more compact (food filled) mesocarp without any air spaces between its tissues, this makes the mango more densed than water and it tends to sinks in the water.

Question 3: Why do cotton seed flies easily?

Students Response: This is because it is light in weight and easily carried by the slightest force of wind. Again, the seed is winged and this greatly aids in its movement. The wings acts as though they were parachutes and this aids in their movement.

Question 4: Why is it difficult to peel of the seed coat of a mango unlike the seed coat of a groundnut using your fingers?

Students Response: The seed coat of a mango is a hard seed coat that looks cemented all round because of the hard material of which it is made, it is therefore difficult to peel of a mango seed coat with your fingers. The seed coat of groundnut is papery and thin and so very easy to peel off with one's fingers.

Findings from Lesson One

In this lesson, all students had equal opportunity to interact and manipulate the specimens given. In their groups, the students were able to identify the specimens by their external features. Students were also able to answer the evaluation questions appropriately confirming that they had discussed and had settled on an answer.

Lesson Two

Procedure and Student-Centred Activities

In lesson two the topic *"Drawing and labeling biological specimens"* was treated. The teaching and learning objectives were that by the end of the lesson, students should be able to:

1. Draw and label the longitudinal section of pride of Barbados flower. (Refer to appendix II).
2. Draw and label the transverse section of a dicotyledonous stem of pepper plant. (Refer to appendix II).

The lesson was based on students' relevant previous knowledge (RPK). Students explained longitudinal section as a section that runs through the length of the whole or part of an organism and transverse section as a section that passes crosswise through a whole or part of an organism.

Students – Centred Activities

Activity 1

Students observed the external parts of Pride of Barbados flower, using hand lens and worked together to identify the names of the external parts of the Pride of Barbados flower. Students further cut the longitudinal section of the Pride of Barbados flower using a sharp blade. They made individual drawings and labelled the following parts of the flower: anther, filament, petal, sepal, receptacle, stigma, style, nectar tube, ovary and ovule.

Activity 2

Students cut thin layer of transverse section of pepper plant stem using a sharp blade. They discussed how they were going to mount the specimen on slides. Some of the suggestions that came up were to wet the slide surface, make slice as thin as possible, gently lower the slice of the specimen and cover with a second slide. They then mounted the thin layer of the stem on light microscope slides for observation. Individually, they observed, drew and identify the names of the internal parts of the pepper stem, as sclerenchyma, vascular bundle, xylem, cambium, phloem, collenchyma, parenchyma and endodermis.

Evaluation questions and students' responses

Students answered the following questions:

Question 1: In what position do you find the sclerenchyma?

Students Response: Sclerenchyma are found almost everywhere in the plant. (stem, roots and in leaves). They can be found in the cortex, pith, xylem and phloem. They are found in fruits and make up the hard coat of many seeds. They can be found in wood and in tree trunks. In stems they can be located after the epidermis. They cover the vascular bundles.

Question 2: How different is the collenchyma from the parenchyma in plants?

Students Response: Parenchyma tissues are usually thin walled and function mainly in food storage, photosynthesis and regeneration of tissues whereas collenchyma tissues have thicker walls than parenchyma tissues. They provide extra support especially in areas of new growth and can therefore provide support for young stems and roots.

Question 3: How would you explain to P.5 child who complains of so many insects around the flowers in their porch?

Students Response: The insects are visiting the flower for a reason. If the child smells the flower, he/she will probably notice that it is sweet scented, the insects perceive this nice smell to and imagine they can find food (Nectar). Nectar is a sweet tasting liquid excreted by flowers which insects love to feed on. The child will probably also notice that the petals of the flowers are attractive. This bright coloured petals must have also attracted the insects to the flowers. So the bright colours and sweet smell of the flowers attract the insects and when the insects approach the flower they feed on the sweet nectar produced by the nectary glands of the flower.

Question 4: How different is the ovary from the ovule?

Students Response: In flowering plants, the ovary is part of the female reproductive organ (gynoecium). It is the part that contains the ovules and matures to become the fruit. The ovule on the other hand is located within the ovary it contains the female gamate cell and develops into a seed after fertilization.

Findings from Lesson Two

The student-centred approach enabled the students to engage each other in conversation in which they made contributions to how to cut and mount the specimen. In this practical activities, majority of the students were able to draw and label the longitudinal section of the following parts of the Pride of Barbados flower: anther, filament, petal, sepal, receptacle, stigma, style, nectar tube, ovary and ovule. Students also observed, drew and identify the internal parts of the pepper stem as sclerenchyma, vascular bundle, xylem, cambium, phloem, collenchymas, parenchyma and endodermis.

Lesson Three

Procedure and Student-Centred Activities

In lesson three the topic *"Classification of substances as acids or bases"* was treated. The teaching and learning objectives were that by the end of the lesson; students should be able to:

1. Classify substances as acids or bases.
2. Identify physical properties of acids.
3. Identify physical properties of bases.

The lesson was based on students' relevant previous knowledge (RPK). Students defined acid as a substance which produces hydrogen ions (H^+) or proton when it is dissolved in water and base as a substance which produces hydroxide ions (OH^-) when it is dissolved in water.

Students – Centred Activities

Activity 1

Students observed and identified some substances made of acids and bases. These include samples of: vinegar, aspirin soap, tomato juice, palm oil, baking soda, sea water, groundnut oil, tooth paste, and milk of magnesia. Students then classified the substances into acids and bases using litmus paper. The students then observed and recorded that the blue litmus turned red in all acids substances and the red litmus turned blue in all substances that are base.

Activity 2

Students performed the following activities to show some physical properties of acids. They squeezed lime (acid) into water and compared it with chalk powder in water. Students observed that the lime was soluble in water but the chalk powder was insoluble which shows that acids are soluble in water. Students also tasted a drop of natural lime and lemon juice and they observed that both juice had sour taste which indicated that acid have sour taste. Students further dipped blue litmus paper into the lime juice and observed that the litmus paper turned red. This proved that acid turns blue litmus paper into red.

Activity 3

Students performed the following experiment to show some physical properties of bases. They burnt cocoa husk and dry plantain peels and made a mixture of a small quantity of the ash (tea spoonful) with a small quantity of water. They tasted a drop of the mixture and observed that it tastes bitter. They further took a filtered solution of ashes and water. The students then dipped their fingers into the solution and rubbed them together. Students observed that their fingers felt soapy which made them to conclude that bases have soapy feel. In addition, students dipped red litmus paper into the solution and observed that the red litmus paper turned blue.

Evaluation Questions and Students Responses

Students answered the following questions:

Question 1: Two bottles labelled A and B all contain clear solutions. One of them is an acid and the other a base. Determine which bottle contains the acid and which one contains the base.

Students Response: Dip blue and red litmus papers into each bottle and when the blue litmus paper changes red, it shows the solution is acidic. When the red litmus paper changes into blue, the solution in which it was dipped is a base (an alkaline solution).

Bottle A	**Bottle B**
Contains acid	Contains base
Solution changes	Solution changes
Blue litmus paper red	Red litmus paper blue

Question 2: Propose a solution to the problem of plants in a garden not being able to grow well because the soil is acidic.

Students Response: Lime water [$Ca(OH_2)$] Calcium Hydroxide which is a base is used to treat soil acidity. $Ca(OH)_2$, reacts with the acid in the soil to produce salt and water.

Question 3: Discuss why marble statues in many parts of the world where the air is polluted by Sulphur (IV) oxide (SO_2) gas is damaged.

Students Response: SO_2 gas dissolves in rain water as shown in the equation below:

$SO_2 + H_2O \longrightarrow H_2SO_3$

Sulphur (IV) oxide + water $\longrightarrow$ Hydrogen trioxosulphate (IV)

The rain water becomes slightly acidic as it contains H_2SO_3 [Hydrogen, trioxosulphate (IV)] and this gradually destroys marble statues. Acid is corrosive.

Findings from Lesson Three

The student-centred approach enabled the students to have equal opportunity to interact and manipulate the teaching learning materials. Students were able to classify the following substances: vinegar, soap, aspirin, milk of magnesia, tomato juice, baking soda, groundnut oil, sea water, palm oil and tooth paste as acids and bases using the litmus paper. Students further performed simple activities showing the physical properties of acids and bases.

Lesson Four

Procedure and Student-Centred Activities

Lesson four the topic *"Measurement (using micrometer screw gauge)"* was treated. The teaching and learning objectives were that by the end of this lesson, students should be able to:

1. Draw and label the external parts of micrometer screw gauge. (Refer to appendix vii).
2. Measure the thickness of objects using micrometer screw gauge.

The lesson was based on students' relevant previous knowledge. Students mentioned the instrument for measuring the thickness of coins and rings as micrometer screw gauge.

Students – Centred Activities

Activity 1

Students observed the external parts of micrometer screw gauge. They then identified the names of the external parts as anvil, spindle, head scale, pitch scale, and thumb screw.

Activity 2

Students determined the thickness of some coins by using micrometer screw. They inserted the object (coin) between the jaws of the instrument and held it firmly. They then read from the sleeve scale (main scale). That was the last figure before the thimble scale. The students then read the value from the thimble scale (vernier scale). This was done by identifying the figure that coincides with the scale line on the sleeve scale. Finally, the reading on the instrument was obtained from the formula:

$$R = M + \frac{V}{100}$$

Where

M = Sleeve (main) scale reading

V = Thimble (vernier) scale reading

R = Reading of instrument

Evaluation Question and Students Response

Students answered the following question:

Question 1: How would you measure the thickness of a wedding ring using micrometer screw gauge.

Students Response: To determine the thickness (length) of an object using micrometer screw gauge.

1. Insert the object between the jaws of the instrument and hold it firmly.
2. Take the reading from the sleeve scale (main scale). That is, the last figure before the thimble scale.
3. Take another reading from the thimble scale (vernier scale). This is done by identifying the figure that coincides with the scale line on the sleeve scale.
4. Avoid error of parallax by taking all the reading at the eye level.
5. Finally, the reading on the instrument could be obtained from the formula:

$$R = M + \frac{V}{100}$$

Where

M = sleeve (main) scale reading

V = thimble (vernier) scale reading

R = reading of the instrument.

Findings from Lesson Four

The student-centred approach enabled students to perform their practicals at their own pace. In this practical activities, majority of the students were able to measure the thickness of coins using the micrometer screw gauge.

Lesson Five

Procedure and Student-Centred Activities

In lesson five the topic *"Measurement (using vernier calipers)"* was treated. The teaching and learning objectives were that, by the end of the lesson, students should be able to:

1. Draw and label the external parts of vernier. (Refer to appendix VIII).
2. Measure the thickness of objects using vernier calipers.

The lesson was based on students' relevant previous knowledge. Students stated the instrument for measuring internal and external diameters of small objects as vernier calipers.

Students – Centred Activities

Activity 1

Students observed the external parts of vernier calipers. They then identified the names of the external parts as main scale, vernier scale, sliding jaw, inside jaws and outside jaws.

Activity 2

Students determined the internal diameter of a ring by using vernier calipers. They inserted the ring between the jaws of the vernier calipers and held the ring firmly in the jaws of the caliper with the help of a locking nut. Students then red and recorded the reading from the main scale. That was the figure on the main scale. The students further read and recorded another reading from the vernier scale. That was the figure on the vernier scale that coincides with another figure on the main scale. The total reading (diameter of the ring) was obtained from the formula:

$$R = M + V$$

Where

R = Diameter of the ring

M = Main scale reading

R = Vernier scale reading

Evaluation Question and Students Response

Students answered the following question:

Question 1: How would you determine the internal diameter of pipe tube using vernier calipers.

Students Response: To determine the length of an object using vernier callipers.

1. Insert the object between the jaws of the vernier calliper; hold the object firmly in the jaws of the calipers with the help of a locking nut.

2. Read and record the reading from the main scale. That is, the figure on the main scale that appears just before the vernier scale.
3. Read and record another reading from the vernier scale. That is, the figure on the vernier scale that coincides with another figure on the main scale.
4. The total reading (i.e. the diameter of the object) can be obtained from the formula:

$$R = M + V,$$

Where R = diameter of the object (reading of the vernier caliper)

M = sleeve (main) scale reading

V = thimble (vernier) scale reading

Findings from Lesson Five

In this practical, the student centred approach enabled students to gain first hand experience in using the vernier callipers to measure the internal diameter of rings. Donnelly and Jenkins (1999) confirmed that student-centred learning is a learning model that places the learner at the centre of the learning process and that the instructor provides students with opportunities to learn independently and from one another and coaches them in the skills they need to do so effectively.

Discussion of Results

Research Question 1: How will the student-centred approach affect the teacher-trainees' skills in planning laboratory practical skills?

From the observation made before the student-centred approach was introduced, it was evident that the teacher-trainees had poor skills in planning laboratory practicals. Most of them did not know the procedures to follow, which apparatus will be appropriate for the lesson and even some precautions to take before and during the practicals.

After the introduction of the student-centred approach, I observed that majority of the teacher-trainees' planning skills had improved. The teacher-trainees were able to give an appropriate title for their experiment to be conducted. They were able to state the aim of the activity as well as identifying apparatus such as hand lens, top pan balance, micrometer screw gauge and vernier callipers. Moreover trainees were able to develop the various steps to follow during practicals including precautions to take before and during the lesson.

Research Question 2: How will the student-centred approach affect the teacher-trainees' skills of performing laboratory practical activities in science?

In answering research question three, it was noticed that there was a drastic improvement in areas like teacher-trainees' observation skills, drawing skills, classification skills and that of measuring skills.

With the observation skills, the trainees were able to observe the external features of specimens such as the tridax, cotton seed, mango seed, coconut fruits using the appropriate apparatus. The trainees were able to draw and label the longitudinal section of pride of Barbados flower and the transverse section of a dicotyledonous stem of pepper plant. The trainees also drew and labeled the external parts of micrometer screw gauge and vernier calipers which they were not able to do before the introduction of the student-centred activities.

In addition to the above, the trainees were able to measure the thickness of a wedding ring using micrometer screw gauge and the internal diameter of pipe tubes using vernier calipers which was a problem for them before the intervention.

Also, trainees were able to classify substances such as; palm oil, tomato juice, baking soda, seawater, groundnut oil, tooth paste, asprin, vinegar and milk of magnesia into acids and bases using litmus paper. This proves the fact that there was an improvement in trainees measuring and classification skills.

Research Question 3: What effect will the student-centred approach have on the teacher-trainees' attitude towards laboratory work in science?

Research question four was the effect the student-centred approach will have on the teacher-trainees' attitude towards laboratory work in science. From the research it came to light that: before the student-centred activities were carried out, trainees showed a lukewarm attitude towards science practical lessons.

But after the intervention, majority of them developed the interest in carrying out simple experiments. They were able to measure objects using micrometer screw gauge and vernier calipers. The trainees also participated actively during the practical lessons which was not the case before the introduction of the student-centred activities. Also, the trainees were able to ask questions about phenomena in their environment. They were as well able to think logically and interpret findings and appreciated the importance of science practical.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

The chapter elaborates on the summary of the findings, throwing light on key issues that emerged from the study. It also draws conclusion on the outcome of the study while making imperative suggestions and recommendation to other would be researchers.

Summary of Key Findings

The following were the major findings that emerged from the study based on the student-centred activities employed in the study.

a. Most of the teacher-trainees were able to manipulate and identify given specimens by their external features.

b. Majority of the students were able to cut, mount, draw and label given specimens such as the Pride of Barbados flower.

c. Students were able to perform simple activities showing the physical properties of acids and bases. This enabled them to classify given substances into acids and bases.

d. A large number of the class managed to measure the thickness of given objects using the vernier callipers and the micrometer screw gauge correctly.

Conclusions

On the basis of the findings, it is concluded that the student-centred approach:

1. strengthens student motivation
2. promotes peer communication
3. reduces disruptive behaviour
4. builds student-teacher relationships
5. promotes active learning and
6. makes student responsible for their own learning.

From the study, it can be concluded that it is possible to improve students' basic practical skills through the use of student-centred approach.

Suggestions

The results of the study showed that the student-centred activities can improve students' practical skills. Hence, it is suggested that pre-service teachers should be made to do a lot of drawing, and labelling of specimen in order to enhance their practical skills.

The student-teachers should be exposed to the skills of classification of various forms of substances as proven from the study.

Again, the teacher-trainees should be given equal opportunity to use apparatus, tools and devices very often to enable them acquire the skill of measuring.

Finally, specimens should also be made available for teacher-trainees to interact, manipulate and identify them during practical lessons.

Recommendations

1. From the findings, it was evident that majority of the students were able to mount and perform simple practical activities needed to teach science at the basic level. Based on this premise, it is recommended that all pre-service sciences teachers in all colleges of education are given a one semester course training on basic practical skills in science in order to equip them for the teaching of science.
2. Another notable evidence was that with procedures and directions given, most of the students able to manipulate and handle apparatus like vernier callipers and micrometer screw gauge which they were not able to do before the student-centred activities were introduced. With regard to this findings, it is recommended that tutors in colleges of education should design course manual on basic practical skills in science to guide pre-service science teachers in the acquisition of hands on basic practical skills in science.
3. After going through the student-centred activities with the students, it came to light that the students' practical skills improved tremendously. This evidence makes it worth recommending that teacher Education in collaboration with the Institute of Education should include in their grading systems and awarding of certificates, basic practical skills in science.

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APPENDIX I

LESSON PLAN 1

Week Ending……………………………….

Reference: GES. (2007). *Curriculum for designated science and mathematics teacher training colleges*. Accra: Teacher Education Division.

Subject: Integrated Science

Level: 200

Topic: Identification of specimens.

General Objectives: To acquire basic practical skills

Day/Date:……………………………………….. Duration: 1 hour

Steps	Specific Objectives	Core Points	Teaching and Learning Materials	Teacher and Learner Activities	Evaluation
1. Recall of previous knowledge	Link students previous knowledge to new lesson.	Animals Wind Water	Mango, guava, coconut, seeds of pepper, tomatoes and	Students describe how seeds of pepper, mango, guava, cotton and coconut	Describe how the following are dispersed: Fruits or seeds

			cotton.	fruits are dispersed.	of pepper, mango, guava, cotton and coconut.
2. External features	Identification of Tridax	Small size Light weight Large surface area Parachute hairs	Tridax fruits	Students observe the external features of Specimen A. Students identify the name of the specimen A (Tridax). Students record and discuss findings.	What external features of the specimen did you use to identify the specimen A?
3. External features	Identification of coconut	Light weight Buoyancy Fibrous mesocarp	Coconut fruits	Students observe the external features of Specimen B. Students identify the name of the specimen B	Apart from specimen B being light weight, enumerate two other external features.

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				(Coconut). Students record and discuss findings.	
4. External features	Identification of mango seed	Adhesive structures Enzyme resistance	Mango seeds	Students observe the external features of Specimen C. Students identify the name of the specimen C (Mango fruit). Students record and discuss findings.	Identify any two differences between the external features of coconut fruit and mango seed.
5. External Features	Identification of cotton seed	Light weight Small size Parachute	Cotton seeds	Students observe the external features of Specimen D. Students identify the	What external features of the specimen did you use to identify the specimen D?

		hairs		name of the specimen D (Cotton fruit). Students record and discuss findings.	
6. Closure	Students summarises lesson. Students answer questions.	External features of tridax, coconut, mango and cotton seed.	Summary notes.	Students copy chalkboard summary and answer written questions.	Outline the external features of the following: (i) Tridax (ii) Cotton seed (iii) Mango fruit (iv) Coconut

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LESSON PLAN 2

Week Ending……………………………….

Reference: GES. (2007). *Curriculum for designated science and mathematics teacher training colleges*. Accra: Teacher Education Division.

Subject: Integrated Science

Level: 200

Topic: Drawing and labeling biological specimens

General Objectives: To acquire basic practical skills

Day/Date:……………………………………….. Duration: 1 hour

Steps	Specific Objectives	Core Points	Teaching and Learning Materials	Teacher and Learner Activities	Evaluation
1. Recall of previous knowledge	Link students previous knowledge to new lesson.	Longer axis Shorter axis	Longitudinal section of pawpaw Transverse section of	Students explain longitudinal and transverse sections.	Explain longitudinal and transverse

			tomatoes.		sections of specimens.
2. Longitudinal section	Drawing and labelling of longitudinal section of pride of Barbados flower.	Anther, Filament, Stigma, Style, Nectary tube, Ovary, Ovule, Petal, Sepal, Receptacle and Flower Stalk.	Pride of Barbados Flowers	Students observe the external parts of pride of barbardos flowers. Students identify the names of the external parts of the pride of barbardos flowers. Students cut the longitudinal section of the pride of barbardos flowers. Students identify the names of the internal	Draw and label the longitudinal section of pride of barbardos flowers.

				parts of the flowers. Students will draw and label longitudinal section of pride of barbardos flowers.	
3. Transverse section	Drawing and labelling of Transverse section of a dicotyledonous stem.	Sclerenchyma, vascular bundle, xylem, cambium phloem, collenchyma, parenchyma and endodermis	Stems of pepper plant.	Students cut thin layer of transverse section of pepper plant stem. Students mount thin layer of the stem on light microscope. Students observe and identify the names of the internal parts of the pepper stem.	Draw and label the transverse section of dicotyledonous stem of a pepper plant.

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				Students will draw and label transverse section of dicotyledonous stem of pepper plant.	
4. Closure	Students summarise lesson. Students answer question.	Longitudinal section Transverse section	Summary notes.	Students copy chalkboard summary and answer written questions.	Draw and label the longitudinal section of an apple and transverse section of an orange.

LESSON PLAN 3

Week Ending……………………………….

Reference: GES. (2007). *Curriculum for designated science and mathematics teacher training colleges*. Accra: Teacher Education Division.

Subject: Integrated Science

Level: 200

Topic: Classifying substances as acids or bases

General Objectives: To acquire basic practical skills

Day/Date:……………………………………….. Duration: 1 hour

Steps	Specific Objectives	Core Points	Teaching and Learning Materials	Teacher and Learner Activities	Evaluation
1. Recall of previous knowledge	Links students previous knowledge to new lesson.	Hydrogen ions / proton donor Hydroxide ions / proton acceptor	Lemon juice Ashes of plant	Students define acid and base.	Define (i) an acid (ii) base
2. Examples of acids and bases.	Classifying substances as acids or bases.	**Acids** — **Bases** Vinegar ——Milk of magnesia Aspirin _Soap Tomato juice —Baking Soda Groundnut oil — Sea water Palm oil _—Tooth paste	Litmus papers, palm oil, vinegar, tooth paste, sea water, aspirin, soap, milk of magnesia, tomato juice, baking soda, groundnut oil.	Students observe and identify some substances made of acids and bases. Students to classify the substances into acids and bases	With the aid of litmus paper, classify the following as acids or bases: pineapple juice, antiseptic (dettol), liquid in car batteries, blood, wood ashes,

				using the litmus papers.	Andrew liver salt and lemon juice.
3. Physical properties of acids.	Identification of physical properties of acids	Soluble Sour taste Blue litmus to red Corrosive pH less than 7	Samples of acids: Vinegar, aspirin and tomato juice.	Students perform activities to show physical properties of acids. Students record their findings for discussion.	Using experiments justify any two physical properties of acids.
4. Physical properties of bases.	Identification of physical properties of bases	Bitter taste Soapy feel Red litmus to blue Corrosive pH greater than 7	Samples of bases: Sea water, tooth paste and soaps.	Students perform experiment to show physical properties of bases.	Demonstrate any two activities to show the physical properties of base.

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				Students record their findings for discussion.	
5. Closure	Students summarise lesson. Students answer questions	Physical properties	Summary notes.	Students copy chalkboard summary and answer written questions.	Compare and contrast physical properties of acids and bases.

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LESSON PLAN 4

Week Ending……………………………….

Reference: GES. (2007). *Curriculum for designated science and mathematics teacher training colleges*. Accra: Teacher Education Division.

Subject: Integrated Science

Level: 200

Topic: Measurement (Using Micrometer Screw Gauge)

General Objectives: To acquire basic practical skills

Day/Date:……………………………………….. Duration: 1 hour

Steps	Specific Objectives	Core Points	Teaching and Learning Materials	Teacher and Learner Activities	Evaluation
1. Recall of previous knowledge	Link students previous knowledge to new lesson.	Thickness	Micrometer screw gauge	Students mention instrument for measuring the thickness of coins and rings.	What instrument is used to measure the thickness of coins?
2. External parts of micrometer screw gauge.	Draw and label the parts of micrometer screw gauge	Anvil, spindle, sleeve, thimble, frame and ratchet.	Micrometer screw gauge	Students observe and identify the names of the external parts of micrometer screw gauge. Students to draw and label the parts of micrometer screw gauge.	Draw and label the parts of a micrometer screw gauge.
3. How to use the micrometer	Measure the thickness of	Main Scale reading Vernier Scale reading	Micrometer screw gauge, coins and	Students demonstrate how to use the	Measure the thickness of the following objects

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screw gauge.	objects using micrometer screw gauge.		rings.	micrometer screw gauge for measuring. Students determine the thickness of coins and rings using micrometer screw gauge. Students record and discusses findings.	using the micrometer screw gauge: keys, coins, cups and rings.
4. Closure	Students summarise lesson. Students answer questions	External parts. .	Summary notes.	Students copy chalkboard summary and answer written questions.	Plan an activity to show how you will measure the thickness of a drinking glass using micrometer screw gauge.

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LESSON PLAN 5

Week Ending……………………………….

Reference: GES. (2007). *Curriculum for designated science and mathematics teacher training colleges*. Accra: Teacher Education Division.

Subject: Integrated Science

Level: 200

Topic: Measurement (Using Vernier Callipers)

General Objectives: To acquire basic practical skills

Day/Date:……………………………………….. Duration: 1 hour

Steps	Specific Objectives	Core Points	Teaching and Learning Materials	Teacher and Learner Activities	Evaluation
1. Recall of previous knowledge	Link students previous knowledge to new lesson.	Internal diameter External diameter	Vernier Callipers	Students state the instrument for measuring internal and external diameters of small objects.	What instrument will you use to determine the internal and external diameters of a drinking glass?
2. External parts of vernier callipers	Draw and label the parts of vernier calipers.	Outside jaws, sliding jaw, vernier scale and main scale.	Micrometer screw gauge	Students observe and identify the names of the parts of vernier callipers. Students to draw and label the parts of vernier callipers.	Draw and label the parts of vernier callipers.
3. How to use	Measure the	Main scale reading	Vernier Callipers,	Students demonstrate to	Determine the internal

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the vernier callipers.	thickness of objects using vernier callipers.	Vernier scale Reading.	rings and cups, tubes of different sizes.	use vernier callipers to measure the internal and external diameters of objects. Students determine internal and external diameters of rings and cups using vernier callipers. Students record and discuss results.	and external diameters of the following objects, using vernier callipers. Rings, cups and pipe tubes.
4. Closure	Students summarise lesson. Students	Internal diameter External diameter	Summary notes.	Students copy chalkboard summary and answer questions.	How will you use the vernier calliper to determine the external diameter of an object?

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	answer questions.				

APPENDIX II

Figure 1

Longitudinal Section of Pride of Barbados

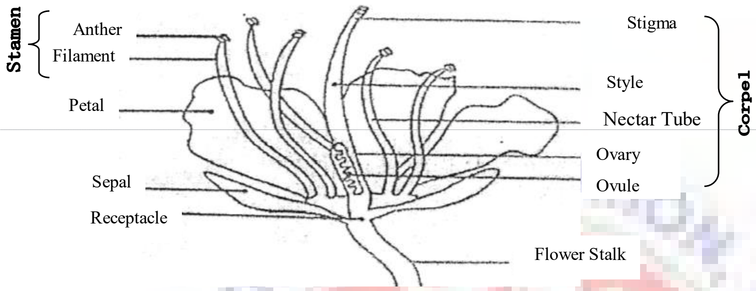

Figure 2

Transverse Section of a Dicotyledonous Stem

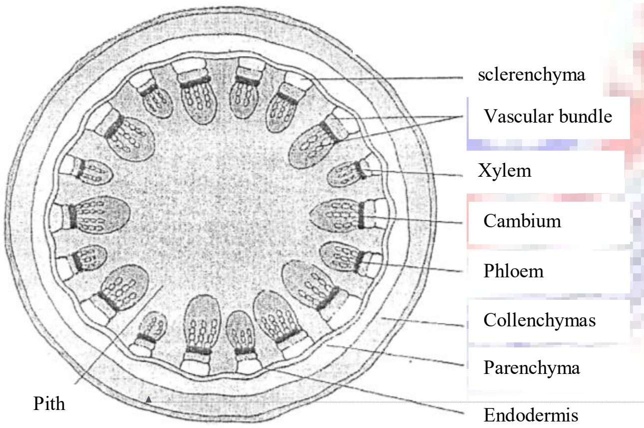

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Figure 3

Micrometer screw gauge

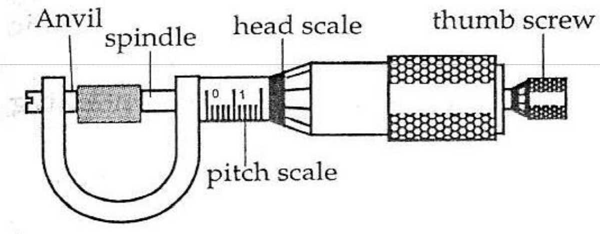

Figure 4

Vernier Callipers