UNIVERSITY OF EDUCATION, WINNEBA

USING PROBLEM-BASED TEACHING AND LEARNING APPROACH TO IMPROVE LABORATORY PRACTICAL SKILLS OF PRE-SERVICE SCIENCE TEACHERS IN E.P. COLLEGE OF EDUCATION, BIMBILLA

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF EDUCATION DEGREE IN SCIENCE EDUCATION

DECEMBER, 2018

DECLARATION

STUDENT'S DECLARATION

I, Wasila Abukari declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and that 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 of this work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR ERNEST I. D. NGMAN-WARA

SIGNATURE:………………………………..

DATE:……………………..

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Lastly, my deepest love and gratitude go to my husband Mr. Baba Yussif Abdulai and my children for their unfailing love, prayers and care. Thank you all.

DEDICATION

This thesis is dedicated to my parents, my husband and the entire family. All teacher trainees pursuing science programme at the E.P College of Education, Bimbilla are not left out.

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ABSTRACT

This study sought to improve laboratory practical skills of pre-service science teachers at the Evangelical Presbyterian College of Education, Bimbilla to enable them teach science lessons through practical mode. Action research design was used in the study. Level 200 pre-service science teachers constituted the sample of 82 who were drawn from the elective science class. The instrument used to correct data for study were attitude scale, semi structure interview and observation schedule. The attitude scale was used to correct quantitative data on pre-service science teacher's attitude to laboratory practical work whiles the observation scale and semi structure interview were used to correct qualitative data on pre-service science teachers acquisition of laboratory practical skills before and after the intervention. Analysis of the data was done using frequency and percentages for quantitative data obtained from attitude and observation scales. The findings of the study revealed that the pre-service science teachers did not have adequate knowledge in laboratory practical skills and that made them not to teach science through practical mode during their teaching practice. It was also observed that their exposure to laboratory practical skills was either inadequate or less effective. The study concluded that the pre-service science teachers were capable of teaching science effectively through practical mode if their exposure to laboratory practical lessons were intensified. The researcher therefore recommended that enough exposure on laboratory practical work should be given to pre-service science teachers through increase school-based laboratory practical sessions and attachment to science research departments where they can learn to improve their laboratory practical skills.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter presents the background to the study, statement of the problem, the purpose of the study, objectives of the study, research questions, and the significance of the study. The chapter additionally, presents the limitations and delimitations as well as the organization of the study.

1.2 Background to the Study

Sustainable development of countries all over the world depends on their advancement in science. Science and technology education is required to propel a country's development and not just education in the broadest sense (Rhoda, 2015). That is the reason why science is a building block for industrial development and bridges technology and socioeconomic development (Ekine & Abay, 2013). They further intimated that a country's ability to provide good health, fight diseases, protect the environment, produce food for its citizenry, develop new industries and technologies depends on the scientific knowledge and skills of its people.

Science education, in particular contributes a lot to human development in the areas of medicine, agriculture, environmental protection and food security. Moreover, it is important for students in their everyday life, in global competitiveness, resource utilization and environmental stewardship, in problem-solving skills, and understanding of the scientific methods (Fakhriyah, Masfuah, Roysa , Rusilowati, & Rahayu 2017). This can be realized when science education is given serious attention in the school curriculum especially in Africa. Updating the standard and quality of science education is essential to foster life-long learning of students leading them to global excellence in education.

The current philosophy of teaching science is an investigative, hands-on, minds-on and authentic learning experience (Gardiner, 1999). These involved practical activities which are experiences in the learning-teaching process where students manipulate materials and observe to understand the natural world. The activities include laboratory practical work, field trip and practical attachment to various research sectors and industries. Students improve their understanding of scientific concepts, inquiry skills and perceptions of science in the laboratory. Laboratory activities include laboratory demonstrations, hands-on activities, and experimental investigations (Hofstein & Lunetta, 2004).

Laboratory activity, here, is used to describe the practical activities which students undertake using chemicals and equipment in a laboratory. Practical activities are experiences in the teaching –learning process where students interact with materials to manipulate, observe and understand the natural world. Laboratory work is an active and interactive ways of teaching and learning method, and requires learners to be involved in observing or manipulating real objects and materials, have a distinctive and central role for the development of learners' understanding of scientific concepts, improving their cognitive skills, developing positive attitudes as well as stimulate learners to greater efforts of achievement. Laboratory activities have had a distinctive and central role in the science curriculum and science educators have suggested that many benefits mount up from engaging students in science laboratory activities (Hofstein & Lunetta, 2004).

Many studies have been conducted about the importance of laboratory in science. Laboratory practical uses as primary means of instruction in science; gives opportunities for students' to manipulate equipment and materials; helps students to build confidence in their problem-solving abilities; maximizes their conceptual development; improve their academic performances (Aladejama & Aderibigbe, 2007). Moreover, laboratory practical values learning new skills and using new equipment, gives opportunity for students' social interaction, illustrates materials given in lectures and develops high interest (Collis, 2008). Also, laboratory practical maximizes students' learning achievement, preventing misconceptions, develop positive attitude towards practical activities, and build self-confidence and stimulates students to greater efforts of achievement (Tarhana & Sesen, 2010).

Science is essentially a laboratory activity oriented subject. Laboratory practical experiences are central goals to science education for the attainment of scientific proficiency. No course in science can be considered as complete without including practical work to it. Laboratory practical activities are experiences in the teaching and learning process where students interact with materials to manipulate, observe and understand the natural world (Hofstein & Mamlok-Naaman, 2007).

Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration setting. The laboratory work should successfully be used and effective in getting students to do what is intended, to promote conceptual change (Abraham & Millar, 2008). The knowledge of laboratory practical skills in science is very important for proper understanding of concepts in science and can be achieved through effective laboratory work. The acquisition of laboratory practical skills is not just putting of equipment and apparatus together, but it needs planning, designing a problem, creating a new approach and procedure through problem-based learning to facilitate the acquisition of practical skills. This implies that problem-based approach can be adapted to teaching and learning of laboratory practical skills to beginning science teachers by incorporating it into the regular laboratory component of the science course. Problem-based learning (PBL), a teaching and learning method founded in the medical sciences and first introduced in 1969, is becoming increasingly popular in other academic disciplines such as education, psychology and business.

The aim of Problem-based approach is to develop self-directed, reflective, lifelong learners who can integrate knowledge, think critically and work collaboratively with others, thus enhancing the chances of students emerging from the College of Education with some of the skills that are highly desirable in the teaching and learning process. Furthermore, by using unstructured real-life problems rather than the content as the focus, students are given opportunities to really learn how to learn (San Tan 2005) and apply it in their teaching situation.

To improve the practical skills of pre-service science teachers, it is highly necessary to tackle the problem from the perspective of developing the students' practical and transferable skills, as well as their content knowledge and scientific understanding, but it is equally important to build students' capacity in the science laboratory practical skills and good teaching strategies at the Colleges of Education in Ghana to teach the subject effectively from the scratch of the education system.

1.3 Statement of the Problem

Pre-service science teachers at the Colleges of Education need to be acquainted with appropriate teaching and learning strategies to put them in a better position to take up the challenge to teach science through practical mode in science education.

The Evangelical Presbyterian College of Education in the Nanumba North District in Ghana offers science bias teacher training programmes. Generally, pre-service science teachers at E.P College of Education, Bimbilla, demonstrated poor manipulative skills, inactive participation in laboratory practical work and fail to teach science through practical mode during their teaching practice. What makes this a serious challenge is not just the failure to teach science through the practical mode, but they resist teaching the science subject during on campus teaching practice as well as teaching attachment programmes. They may skip topics that require practical work to the disadvantage of pupils where supervision is weak. It is for this reason that this study used Problem-Based Approach in science teaching and learning to improve the laboratory practical skills of pre-service science teachers in E.P College of Education, Bimbilla.

1.4. Purpose of the Study

The purpose of the study was to use Problem-Based Teaching and Learning Approach (PBL) to improve laboratory practical skills of pre-service science teachers of Evangelical Presbyterian College of Education, Bimbilla.

1.5 Objectives of the Study

The objectives of the study were to:

1. Find out the causes of pre-service science teachers' poor laboratory practical skills.
2. Use problem-based teaching and learning approach to improve laboratory practical skills of pre-service science teachers of E P College of Education.

1.6 Research Questions

This study sought to answer the following questions:

1. What are the causes of poor laboratory practical skills among pre-service science teachers of E P College of Education?
2. To what extend will the use of problem-based teaching and learning approach improve the laboratory practical skills of pre-service science teachers of E P College of Education?

1.7 Significance of the Study

The governments of Ghana and development partners have done a lot by way of interventions to support science education over the years. A lot of resources have gone down the drain with a little or no serious impact on quality teaching and learning in science education at most of the educational levels in Ghana. There is therefore the need to re-examine some of the factors that lead to the inadequate laboratory practical skills of pre-service science teachers at higher levels of education in Ghana.

The relevance of the study stems from the fact that, pre-service science teachers' acquisitions of laboratory practical skills affect their teaching styles and their performance in teaching practice component of the college programme. Therefore, findings of the study will contribute to guiding the college authorities to make sound and vibrant policies in areas such as science curriculum materials and infrastructure, organize workshops to build science tutors capacities and make the college environment more science friendly.

By using the problem-based approach to teaching science, the acquisition of laboratory practical skills and their incorporation into the teaching practices of trainee teachers in science is expected to increase and their achievement levels in science greatly improve. The study would also add to the body of knowledge or literature in science.

1.8 Limitations of the Study

Ideally, Colleges of Education offering science programmes should be targeted for a study like this. Time and the cost implications prevented extension of the study to other colleges in the Northern Region. Therefore the results would strictly be applicable to the Evangelical Presbyterian College of Education, Bimbilla.

1.9. Delimitation

The study was delimited to the Evangelical Presbyterian College of Education in the Nanumba North Municipal of Northern Ghana**.** Elective science students at all levels in the school participated in the study which focused on improving acquisition of laboratory practical skills through problem-based instructional approach.

1.10 Organization of the Study

The research was presented in five chapters. Chapter one presented the background to the study, statement of the problem, purpose of the study, significance of the study, objectives, research questions, limitations, delimitation and organization of the study.

The second chapter constituted the review of related literature on the subject. Chapter three dealt with the methodology of the study which comprised of design of the study, population, sample and sampling techniques used data collection instruments and the procedures for analyzing the data. Chapter four was to the results while chapter five contains summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter presents related literature on the subject of study. The literature review is specifically on improving the laboratory practical skills using problem-based approach in teaching and learning of science, assessment of using laboratory practical approaches and various learning environment for teaching science, and measures of ensuring that practical work forms the basis of effective teaching of science by pre-service science teachers.

2.2. Laboratory Practical skills and Science Teaching

Generally, laboratory exercises require practical skills. According to Hofstein (2004), a practical work in science education is an activity used to engage students in investigation, discoveries, inquiries and problem solving activities and is the center of science teaching and learning. Laboratory practical work is not new in science and technology education. It forms the basics of teaching science and eventually leads to acquisition of practical skills especially to young learners.

Laboratory practical work as used in science education literature refers to any type of science teaching and learning activity in which students, working either individually or in small groups, are involved, as an important element of what they are doing, in manipulating and/or observing real objects and materials. Most of these science education literatures ruled out the use of virtual objects and materials including video materials, a computer simulation or textbooks materials from the context of laboratory practical work or skills in science education and practice. In this regard, five groups of objectives that may be achieved through the use of the laboratory in science classes are:

1. **Skills:** that includes manipulative, inquiry, investigative, organizational, and communicative.

2. **Concepts:** for example, hypothesis, theoretical model, taxonomic category

3. **Cognitive abilities:** critical thinking, problem solving, application, analysis, synthesis

4. **Understanding the nature of science:** scientific enterprise, scientists and how they work, existence of a multiplicity of scientific methods, interrelationships between science and technology and among the various disciplines of science.

5. **Attitudes:** for example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, collaboration, and liking science. Silvestrone (2005) however stated in support of learning objectives in science that the quality of an examination increases when learning objectives are constructed in depth, clearly communicated, and applied throughout examination administration and grading.

Similarly, laboratory practical work takes place in a wide range of science courses. Practical works are some sorts of learning exercises in a laboratory, but this view can be extended to include fieldwork, museum or gallery visits, placement and work. Experiential learning theorists are with the view that students learn conveniently and efficiently by 'doing' than by 'listening' (active rather than passive learning) and this is a major strength of learning in the field where students are involved in project planning, problem-based learning, data collection and analysis. Therefore, practical work forms an essential part of the learning experience for pre-service science teachers. It enhances both their subject-specific and generic skills that will be of value throughout their college lives and the teaching profession.

According to Yadav and Mishra (2013), no course in science can be considered as complete without including some practical work in it. This makes clear that science as a field of study should be learnt through experimental method. Millar, Tiberghien and Marechal (2002) classified practical tasks into four groups. These are illustration (of theory), exercise (to practice standard procedures), experiences (to give students a 'feel' to phenomena) and investigation (to allow students to experience scientific enquiry).

Several studies have been conducted on the role of laboratory practical work in science (Hofstein & Lunetta, 2004). Laboratory practical work is used as primary means of instruction in science. It gives opportunities for students to manipulate equipment and materials, helps students to build confidence in their problem-solving abilities (Tarhana & Sesen, 2010). Domin (2007) holds the view that laboratory practical work maximizes students conceptual development whilst Gobaw (2016) asserted that it develops their academic performance.

The fundamental purpose of laboratory practical activities in school is therefore to help science students make links between the real world of objects, materials and events, and the abstract world of thought and ideas. The laboratory has been given a central and distinctive role in science education, and science educators have suggested that rich benefits in learning accrue from using laboratory activities. It is probably in the light of this that Tiberghien (2000) described practical work as trying to help students make links between two ‘domains’ of knowledge: domain of objects and observables and the domain of ideas.

Also, laboratory practical work in science places value on learning of new skills and using new equipment. This gives opportunity for students social interaction illustrates materials given in lectures, discussions, theories and develops high interest and attitude; and stimulates students to greater efforts of achievement. Wigfield and Cambria, (2010) carried out a study to determine learning outcomes by measuring students’ academic performance and their skill in laboratory work, classification of species and writing research proposals. Their view is that the results from their studies showed that students enrolled in both lecture and laboratory courses performed better in classification of species, research study design, proposals writing and in essay writing as compared to students taking lectures only.

However, few studies have claimed that several issues constitute a setback on implementation of the laboratory work. For example, Di Trapani and Clarke (2012) indicated that, the laboratory activities largely focus on illustrating concept and the delivery of information because of several factors. Among the factors are equipment and other resource constraints, large groups size, lack of sustained and repeated exposure to given practical skills and experimental techniques, poor organizational and time management, and variations in instructors skills in teaching the laboratory teaching and learning.

To equip the pre-service science teachers with laboratory practical skills important in their teaching profession, laboratories should be efficiently used by tutors and students, and tutors themselves should possess these skills. Also, modern approaches to the teaching and learning of science such as problem-based learning (PBL) need to be adopted by both tutors and pre-service teachers to enhance the acquisition of laboratory practical skills. Therefore, consideration in the process of developing and evaluating a laboratory work task is important (Selccedil, 2010).

2.4 Benefits of Laboratory Practical Work

Many studies have been conducted about the importance of laboratory. When laboratory practical is used as primary means of instruction in science, it gives opportunities for students to manipulate equipment and materials. It also helps students to build confidence in their problem-solving abilities and maximizes their conceptual development (Domin, 2007). Aladejana and Aderibigbe (2007) indicated that it develops students' academic performances and values for learning new skills, and for using new equipment. This gives opportunity for students' social interaction; illustrates materials given in lectures and develops high interest. This is corroborated by the findings of Coll (2008) that it maximizes students' learning achievements, preventing misconceptions, develop positive attitude towards practical activities, and build self-confidence. Tarhana and Sesen (2010) noted that practical work stimulates students to greater efforts of achievement. According to Wambugu and Changeiywo (2008), students are facing many emerging issues, such as emergence of new drug resistant diseases, effects of genetic experimentation and engineering, ecological impact of modern technology, global warming, famine, poverty, health issues, population explosion, and other environmental and social issues. To overcome the challenges, students need to be equipped with the 21st century skills in science and technology education to address the challenges. Students should be global citizens that recognize the critical need for the developing 21st century skills. Thus higher education graduates today, more than ever, need a basic understanding of science and technology in order to function effectively in an increasingly complex and technological society.

According to Chabalengula, Mumba, Hunter & Wilson (2009) Science education comprises six domains: cognitive, psychomotor, affective, application, creativity and nature of science. The cognitive domain of science includes products, such as scientific laws, principles and theories. The psychomotor domain, include practical skills, or science process skills, such as observation, manipulation of equipment/materials (assembling, measuring, and experimenting), classifying, communicating, inferring, predicting, identifying and controlling variables, interpreting data, and formulating hypotheses.

The affective domain is primarily associated with explorations of human emotions, such as expression of personal feelings, decision making about personal values and about social and environmental issues. The application domain requires students to transfer what they have learned into practical situation, especially in their own daily lives. The creativity domain is essential to science as it is used by scientists in generating problems and hypothesis and in the development of plans of action.

This explains why science educationists have taken their time to establish what constitute problem-based approaches to guide and improve the laboratory practical skills of students as well as pre-service teachers particularly in the context of this study.

2.5 Effectiveness of Laboratory Practical Activities

The effectiveness of laboratory work is useful to consider in the process of developing and evaluating a laboratory work task (Millar, 2002). Sutman, Schmuckler and

Woodfield (2010) maintains that high quality and appropriate practical work is central to effective learning in science and it is a key factor in engaging, enthusing and inspiring students, thus stimulating lifelong interest in science. To equip students with practical skills important in their future careers; laboratories should be efficiently used by teachers and students, and teachers themselves should possess these skills. However, planning and carrying out practical work and assessment abilities in practical work were completely neglected in Ethiopia because the instructors themselves do not have the necessary practical skills to organize, carry out and evaluate investigative science activities (Bekalo & Welford, 1999).

According to Millar, Tiberghien and Le Maréchal (2002) the teachers objectives (what the students are intended to learn from the task) and the task design (what the students are intended to do) are influenced by teachers views of science and learning, and by practical and institutional factors such as the resources available, the requirement of the curriculum, its mode of assessment, and so on. What the students actually do on the task and what they actually learn are influenced by the students' views of science and of learning, and by practical and institutional settings. Hofstein and Lunetta (2004) stated that the learning environment depends markedly on the nature of the activities conducted in the laboratory, the expectations of the teachers (and the students), and the nature of assessment, the materials, apparatus, resources, and physical setting, the collaboration and social interactions between students and teachers, and the nature of the inquiry that is pursued in the laboratory.

An effective laboratory environment requires teachers' preparation and planning: students' conceptual pre-knowledge about the experiment; environment to use and reinforce such knowledge; usage of basic and higher-level science process skills;

establishment of links between the subjects taught in classroom and laboratory and students' daily lives; and the maintenance of laboratory safety and safety awareness among students (Feyzioğlu, 2009).

Lunetta, Hofstein and Clough (2007) have listed numerous factors which should be considered to alleviate the associated problems in designing and implementing student-based laboratory experiments.

These include learning objectives, instructions provided by the teachers and the laboratory guide, materials and equipment available, the nature of the activities, student–student and teacher–student interactions during the laboratory work, how performance and laboratory reports are to be assessed, the preparation, attitudes, knowledge, and behaviors of the teachers.

Toplis (2012) concluded in their assessment of practical work that since practice in school is led by assessment pressure, if there is a desire for teachers to re-focus some of the time spent in doing laboratory practical work on developing useful practical skills for further study and employment, then it is essential that such skills are formally included in the summative assessment process. They suggested a balance between laboratory practical skills and augmentation of knowledge and understanding of substantive concepts as important line with campaigns being organized for Science and Engineering around 2011 in the United Kingdom to ensure that students have the necessary science practical skills to enter the workplace.

The question that needs to be answered is, do science teachers use practical work in their teaching? This is problematic across the globe but more pervasive in developing countries (Abraham & Reiss, 2012).

Other researchers however observed that, in science, laboratory practical work is central both to the appeal and effectiveness of science education and to the development of practical skills that will be of use in Higher Education and/or the workplace. Abraham and Reiss (2008) reported that the UK, the House of Commons Science and Technology Committee in 2002 concluded that practical work, including fieldwork, is a vital part of science education as it helps students to develop their understanding of science, appreciate that science is based on evidence and acquire hands-on skills that are essential if students are to progress in science. This is based on the idea that the use of practical lessons in the formative years of the child is essential to laying solid founding for the child in education. This thinking is corroborated by the theoretical positions on learning by various educational philosophers such as the pragmatists, empiricists and existentialists.

2.6 Teachers' Experiences

There is debate about the causal relationship between teachers' experiences and students' achievement. Few studies indicate that the effect of teacher experience is not significant predictor on student performance (Haider & Hussain, 2014; Liu, Lee & Linn, 2010). For example, Haider and Hussain (2014) showed that there is weak and negative weak relationship between the teacher factors, such as assessment interval, communication language, the distance of residence, and the teacher's personal characteristics (gender, age, academic and professional qualification, designation, experience, and in-service training), and student achievement in English, Chemistry and Mathematics. Similarly, Zhang (2008) stated that science teachers possessing of advanced degrees in science or education significantly and positively influenced student science achievement but years of teaching experience in science do not directly influence student science achievement.

However, the majority of studies indicate that the effect of teacher experience on student achievement is the greatest in the first few years (Clotfelter, Ladd & Vigdor (2007). Nunnery, Kaplan, Owings and Pribesh (2009); Richardson (2008) , and Lewis (2006) suggests that the extent to which teachers realize the potential for change depends on the types of support and professional development on curriculum and subject matter knowledge that they are offered. The teachers would have benefited from structured support and professional development which specifically addressed their personal and professional needs. These needs included guidance on how students find their way through the course, explanations of how particular activities were expected to achieve a particular purpose, guidance on how to manage these new practices and guidance on the potential needs of their students and ways in which they could support their students through the changes. Dial (2000) carried out a study to examine whether years of teaching experience and a teacher's degree level have an effect on overall achievement of students on the communication arts and mathematics sections of the Missouri Assessment Program.

The results indicated teacher degree level alone had no effect on student achievement but years of experience, as well as the interaction between years of experience and degree level, had an effect on student achievement in both communication arts and mathematics. Clotfelter et al. (2007) concluded that a teacher's experience, test scores and regular licensure all have positive effects on student achievement. Gobaw (2016) recommends that biology educators and technical support staff require training to be competent and confident to respond positively to the unpredictability of working with biological material and embrace the opportunities afforded by the breadth of the biosciences because they are vital contributors to the progress of science.

2.7 Science Teachers' Attitudes towards Laboratory Work

Michael (2014) observed that Science teachers contribute to the overall education of students, and that, they need some moderately well-formed view of what education is, and the goals it should be pursuing. Teachers and administrators need some conception of an educated person, as this forms the core of their individual classroom teaching and policy development. Matthews (2008) noted further that,

> "The conviction that the learning of science needs to be accompanied by learning about science is basic to liberal approaches to the teaching of science. If students do not learn and appreciate something about science, its history, its interrelations with culture, religion, worldviews, and commerce, its philosophical and metaphysical assumptions, its epistemology and methodology, then, the opportunity for science to enrich culture and human lives is correspondingly minimized".pp1-26.

This implies that the teaching of science must be accompanied with understanding of its processes and purposes for it to be used to support national development.

Monare (2010) studied that the attitudes of teachers towards the aims of science laboratory work can be affected by the availability of well- equipped laboratories, adequacy of laboratory equipment and years of teaching experience. However, they found that there was no difference in educational level and gender of teachers regarding to their attitudes towards the aim of science experiments. The teachers consider experiments to improve students' manipulative and cognitive skills and to develop sense of cooperative skills among students as the other important ones. Based on the findings, they concluded that the availability of well-equipped science laboratory affects teachers' attitudes towards aims of science experiments positively. According to Abudu, and Gbadamosi (2014), attitudes of teachers teaching chemistry in senior secondary schools have significant effect on the achievement of students in chemistry as one of the science subject. Festile (2017) observed that more emphasis is placed on lectures and discussions even where the intention is to guide learners to acquire practical skills. He noted further that Science is usually presented as a rigid body of facts, theories to be memorized and practiced rather than a way of knowing about natural phenomena.

2.8 Students' Attitudes towards Laboratory Work

Science experiments develop students' observational skills. Nakanyala (2015) found that practical teaching techniques are perceived by science learners to be the most effective method but its utilization by teachers falls short of expectations.

According to Wood (2009) students' attitudes to practical work are influenced by the nature of their prior practical work. In addition, Kampourakis and Tsaparlis (2003) reported that only a small proportion of the students found the practical activity relevant/useful to the solution of the problems, and these students had a much higher achievement than the rest of the students. Luketic and Dolan (2013) on the other hand stated that students positive attitudes towards their laboratory work are influenced by the extent of their experiences in learning science and their perceptions are consistent amongst regular- and high-achieving students regardless of grade level.

Mathew concluded rather interestingly that history and philosophy of science should be part of pre-service and in-service science teacher education programs because science teachers need to broaden their scope so they can engender critical thinking in their learners. To support Mathew's concluding note, pre-service science teachers need to broaden their scope so as to engender today's valuable skills such collaboration, communication, problem solving/decision making in their learners and to improve upon their attitude and professional best practices.

2.9 Students' Prior Background

Higher education admissions officials typically use higher education entrance examination scores on university entrance to predict an applicant's probability of academic success in the universities. Moreover, employers use cumulate grade point average of the students as main selection criteria. Research shows that undergraduate students' performance depend on many factors such as availability of learning resources, gender, age, socioeconomic status of the students (Rockoff, 2004). Yet, there is little evidence on the relationship between students' theory and practical skill performance.

A study conducted by Musasia, Abacha and Biyoyo (2012) equally showed that there is a statistically significant relationship between students' theory and practical performance scores. Ejidike, and Oyelana (2015) reported that there are significant differences between students' performances in physics theory and practical; between female Physics theory and practical and also between male Physics theory and practical. On the other hand, there is no relationship between students' achievement in theory and practical work scores (Gobaw & Atagana, 2016). Akanbi and Usman (2014) also hold the view that there is no relationship between physics student performance in micro-teaching and that of teaching practice. Several studies have been carried out to examine the relationship between students' high school background and university course achievement. But there is still a debate among researchers. For example, Sadler and Tai (2001) have shown that high school physics course has a positive relationship with the grade earned in introductory college physics. Karemera, Reuben and Sillah (2003) showed that high school achievement is significantly correlated with college performance. A study conducted by Tai, Sadler and Loehr (2005) to examine the link between high school chemistry pedagogical experiences and performance in introductory college chemistry showed that several high school pedagogical experiences are linked with varying levels of performance in college chemistry.

Noble and Radunzel (2013) stated also that academically underprepared students have to spend more time and money taking remedial courses in college, earn lower grades and have lower retention rates. Geiser and Santelice (2007) have suggested that high school grades are the best predicators of academic performances. Adeyemi (2008) showed also that the Junior Secondary Certificate Examinations were a good predictor of performance at Senior Secondary Certificate Examination.

Sawyer (2008) found that high school course work and high school grades are related to achievement test (ACT) scores and encouraging students to take more rigorous college-preparatory courses help to earn higher grades in these courses. Loehr, Almarode, Tai and Sadler (2012) studied the association between students' high school science education and mathematics experiences with introductory college biology the final course grade in introductory biology courses. The result showed that advanced high school science and mathematics coursework was positively associated with students' achievement in introductory college biology.

On the other hand, Wang (2013) claimed that there is little connection between mathematical educational knowledge and the educational background. Tai et al. (2005) stated that overemphasis on laboratory procedure in high school chemistry was associated with lower grade in college.

There is also a debate that practical skill test scores varies among sexes. For example, Ochonogor (2011) showed that there is a significant difference in performance level between male and female undergraduate biology students in that the female students perform significantly better than the males. However, Achor, Kurumeh, and Orokpo (2012) showed that male and female students' performances in a test of theoretical knowledge in chemistry do not significantly predict their performance in Senior Secondary Certificate Chemistry theory examination. Jack (2016) argues also that sex does not influence students' acquisition of laboratory practical skills. However, none of the studies have examined thesis variables to determine the relationship between undergraduate biology students' prior secondary and college preparatory school biology laboratory back ground and their undergraduate laboratory skill performance. Hence, it is important to establish if there is correlation between prior back ground in biology laboratory at secondary and preparatory schools and the biology laboratory skill performance test scores.

2.10 Problem-Based learning and Laboratory Practical Skills

Problem-based approach sees a shift in educational focus from a teacher-centred approach to teaching and learning to a student-centred one, where students construct meaning for themselves by relating new concepts and ideas to previous knowledge. It is an alternative approach to teaching and learning, which encourages active involvement of the learner (Sen Tan, 2006). As a learner-centred method that challenges the learner to take a progressively increasing responsibility for his or her own learning, PBL is therefore consistent with the constructivist theory. Furthermore, it also draws from another aspect of constructivism, which is to do with learning through social interaction, which recognizes the impact of others' ideas on the way learners make sense of things (Harlen, 2005).

Sharpe (2012) postulated that the use of problem based approaches and skills in teaching science plays very significant roles in teaching science at all levels of education. Science laboratories have very important role in the education system for pre-service science teachers to bring rapid and significant advancement to the teaching and learning of science and the society.

Problem-Based Learning can be an effective teaching approach to support students' learning for critical thinking and problem solving. Promoting problem-based learning in the laboratory empowers the students to take these trained skills and develop problem solving abilities. Hence, laboratory works provide excellent opportunities to incorporate problem-based teaching and learning in to the curriculum. Problem - based science laboratory instruction improves scientific skills and critical thinking (Tessier, 2010).

Problem-based learning (PBL), a teaching and learning method sees a shift in educational focus from a teacher-centred approach to teaching and learning to a student-centred one, where students construct meaning for themselves by relating new concepts and ideas to previous knowledge. It is an alternative approach to teaching and learning, which encourages active involvement of the learner (Seng Tan, 2004). As a learner-centred method that challenges the learner to take a progressively increasing responsibility for his or her own learning, PBL is therefore consistent with the constructivist theory (Kelly & Finlayson, 2007). Furthermore, it also draws from another aspect of constructivism, which is to do with learning through social interaction, which considers the impact of others' ideas on the way learners make sense of things (Harlen, 2005).

The aim of PBL is to develop self-directed, reflective, lifelong learners who can integrate knowledge, think critically and work collaboratively with others thus, enhancing the chances of students/pre-service science teachers emerging from College with some of the skills that are highly desirable in the teaching and learning process and other work places. Furthermore, by using unstructured real-life problems rather than the content as the focus, students are given opportunities to really learn how to learn (Seng Tan, 2004).

Mungin (2012) stated that PBL provides an alternative to traditional education: according to him, in principle, PBL reverses traditional education by putting the problem first and using it to motivate learning. By using real-world problems, PBL enables students to see the relevance that they often miss in other contexts. The promise of PBL was that students would learn better, understand what they learned, and remember longer by working cooperatively in groups.

In PBL, the problem, as the focus of the learning, is purely an ill-structured, complex one, with no clear 'right answer'. This provokes extended collaboration among groups, leading to conceptual learning. Students automatically have to activate their prior knowledge in order to start thinking about the problem confronting them, and build it into new knowledge, which is the basis of constructivism. This has been noted to facilitate learning (Exley & Dennick, 2004).

Laboratory classes typically involve students performing teacher-structured laboratory exercises or experiments. Each step of a procedure is carefully prescribed and students are expected to follow the procedures exactly. Usually, little is left to the students' own thought or ingenuity. This type of laboratory activity is usually termed as a recipe laboratory. The technique requires little student engagement with the content. Students can be successful in their laboratory class even with little understanding of what they are actually doing. However, the student may have little choice but to adopt this passive approach while they grapple with new techniques and equipment, especially when the preparation for the laboratory has involved no more than reading the laboratory manual.

At this stage, it is important to highlight the expense of running laboratory sessions in schools. Firstly, specialized laboratory space is costly to build, equip and maintain. Secondly, it requires technical and academic staffing, as well as postgraduate demonstrators. Laboratory work is also time-consuming, and finally, there is ongoing expense of consumable chemicals and apparatus. The question is raised as to whether the students are deriving maximum benefit from these laboratory sessions, and if the typical recipe lab format can be justified in the context of such expense.

In recipe laboratory, the activity is predetermined with demonstrators, technicians, and staff all clearly knowing what is expected to happen. Therefore, errors can be clearly identified by the teaching staff and rectified for the students before they continue with the laboratory work, with the result that students get little experience of problem-solving in the laboratory. Additionally, all the students are generally carrying out the same experiment and this can lead to students only being concerned with getting the same result as their laboratory neighbor.

However, recipe laboratories have the great advantage that they allow the inexperienced student to take the same attitude to laboratory work as is taken by the professional scientist: the recipe allows the student to devote all his or her attention to the technique and not to worry at all about theory. They get direct opportunities to develop manipulative and technical skills. This maximizes the quantity of practical experience gained by students, and the quality of the results they can potentially obtain.

Conversely, the students are not concerned with matching their learning in the laboratory to previous experience. They consolidate their learning by asking themselves what is going on in their own heads unlike the researchers and professional scientists who are doing the laboratory work for a particular purpose, which has meaning for them. The other problem with recipe type laboratory is that the actual practical aspect of any experiment represents only a small part of the whole process of experimental science while in recipe laboratory the practical aspect is all that is covered.

It is clear from the foregoing that recipe laboratory have their advantages, and with modifications, could be much more effective in teaching and learning science, which forms the bases and focus of this study. Incorporating student ownership, relating experiments to previous experiences, and getting students to use higher order cognitive skills would provide authentic investigative processes. Laboratory sessions should provide students with the opportunity to hypothesize, explain, criticize, analyze, and evaluate evidence and arguments. Kelly and Finlayson (2007) suggested that problems act as the context and driving force for learning, and that the acquisition of new knowledge is done through these contexts. PBL differs to the familiar case-based or problem-solving approaches since in PBL the problems are encountered before all the relevant knowledge has been acquired.

There are however, a number of implementation issues that must be addressed. Woods (1997) listed the main issues with implementation of a PBL approach into a traditional chemical engineering lecture course as follows:

1. Preparing the students with the required skills
2. Students must be willing to take charge of their own learning and to cope positively with the attitudinal shifts that occur when they experience change
3. Empowering the students to be their own facilitators
4. Selecting and preparing teachers to operate in PBL courses (called the facilitators)
5. Student attendance and participation
6. Choosing and formulating the problem, preparing resources
7. Creating the student groups

The researcher therefore took in to account the issues raised above in conducting this studies since the experiences and behavior of the pre-service science teachers being studied are similar to what Wood has noted.

With respect to point 4, in general the facilitator is not there to provide answers to students' questions but to guide the groups in their discussions as this study sought to do. This can be a difficult activity to engage in, and PBL facilitators require training and continuing support to ensure that their role helps the group to function optimally (Exley & Dennick 2004). According to Kelly and Finlayson (2007) problem-based approach in laboratory practical work ensures that the students still get experience with all the key instrumentation and techniques, and cover similar science concepts. In fact, they reported that, the actual experimental method employed in solving problems in problem–based learning is very similar to the procedure followed in the traditional laboratory.

The development of skills, both general and technical, chemical concepts, knowledge and understanding are the core aims of the Problem-Based Learning (PBL). This can however be achieved through an alternative teaching and learning environment combining pre-laboratory work, group work, discussion, practical work and alternative assessment. The development of the problem-based laboratory practical work is to reflect on the desired learning outcomes in terms of skills and scientific method that should be developed from laboratory work. The range of skills that should be developed through laboratory practical work includes: confidence in laboratory work, recording skill, data manipulation, observational skills, team work, Communication/presentation, problem-solving and awareness of safety.

Skills, such as technical and observation skills, confidence in practical work, and data collecting are integral parts of most laboratory sessions; however, what of skills such as data interpretation, problem-solving, team-work and communication of findings? Many of these elements are missing in the traditional laboratory practical work. It is therefore, necessary to adapt the PBL that would afford students the opportunity to develop and use all the skills listed above.

What is very important for science teachers as far as PBL is concerned is designing the teaching and learning environment to include pre-laboratory work, group work, discussion and alternative assessment. Pre-laboratory session is used before the laboratory work to prepare the mind of the learner. The elements of an effective pre-laboratory exercise include: revision of theory, re-acquaintance with skills, planning the experiment to some extent and discussion with peers.

Problems in PBL can be introduced with mini lectures, similar to the form of pre-laboratory sessions used in research work. Similarly, Small-group co-operative learning, individuals can pursue their own learning needs within the context of the group, referring to others for support, feedback, and validation. Much learning occurs from interactions between group members; provided it is appropriately structured to allow discussion and consideration of different points of view. Group work both in and out of the laboratory is an integral part of PBL.

Alternatively, discussion which is defined as a wide range of informal situations where talk between people occurs can be used to make PBL effective. Specifically, it refers to a particular form of a group interaction where members join together to address a question of common concern, exchanging different points of view in an attempt to reach a better understanding of the issue. Again, discussion both before the laboratory practical class and during the pre-laboratory session is encouraged in PBL.

Nicol and Boyle (2003) have shown that students discussing concept questions in small groups not only enhanced their conceptual understanding, but it also proved to be a powerful motivating force. They also reported that students showed a preference for thinking about the problem prior to the discussion; as it forces each individual to think about the problem and formulate their own reason for their selected answer, prior to the group discussion. The practice also motivates the students as they feel that they benefit more from the future peer discussion. This makes them more likely to engage in dialogue and to provide reasons for, and defend their ideas just as they are able to identify gaps in their thinking and the thinking of their peers.

Many advocates of PBL promote the use of oral presentations in various disciplines Allen and Tanner (2003) reported the use of poster presentations in laboratory practical work. Wimpfheimer (2004) on the other hand, described the benefits of posters, including the fact that it encourages creativity and provides another platform for reaching students who perhaps have been overlooked in the traditional laboratory work. Also posters, because of their limited size, stress the importance of clear and concise information and can encourage collaborative work in a way than written laboratory reports. Moreover, a positive attitude toward posters is developed both by students and instructors in practical laboratory work.

Finally, written reports are still encouraged and have its advantages, including the fact that it draws together the method and results and enables students to report, analyse and draw conclusions in a concise and informative style. Therefore, written reports are an integral part of PBL, however, the emphasis is on the conclusions that the students have to draw from their results, and how these related to the original problem they were given.

With these as a motivation for enhancing the laboratory practical skills and experiences for our pre-service science teachers, our traditional laboratory approach to instruction, a typical recipe-type laboratory approach with written laboratory reports as the assessment, was analyzed, adapted, and a PBL incorporated to improve the laboratory practical skills and experiences of the pre-service science teachers at E.P. College of Education.

2.11 Summary

This chapter discusses the review of related literature. The chapter starts with a brief explanation of the laboratory work and its role in science education in general and in chemistry education in particular. It also focuses on assessment of laboratory work, problem-based learning and laboratory practical skills, the role of laboratory manuals in chemistry laboratory instruction, effectiveness of laboratory practical activities, the relationship between students' laboratory skill performance and their prior background, instructors experiences and students attitudes. It discusses the development of a conceptual model and the design of the model.

It also presents the task of the current research, which was to improve the level of the pre-service science teachers' chemistry laboratory practical skill performance, identify the most predicting variable and investigate whether there is relationship or not between the acquisition of laboratory practical skills and students ability in the incorporation of practical approaches into their teaching and learning.

CHAPTER THREE

METHODOLOGY

3.1 Overview

In this chapter, the research design, population and sample of the research, instruments used in the study, validity and reliability of instruments, intervention procedures (pre-intervention, intervention and post-intervention, data analysis methods and discussion of ethical issues are provided.

3.2 Research Design

Action research design was used to collect data for the study. Educational action research aims at solving classroom problems or local school problems through the application of scientific methods (Mertens, 2014). The choice of this research design is however based on number of strengths such as it being conducted into current issues of concern and usually involves only those people directly involve. It also promotes teachers personal development and improves on his/her efficiency.

Moreover, it helps the teachers to understand what actually goes on with regards to the teaching and learning process. The choice of action research design aimed at solving an immediate classroom problem of poor acquisition of laboratory practical skills by pre-service science teachers as well as teaching science through practical mode. However, the action research also has some disadvantages which include; it is labor and time consuming because a lot of efforts and time is needed for the interventions and data collection. Also, data collection is sometimes not accurate or genuine because the correct values are always difficult to determine.

3.3 Population

The population of study was the pre-service teachers of E.P College of Education, Bimilla. The college is located at the north eastern part of Bimbilla Township. The accessible students' population was made up of 990 (329 females and 661 males). The target population was 450 level 200 pre-service teachers who were being prepared for teaching practice. The college also had a staff strength of 45 of which four were females and 41 males. The total number of Science Tutors in the college was eight made up of one female and seven male.

3.4 Sample and Sampling Techniques

The sample of the research consisted of 82 level 200 pre-service science teachers. They were made up of 22 females and 60 males. Purposive sampling method was used to select the level 200 pre-service science teachers for the study. All the 82 pre-service science teachers of the sample participated in the interview session. This was because the pre-service science teachers are those who are being prepared to teach science during their teaching practice from the second semester to level 300. Therefore, the researcher focused on them to give them enough training on practical laboratory teaching sessions to build their laboratory practical skills to be effective in their teaching practice and beyond.

3.5 Research Instruments

The instruments that were used to collect data were laboratory practical skill observation- scale, interview and attitude scale.

3.6 Observation

The purpose of classroom in educational research, according to Johnson and Christensen (2004), is to observe educators in their natural settings as it normally occurs. Much can be gained by observing the interaction between educators and students, materials, problems and procedures. A laboratory practical skill observation scale was developed to investigate pre-service science teachers' use of practical skills during on-campus teaching practices (Appendix A). The observation scale consisted of six descriptors, namely; observing, measuring and comparing, questioning, predicting, critical thinking and collaborating, recording results, evaluating and communicating findings

3.7 Interview

A qualitative measure such as interviews, allow researchers to enter the inner world of other persons and to gain an understanding of that person's perspective (Johnson and Christensen 2004). A semi-structured interview guide was developed and used to guide the pre-service science teachers on laboratory practical skills (Appendix B). The guide consisted of five items which sought to address the knowledge, level of used of laboratory practical skill, problems that pre-service science teachers experience in teaching science through practical mode, their prior background and how they can supported to implement laboratory practical skill more effectively.

3.8 Attitude Scale

In order to investigate the attitude of the pre-service science teachers towards the incorporation of practical skills and teaching science in practical mode, a likert-type attitude scale was used (Appendix C). It consisted of 14 items. This scale was originally used by Sharpe (2012) and was adapted to ascertain the attitude of science teachers and students towards practical work. The scale was suitable for the study as it was originally used in similar study to measure pre-service science teachers' attitude towards laboratory practical skills teaching science through practical mode towards teaching of practical work and science process skills.

The scale consisted of two sections, A and B. Section A consisted of two items to obtain background information on the participants such as gender etc. Section B consisted of 12 items which were to gather information on the previous practical mode of the pre-service science teachers during their on-campus and off-campus teaching practice. Each item of the scale consisted of a statement followed by three options namely, Agree, Disagree and Neither of both. Some of the items were to establish whether pre-service science teachers enjoyed laboratory practical work, whether they are able to learn from laboratory practical work and whether they preferred teaching science through practical mode during their on-campus and off-campus teaching practice.

3.9 Validity of the Instruments

Validity of research instruments implies the extent to which the instrument was able to adequately collect the information it was meant for or measure the phenomenon it was designed for. Two important elements of validity ensured in this study are internal and face validity. Internal validity is about designing appropriate controls to do away with extraneous variables that may give rise to alternative interpretations. This validity was ensured by submitting the research instrument to the research supervisor for comments and suggestions which were later incorporated into the final instrument. All observations and interviews were conducted by the researcher.

3.10 Reliability of the Instruments

Reliability of the instruments was also ensured by making sure that the test or procedure produces similar results under constant conditions all times.

A pilot test was carried out in an attempt to avoid time and money being wasted on an inadequately designed project. It is normally carried out by on members of the relevant population, but not on those who will form part of the final sample. The instruments were pilot tested on a section of the second year pre-service teachers. The students used for the pilot test did not form part of the sample for the study.

It was realized after the pilot test that some of the interview questions had to be modified to avoid ambiguity. The pilot test helped to elicit the right responses because of the modifications and restructuring carried out.

3.11 Data Collection Procedure

The researcher observed the lessons of the pre-service science teachers during their on-campus teaching practice, one lesson each was observed for each of the pre-service science teachers.

The observation took place between April and May 2018. During each visit notes were taken, the notes were description of what happened in the classroom, for example the type of learning strategies used by the pre-service science teachers. As a non-participant observer, the researcher tried to be objective and not get involved in the dynamics of the class.

In observation, data was collected on the current status of the subjects by watching them, listing and recording what was observed rather than asking questions about them. The rational for use of observation was to obtain first-hand information without relying on the report of others. It can also offer data when respondents are unable and or unwilling to offer information. Observation was carried out at the pre-intervention and post-intervention stages during laboratory practical lessons. Each science tutor was observed for 2 periods of 1 hour each. To clarify certain issues, a brief discussion was held with each science tutor to determine the topic, the learning content to be covered, the assessment standards as well as the practical skill to be developed. The tutors were also told that the researcher was only interested in observing the nature of practices during laboratory practical work.

There were semi-structured interviews held between April and May 2018 to ascertain the understanding of the pre-service science teachers' knowledge on laboratory practical skills, how pre-service science teachers incorporate laboratory practical skills in their teaching practice and the support pre-service science teachers need to improve their practices with regard to the teaching of science through practical mode. The interviews were held after the observation. Each pre-service science teacher participated in the semi-structured interview.

The dates for each interview were determined by each pre-service science teacher and lasted between 25 and 30 minutes. Each pre-service science teacher was interviewed once. In addition to the interview and observation the attitude scale was completed by pre-service science teachers. They used given enough time to complete the questionnaire. It was collect when the participant indicated that he/she had completed it.

3.12 Intervention Procedure

A set of strategies was used to improve the laboratory practical skills of pre-service science teachers. The process was in three phases: Pre-intervention, Intervention and Post-intervention

3.12.1 Pre-Intervention

Firstly, the pre-intervention is the procedure that was adopted to identify the causes of poor acquisition of laboratory practical skills by pre-service science teachers using observation and interview and attitude scale. During laboratory practical lessons and on-campus teaching practice by the pre-service science teachers, it was observed that most of the pre-service science teachers lacked laboratory practical skills necessary to carry out practical work especially during their teaching practice programmes. During the observation, the researcher noticed some inappropriate behaviour of the pre-service science teachers such as:

i. Inactive participation in laboratory practical work.
ii. Demonstration of poor manipulative skills
iii. Failure to teach science lessons through practical mode.

A laboratory practical skill observation scale was used to find out how often laboratory practical skills were used by tutors and students during laboratory practical work.

A semi-structured interview was also conducted to have a greater understanding of the science tutor's and the pre-service science teachers' laboratory practical skills and their practices with respect to teaching of science. The guide consisted of five items each for both the tutors and pre-service science teachers.

Furthermore, attitude scale was conducted to investigate the attitude of the pre-service science teachers towards the incorporation of practical skills into their teaching practices and possibly teaching science in practical mode. Likert-type attitude scale was used.

After the observation and interview administered, pre-service science teachers' laboratory practical skills were inadequate, and this called for intervention strategies.

3.12.2 Intervention

In an attempt to improve the laboratory practical skills of the pre-service science teachers, Problem-Based Learning approach was designed and implemented for second year pre-service science teachers. The laboratory session lasted for two hours, inclusive the advanced preparation, pre-laboratory activities, laboratory activities, teaching/writing and presentation of laboratory report which were delivered during the laboratory time.

In some cases, the tasks were run in two laboratory sessions; however, most of the tasks were completed within one session. Two practical activities were carried out to improve the pre-service science teachers' acquisition of practical skills. These activities include the task of labeling solutions correctly as well as comparing state laboratory results with laboratory analysis.

3.12.3 Advance preparation

To begin with the assignment, the students were given the task a week before the laboratory session, and were expected to provide written evidence of having tried to solve the problem before starting the pre-laboratory discussion. The students were also tasked to look for resources to support the theory, and practical elements of solving the problem. They were requested to search for technical information such as a possible procedures and/or chemicals/apparatus needed for the laboratory practical work.

3.12.4 Pre-Laboratory Activities

During the pre-laboratory discussion the students were put in groups to discuss and bring out ideas on the task assigned to each of the groups in order to find solutions to task presented. Individual students were also given the opportunity to make independent submission of their findings on the task. Before going into the laboratory, all safety or technical information which the students required were clearly given to them in a face-to-face discussion with the researcher.

The guide to the conduct of the task as well as all relevant information for the success of the activity was developed and posted at vantage places in the laboratory beforehand. The students were also tasked to actively research their problem using books and websites, and to solve the problem through collaboration with their peers in small groups. Besides developing the general skills mentioned in chapter two of this study, the aim of the pre-laboratory exercise was to provide a platform for enhanced understanding of the task by the students.

3.12. 5 Laboratory Activities

Once in the laboratory, students set about solving the problem, again both in groups and individually. Having guided the students of the nature and flow of the activities to be carried out the pre-laboratory stage of this report, the students were at this stage, tasked to carry out the following practical activities.

3.12.5.1 Activity one: the Case of Unlabelled Bottles

This practical work was an experiment which required students to label five unlabelled bottles containing solutions correctly; the students were to provide the names of the solution and concentrations. The students were not given any other solutions apart from indicators. Secondly, having identified the bottles, the students must accurately determine the concentration of one solution by titration. They must decide which other solution to use in the titration and which indicator. The solutions were acids and bases of varying concentrations, namely: Acetic Acid 0.05M, Hydrochloric Acid 0.05M and Hydrochloric Acid 0.075M.

This problem aimed to further the pre-service science teachers' understanding of acids and bases, indicators and quantitative measurement. From the preceding week's experiments, they should be able to distinguish easily between the acids and bases, but the next level was to determine different strengths of acids and bases so as to distinguish between, for example, the sodium carbonate and the sodium hydroxide, and then also to distinguish between different concentrations of the same solution, i.e. the 0.05M and 0.075M hydrochloric acid solution. They were encouraged to use a variety of techniques, from indicator theory to 'small-scale' titrations to solve this. Given the added challenge of using as little of the solution as possible, meant that they were discouraged from using the typical standard titration equipment, and instead encouraged to try well plates and small beakers to carry out small-scale titrations.

This encouraged the students to think 'outside the box', thus developing a better appreciation of alternative methods, and adapting their previous knowledge of titrations to a new context.

This was instead of the traditional prescribed lab where students weigh out a primary standard (Na_2CO_3) and carry out standardization against HCl.

3.12.5.2 Activity 2: State Laboratory vs. Laboratory Analysis

The second activity in the laboratory was State Laboratory vs. Laboratory Analysis. This is another Problem-Based Learning experiment that was carried out by students in their first semester. It built on the previous week's skills, concepts and techniques, including problem solving, group work, acid base theory, titrations and mole calculations. It is also an experiment which required group work both during the laboratory session and thereafter.

In the experiment, Students were given a number of 'vinegar' samples taken from an alleged 'suspect' batch found at college local market. Then, representing either the State Laboratory (on behalf of the consumer) or Laboratory Analysis (on behalf of the shop owner), the students carried out an analysis of these samples to determine if the vinegar was suitable for resale or use. They did their analysis over two laboratory sessions by two different methods and compared their results which were presented at the next stage of this report.

3. 12.6 Presentation of Laboratory Report

The students who were led by their group leaders presented their reports of task for contributions from the other members in class. The task concluded in an oral debate, where the groups 'defend' their results and make recommendations. The groups were encouraged to find potential mistakes (such as using a graduated cylinder to measure an accurate volume for a standard) and gaps in the other groups' arguments.

Having fine-tuned the results from the groups, the students submitted written reports on the activity and in some cases they displayed poster presentations to conclude their laboratory session. The students also reported on the pre-laboratory elements and the group work and indicated that those activities were most beneficial to them in the task. The students further reported that the pre-laboratory element gave them the opportunity to understand what was expected of them before engaging in the exercise. Finally, the students were very positive about the whole experience and one reason given by a student for enjoying the Problem-Based Learning laboratory activity was that it "*Gave us the chance to learn why we were doing an experiment and research background to it. This allowed a proper understanding of the procedure rather than just following the manual*".

There were however, elements the students disliked, such as having to do more work outside of the designated laboratory time than the traditional students, and a few did not participated actively in the oral presentations. Throughout the duration of the Problem-Based Learning, the resources needed were either the same as in the traditional laboratory or other basic glassware/chemicals which were readily available in the laboratory.

3.12.7 Post-intervention stage

This stage of the methodology evaluated the outcome of the study. Post intervention activities were carried out. The likert-type attitude scale was used and it contained the same statement which was used during the pre-intervention stage. Results obtained from the post intervention activities indicated that there was improvement in acquisition of laboratory practical skills by the pre-service science teachers. Results was analyzed and presented in chapter 4. Pre-service science teachers could also be seen teaching science through practical mode.

3.12.7.1 Data Analysis

Participant's responses were recorded to give appropriate descriptions about the pre-service science teacher's acquisition of laboratory practical skills and teaching science through practical mode regarding the topic under study. A thematic data analysis was adopted. This entailed the transcription of the recorded interviews, close reading of the text and the identification of patterns which were used to generate themes for the analysis. The results of the attitude scale were analyzed through the computation of frequencies and percentages. This was then used to describe the data collected during the pre-intervention and comparing it with the data collected during the post-intervention.

3.12.7.2 Ethical Considerations

The Head of Department (Science), the Academic Counselor for the elective science group as well as the participating tutors were all informed about what the study sought to find. The tutors were assured that their identity would not be revealed and that they could withdraw at any time of the research if they chose to. Also, honesty was assured through conveying information truthfully and honoring commitments. Moreover, for the purpose of objectivity, the facts of the research were allowed to speak for themselves and improper biases and misrepresentation were avoided. Finally, respondents' anonymity and confidentiality of the information volunteered by them were ensured throughout the research.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

The study is aimed at improving the acquisition of laboratory practical skills of pre-service science teachers. The results of the research and the analysis of the findings are therefore presented in two sections in this chapter namely: pr-intervention and post intervention results. The results are presented in frequency tables and discussed to address the objectives of the study. Analysis of the findings is categorized under the various research questions of the study.

4.2 Gender Distribution of Respondents

The gender distribution of the pre-service science teachers is presented in table 1.

4.3 Pre-Intervention Results

This section presents the results of the activities which were carried out before the intervention. At this stage, an interview was conducted to find out the level of acquisition of laboratory practical skills by pre-service science teachers at the E.P. College of Education, Bimbilla. The findings are reported under research question one.

Table 1: Gender Distribution of Pre-Service Science Teachers

Gender	Frequency	Percentages (%)
Males	60	73
Females	22	27
Total	**82**	**100**

As shown in Table 1, majority of respondents were males. There were 73 % and 27% males and females pre-service science teachers respectively.

4.4. Research Question One: What are the Causes of Poor Laboratory Practical Skills among pre-service science teachers of E P College of Education?

This research question was concerned with the causes of the poor laboratory practical skills of pre-service science teachers. The research question was addressed by finding out from pre-service science teachers the reasons for their poor laboratory practical skills and their inability to teach science through practical mode during their on-campus teaching practices. Data was collected mainly through interview. A number of themes were identified during the analyses of the qualitative data that related to factors responsible for the poor laboratory practical skills of pre-service science teachers. These themes are outlined and discussed.

It was found out during interview conducted at the pre-intervention stage that, one of the main factors responsible for the poor laboratory practical skills of pre-service science teachers was their inadequate knowledge of laboratory practical skills. The pre-service science teachers' knowledge of laboratory practical skills was probed through interview and the results of this are summarized in Table 2.

Table 2: Pre-service Science Teachers Knowledge of Laboratory Practical Skills

Response	Frequency	Percentage (%)
Skills that learners use when they do practical work	20	24
Skills that the learners use when conducting investigation	28	34
No idea of what laboratory practical skills is	34	42
Total	**82**	**100**

From Table 2, 20 representing 24% of the pre-service science teachers viewed science laboratory practical skills as the skills learners use when they do science. The pre-service science teachers confessed to the researcher that they held a different view about laboratory practical skills. These were expressed in the following excerpts:

"Madam, I initially associated laboratory practical skills with hands on experiences; critical and creative thinking just like many of my colleagues". "My studies in sciences at the College influenced my view''.

Another pre-service science teacher eloquently pointed out that *"My prior laboratory practical skills experiences from the Senior High School did not change any of my laboratory practical practices and my mode of teaching science during on-campus teaching practice".*

Furthermore, pre-service science teachers were of the opinion that laboratory practical skills should not only be confined to science, but that these skills should be developed in other science practical related courses during problem-solving or in learning areas such as life orientation.

However, 28 (34%) of the pre-service science teachers described laboratory practical skills as the skills that learners use when they conduct an investigation or solve a scientific problem. It was also pointed out that laboratory practical skills are related to predictions, observations and the recognition of patterns and inferences.

The remaining 34 representing 42% of the pre-service science teachers appeared to have a limited understanding of laboratory practical skills. When prompted to give an example of a laboratory practical skills neither was able to do so. This finding is in agreement with the work of (Webb & Glover, 2004). Webb and Glover, (2004) further cautioned that if educators do not have an appropriate understanding of the processes of science, they cope in ways that impoverish children's learning opportunities and hence affects their academic achievement.

Also, some of the pre-service science teachers explained their inadequate knowledge of laboratory practical skills as the cause of their unwillingness to go about teaching science through practical mode. Murphy (2009) commented on the worldwide problem of educators' confidence or rather lack of confidence to teach science through practical mode. In an extensive review of the constraints on science laboratory practical skills, Murphy (2009) concluded that one of the major issues in primary science teaching that places a damper on practical skills may be attributed to the educators' lack of confidence in running laboratory practical lessons and that, this lack of confidence could be because of the severe lack of appropriate pre-service teacher training in laboratory practical skills.

4.4.1 Impediments to Teaching and Learning of Laboratory Practical Skills

It was also found out that the impediments to teaching and learning of laboratory practical skills influenced pre-service science teachers' attitudes to the teaching of science through practical mode during their on-campus teaching practice. The pre-service science teachers' responses to the impediments of acquisition of laboratory practical skills were similar and related. The pre-service teaching confessed that the impediments to teaching and learning of laboratory practical skills influenced their teaching of science through practical mode. These were expressed in the following excerpt: *"the number of practical work sessions prescribed in the syllabus is inadequate; we need to have at least four practical sessions per semester"* They perceived a number of barriers preventing them from adopting the practical mode approach to teaching science during their on-campus teaching practice. Some of these impediments were structural (e.g. lack of collaboration and support of school colleagues, prior background of laboratory practical skills) and lastly, they identified the curriculum as another barrier (e.g. the poorly constructed curriculum with respect to laboratory practical work).

4.4.2 Learner Attitude

Another impediment reported was that when the learners are asked to make a prediction on any subject in class, they merely guess without considering the subject matter under discussion. The pre-service science teachers mentioned that their poor interest in laboratory practical work and lack of general scientific knowledge placed a damper on their acquisition of laboratory practical skills. Learner autonomy and self-responsibility were also highlighted as impediments since the learners need constant guidance with less experimental procedure, the reading and interpretation of questions as well as continual reminders to clean their work space.

One pre-service science teacher pointed out that *"we need to be given autonomy so that we can be responsible for our learning"*. These factors according to the pre-service science teachers make the acquisition of practical skills and teaching science through practical mode exhausting, time-consuming and difficult.

4.4.3 Inadequate institutional support

All the pre-service science teachers (100%) indicated that, the nature of the Colleges of Education Science Curriculum do not support the development of laboratory practical skills in the pre-service science teachers. The over concentration on passing the promotion examinations by both the pre-service teachers and tutors at the college is another factor that influence the attitude of pre-service science teachers towards laboratory practical work and teaching science through practical mode. The respondents indicated that, the number of laboratory practical work carried out were not enough and more laboratory practical work was needed to increase their competencies with regard to the teaching science through practical mode. There were 80% of the pre-service science teachers who emphasized the inadequacy of practical work in their course content (i.e. laboratory practical skills) as one of inadequate institutional support .When prompted about what is needed to teach science through the practical mode more effectively in the interview, the pre-service science teachers indicated as presented in the following excerpts.

'We need learning materials and other resources here in the college to guide our teaching. Our tutors should introduce activities that will reinforce our use and development of laboratory practical skills".

The sentiment regarding the lack of support and the availability of learning material and resources as highlighted by the pre-service science teachers in this study indicate that these kinds of services need to be accelerated and improved. Darling-Hammond (1998) in an extensive over view of educational reform efforts concluded that reform efforts must focus on building the capacity of educators in terms of the content to be taught and how it could be taught best to deal with the changes successfully. Authors such as Fullan (2007) argue that the process of development has to be enhanced with high quality teaching and training materials.

4.4.4 Pre-service science teachers' educational background and experiences of laboratory practical skills

Again, the attitude of pre-service science teachers towards laboratory practical skills and teaching science through practical mode was also influenced by their individual educational background. The pre-service science teachers interviewed for this study indicated that they had themselves learned science dogmatically, using rote memorization of facts, principles and laws. When they were at senior high school, their own science teachers had relied heavily on the traditional teaching paradigm since it was considered as one of the most effective approaches. They stated that their science teachers were always well prepared and had the ability to hold the learners attention for quite a long period of time. The pre-service science teachers also stated that their science teachers were always in control of the learning content. 80% of the pre-service science teachers recalled that, although in their SHS student days, their science teachers did most of the talking and supplied them with information, they were also requested to answer stimulating questions. Some pre-service science teachers also indicated during the interviews that they had been taught by means of demonstrations and neat wall charts. Excerpts of such comments are presented below.

"At our time, the wall charts were displayed against the wall after the lesson to beautify the classroom one pre-service science teacher explained. Thus, the current practices of pre-service science teachers reflect their prior background and how they were taught during their time as SHS students".

4.4.5 Improving pre-service science teachers' acquisition of laboratory practical skills

The pre-service science teachers suggested a number of measures that could be adopted to improve their laboratory practical skills. In the first place, during the interview, pre-service science teachers indicated the need for the design and development of learning materials consistent with methods of laboratory practical skills that will motivate and guide them to introduce teaching and learning activities that will reinforce the acquisition and use of laboratory practical skills in their science teaching practices.

Secondly, pre-service science teachers indicated the need to have adequate laboratory practical work sessions. Verbal reactions from the pre-service science teachers revealed that they were not supported by the college to teach any differently in their on-campus or to change their practices so as to align their practice with laboratory practical skills. For this reason data generated from this study suggests the need for science teachers to be exposed to developmental programmes whereby modern approaches such as problem-based learning and inquiry teaching strategies are instilled and developed. In order for pre-service science teachers to transform their practices as well as teach science through practical modes, they should be afforded the opportunity in hands-on work, posters, apparatus and other stimulus material, thus, the problem-based learning approach.

Again, respondents suggested that there is the need to establish communities to improve the general attitude of pre-service science teachers towards laboratory practical skills and practical work. Getting educators to change is a difficult phenomenon, according to Webb and Glover (2004) since most of them particularly resist complex, conceptual, longitudinal changes as opposed to change in management routines to changes. Communities of practice provide opportunities for pre-service science teachers to support one another morally and emotionally and to engage in dialogue to discuss the meaning of educational changes and how to deal with them successfully. Communities of practice may serve as a source in which the pre-service science teachers discuss and share effective practices, identify barriers, focus collectively on their learning and share norms and values.

4.5 Post Intervention Results

The results of the study which was conducted after the intervention is presented in line with research question two. The focus here is whether or not there was improvement after the intervention. Attitude and observation scales were used as data collection tools. Details of the findings are presented as follows:

4.5.1 Research Question Two: To what extent will the use of problem-based teaching and learning approach improve the laboratory practical skills of pre-service science teachers of E P College of Education?

The second research question was purposed to ascertain the extent to which the use of problem-based learning could improve the laboratory practical skills of pre-service science teachers. The research question was addressed by using an attitude scale developed by Sharpe (2012) and observation scale as well. The attitude scale was a 10-item scale that rated the responses of pre-service science teachers on a three point likert-type scale. The gradations on the scale are as follows; Agree = 3, Neither agree nor disagree = 2, Disagree = 1. The pre-service science teachers' responses to the use of problem-based learning approach to improve their laboratory practical skills are summarized in Table 3.

It is evident from Table 3 that majority 70% (57) of the pre-service science teachers agreed that they enjoyed problem-based learning approach in laboratory practical lessons. Only 30% (25) of pre-service science teachers neither agreed nor disagreed to this.

Sixty percent of pre-service science teachers also agreed that problem-based learning improved their laboratory practical skills acquisition during laboratory practical work. Twenty percent neither agreed nor disagreed whilst 20% (16) disagreed. Again, 50% (41) of the pre-service science teachers agreed that they preferred the problem-based approach to traditional approach in laboratory practical lessons but 40% (33) were not also sure of this whilst 10% (8) disagreed.

Table 3: Distribution of Participants' Percentage Frequency Response to Question Items

Statement	Percentage	Frequency	Response
	Agree	**Neither Agree nor Disagree**	**Disagree**
1. I enjoy problem-based learning approach in laboratory practical lessons.	70 (57)	30(25)	0
2. Problem-based learning improved my laboratory practical skills acquisition during laboratory practical work.	60(49)	30(25)	10(8)
3. I prefer the problem-based approach to traditional approach in laboratory practical lessons.	50(41)	50(41)	0
4. Problem-based learning approach is my favorite part of laboratory practical work.	50(41)	40(33)	10(8)
5. Problem-based learning and laboratory practical skills help pre-service science teachers to teach science through practical mode during their on-campus teaching practice.	90(74)	10(8)	0
6. I find practical work using the problem-based approach easy to do.			
7. What is learnt in problem-based learning approach will be useful to pre-service science teachers even when they leave college.	30(25)	30(25)	40(33)
8. I find problem-based learning to be a way of improving pre-service science teachers' laboratory practical skills and teaching science teaching science through practical mode.	50(41) 100(82)	40(33) 0	10(8) 0
9. I think we should use more problem-based learning and laboratory practical skills in science lessons.			
10. Pre-service science teachers have freedom in problem-based learning during laboratory practical work.	80(66)	20(16)	0
	50(41)	40(33)	10(8)

Interestingly, 90% (74) pre-service science teachers agreed that problem-based learning and laboratory practical skills helped them to teach science through practical mode during their on-campus teaching practice whilst 10% (8) were not sure. There were 40% (33) of the pre-service science teachers who disagreed that practical work using the problem-based approach was easy to do and 30% (25) neither agreed nor disagreed whilst 30% (25) also agreed. In addition, 50% (41) indicated that what is learnt in problem-based learning approach will be useful to pre-service science teachers even when they leave college.

Notwithstanding these, all pre-service science teachers (100%) agreed that they found problem-based learning to be a way of improving their laboratory practical skills and teaching science teaching science through practical mode. Over 80% (66) of pre-service science teachers agreed that they should be taught more laboratory practical skills using problem-based learning approach in laboratory practical work and 20% (16) neither agreed nor disagreed.

Fifty percent of the respondents agreed with item 10 on the attitude scale that pre-service science teachers had freedom in problem-based learning during laboratory practical work. Findings with respect to the research question two are in line with Exley and Dennick, (2004) who posited that in Problem-Based Learning, the task, as the focus of the learning, is purely an ill-structured, complex one, with no clear 'right answer'. This provokes extended collaboration among groups, leading to conceptual learning. Students automatically have to activate their prior knowledge in order to start thinking about the problem confronting them, and build it into new knowledge, which is the basis of constructivism. This has been noted to facilitate learning. Thus, problem-based learning largely improved pre-service science teachers' acquisition of laboratory practical skills.

Aside the attitude scale, laboratory practical lessons' observations were also conducted to ascertain how pre-service science teachers acquired laboratory practical skills.

4.5.2 Findings from Observation

Teachers were rated against the first descriptor of the laboratory practical lesson skills by observation. This measure indicated the extent to which learners were able to make observation and comparisons. Table 4 shows the rating of pre-service science teachers.

Table 4: Level of use of Observing and Comparing Skills among Pre-Service Science Teachers

Criterion	Frequency	Percentage (%)
Performed in outstanding manner	0	0
Performed well	50	60
Performed satisfactorily	16	20
Not used	16	20
Total	**82**	**100**

The above shows that majority of the pre-science teachers observed and compared phenomenon during laboratory practical work. Specifically, as seen from Table 4 they were able to observe and compare the change of solutions in the task of differentiating and labeling unlabelled bottles containing solutions of acids and bases. They were then required to observe and compare each solution in terms of the colour change and intensity of the colour. This exercise engaged the learners and they participated actively not just that it was simple but because it was very unusual to them.

One revealing observation from this exercise was that 20% of the participants either performed satisfactorily or did not use the skill of comparing and observing. This indicates that few pre-service science teachers rarely used practical skills in teaching. They did not perform satisfactorily when they were observed in this study. Closely related to this is the zero score for outstanding performance in the exercise. This can be improved through regular use of practical teaching activities.

4.5.3 Pre-Service Science Teachers' use of collaborative and critical thinking Skills

The researcher undertook to measure the degree to which pre-service science teachers used their collaborative and critical thinking skills during laboratory practical work. Table 5 illustrates how the pre-service science teachers were rated on collaboration and critical thinking on observation scale of the laboratory practical skills.

Table 5: Pre-Service Science Teachers Level of use of Collaborative and critical thinking skills.

Criterion	Frequency	Percentage (%)
Performed in outstanding manner	49	60
Performed well	25	30
Performed satisfactorily	8	10
Not used	0	0
Total	**82**	**100**

It can be viewed from Table 5 above that 60 percent of the pr-service science teachers considered in the exercise collaborated and used critical thinking in an outstanding manner. Almost all of the pre-service science teachers who participated in the exercise collaborated and used critical thinking skills only at varying degrees. Only 10 percent of the pre- service science teachers considered were not actively engaged in collaborative discussions as well as using critical thinking skills throughout the entire period they were observed.

4.5.4 Pre-Service Science Teachers' use of Recording Skills

This was intended to assess the rate at which record keeping skills were used by the pre-service science teachers while performing laboratory duties. The results of this are presented on Table 6.

Table 6: Level of Pre-Service Science Teachers' use of Recording Skills

Criterion	Frequency	Percentage (%)
Performed in outstanding manner	25	30
Performed well	41	50
Performed satisfactorily	16	20
Not used	0	0
Total	**82**	**100**

From Table 6, it can seen that 30% of the pre-service science teachers observed performed in an outstanding manner as they recorded results of the practical lessons they taught accurately. Also, 50% of pre-service science teachers performed well. Twenty percent of the teachers' performance was described as satisfactory.

4.5.5 Questioning skills of Pre-Service Science Teachers

The researcher rated the pre-service science teachers on their questioning skills regarding how well they were able to raise questions which could be answered by scientific investigations as well as questions that may arise from curiosity and the desire to understand. Table 7 is the record of the degree to which the pre- service science teachers used questioning skills. The table revealed that revealed that the pre-service science teachers' knowledge of investigable questions was high. Learner independence was promoted in asking investigable questions. The questions were not direct, not simple, not demanding recall of facts, etc but elicited a bit of critical thinking.

Table 7: Pre-Service Science Teachers Level of use of Questioning Skills

Criterion	Frequency	Percentage (%)
Performed in outstanding manner	50	60
Performed well	16	20
Performed satisfactorily	16	20
Not used	0	0
Total	**82**	**100**

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

This chapter provides summary of all major findings of the study and conclusions were drawn based on these findings. The chapter ends with some recommendations.

5.2 Summary of Findings

The purpose of the study was to use Problem-Based Learning Approach to improve laboratory practical skills of pre-service science teachers of E.P. College of Education. An action research design was adopted for the study. It entailed interview with 82 level 200 pre-service science teachers of E.P. College of Education, classroom observation and use of attitude scale. The following were the major findings of the study.

1. It was found out that fewer laboratory practical works were being conducted as recommended in the curriculum guide out line.

2. Majority of the pre-service science teachers were not aware of the laboratory practical skills, and so did not applied them during their on-campus teaching practice. The elements relating to observing, experimenting, manipulating collaborating, critical thinking, communicating, collecting data and interpreting results were not observed.

3. Again, some of the pre-service science teachers held predominantly traditional beliefs about science teaching and learning practices. Pre-service science teachers believed that the conventional approach to teaching science is still appropriate although they acknowledged the need for practical work.

4. With regard to teaching of science through the practical mode, all the pre-service science teachers agreed that practical work makes the teaching and learning of science easier and understandable as well as gives learners the idea of what scientist do in the real world. However, pre-service science teachers were skeptical about how to teach science through practical mode during their on-campus teaching practice.

5. Also, pre-service science teachers recognized several challenges of laboratory practical skills acquisition and teaching science through practical mode. These were however related to their prior knowledge and general structure of the college laboratory practical work.

5.3 Conclusions

Laboratory practical skills play a significant role in the teaching and learning of science through practical mode. To achieve this goal, colleges of education need to evaluate the attainment of the intended objectives. The aim of this study was to improve the laboratory practical skills of pre-service science teachers of E. P. College of Education, Bimbilla. The study uncovered that pre-service science teachers had low knowledge about laboratory practical skills. The results implicated a need for the college to set standards for each practical skill, and to monitor the pre-service science teachers' progress during their teaching practice program period in the acquisition of their laboratory practical skills.

The result of the study showed that many pre-service science teachers in E.P. College of Education were not knowledgeable about the laboratory practical skills which influenced their science teaching through practical mode during on-campus teaching practice.

Moreover, the understanding of the concept laboratory practical skills affected pre-service science teachers' level of confidence and attitude towards the teaching of science through practical mode. Overall, the Students showed positive learning gains from the intervention.

5.4 Recommendations

Based on the outcome of the study and the conclusions drawn, the following recommendations were made for consideration.

1. Educators at the E.P. College of Education should review the structure of laboratory practical work in the school and implement changes that would promote the acquisition and use of all laboratory practical skills.
2. Science Department of the college should intensify laboratory practical work by increasing the number of laboratory practical activities in each semester to afford the pre-service science teachers more opportunity to practice and develop their teaching skills.
3. The need for regular professional development of science instructors of the E. P. College of Education on laboratory practical skills is recommended to update their knowledge and skills on current approaches and methods which promote acquisition of laboratory practical skills in science laboratory.
4. The College should make arrangements with well-established science and technology departments as well as research institutions in the Northern Region for practical laboratory training for pre-service science teachers to build their confidence and willingness to teach science through practical mode.

The authorities of the E. P. College of Education should ensure that the recommendations of this study are implemented to lay a good foundation for training pre-service science teachers in laboratory practical skills.

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APPENDICES

APPENDIX A

Interview Schedule for Pre-service science teachers

1. What is your understanding of the concept of laboratory practical skills?
2. To what extend do you employ these basic skills in your science teaching and learning during teaching practice programmes?
3. What problems do you experience in teaching science through practical mode?
4. How can pre-service science teachers be supported to implement laboratory practical skills more effectively?
5. Could you describe your prior background and experiences concerning the teaching and learning of science?

APPENDIX B

Observation Scale for Laboratory Practical Skills

To what extent did Problem-Based Learning improved the acquisition and use of laboratory practical skills by pre-service science teachers?

Place 'x' in the box indicating how often you observed each of the following:

Score Criterion

1 Not seen

2 Performed satisfactorily

3 Performed well and advanced manner

4 Performed in outstanding

Statement	1	2	3	4
1. Did the learners use their senses (sight, smell, taste and hear) to collect data in a practical situation?				
2. Did the learners describe event in general to identify its similarities or differences?				
3. Did the problem-based learning improved learner independence in contributing an investigable question to develop their critical thinking?				
4. Did the pre-service science teachers make any predictions and to respond to "what if" question?				
5. Did the problem-based learning improved learner independence to carryout instructions, follow procedures and collecting data?				
6. Did the learners record the results that they obtain from investigation during practical work?				
7. Were the learners motivated to reflect or to construct meaning to their ideas during laboratory practical work?				
8. Did the learners evaluate and communicate their findings in laboratory practical work?				

APPENDIX C

Attitude Scale

Instruction: Respond by ticking (√) in the box where applicable

Statement	Agree	Disagree	Neither of both
1. I enjoy problem-based learning approach in laboratory practical lessons.			
2. Problem-based learning improved my laboratory practical skills acquisition during laboratory practical work.			
3. I prefer the problem-based approach to traditional approach in laboratory practical lessons.			
4. Problem-based learning approach is my favorite part of laboratory practical work.			
5. Problem-based learning and laboratory practical skills help pre-service science teachers to teach science through practical mode during their on-campus teaching practice.			
6. I find practical work using the problem-based approach easy to do.			
7. What is learnt in problem-based learning approach will be useful to pre-service science teachers even when they leave college.			
8. I find problem-based learning to be a way of improving pre-service science teachers' laboratory practical skills and teaching science teaching science through practical mode.			
9. I think we should use more problem-based learning and laboratory practical skills in science lessons.			
10. Do Pre-service science teachers have freedom in problem-based learning during laboratory practical work			