# CHAPTER ONE

**INTRODUCTION**

## 1.1 Background of the Study

Chemistry has become one of the most important disciplines in the school curriculum; its importance in the general education has gained world-wide recognition. Chemistry as a branch of science that is rational and mathematical, discipline where certain measured and controlled inputs lead to certain predictable outputs was developed greatly throughout the 20th century and introduced in the curriculum of secondary education, as part of science courses (Kasalta & Tzougraki, 2009).

It is worth to emphasize that the field of chemistry and science and technology are related to the economic heart of every highly-developed industrialized and technologically advanced society (Burmeister *et al.,* 2012). The benefit of learning and advancing in science and technology can be intrinsic and extrinsic, and such has been identified with chemistry. Teaching and learning of science have significant roles towards technological development in a developing nation since chemistry is embedded in our life and society, economical, ecologic and societal influences (Hofstein *et al.,* 2011).

In chemistry teaching, the laboratory is the unique forum for the pursuit of the above aims. The expectation is that during laboratory activities, students are provided with experiences predisposing towards acquisition of scientific process skills needed for the collection and discovery of new information. Therefore, the need to equip students with process skills during laboratory teaching becomes evident.

The laboratory in the school has been defined by several authors in different ways. Maduabum (2010) sees a laboratory as a place where scientific exercises are conducted by the science teachers for the benefit of the students (learners). The laboratory exercises include; experiments and other activities which help the students in acquiring scientific skills. Ezeliora (2009) defined science laboratory as a workshop where science is done or where scientific activities are carried out under conducive environment. She also sees the laboratory as a place where science equipment, materials or instruments are housed for security and safety. Igwe (2012) observed that a laboratory can be indoor such as the sufficiently designed and equipped room found in most schools or outdoor involving such places as riverside, workshop, field and even market for carrying out scientific studies. He further stated that whatever the type of laboratory employed in science teaching, the same laboratory experience should be attained, that is a participation in the series of experimental, observational and demonstrating activities which provide opportunity for students to develop understanding of practical and theoretical concepts through solutions of problems.

According to Omiko (2007), a laboratory is a room, or building or a special period of time equipped and set apart for practical or experimental studies to take place. He sees the laboratory as the heart of a good scientific programme which allows students in the school to have experience which are consistent with the goals of scientific literacy. This implies that science teaching and learning cannot be completely done in a secondary school where there is no equipped laboratory. Ufondu (2009) explained that the laboratory is an indispensable organ of the school if effective teaching and learning of the science subjects are to be achieved.

Dienye and Gbamanja (2010) observed that laboratory method of teaching is an activity involving a two-way approach carried out by one or more persons through the exercise and experimental approaches both of which are useful in science teaching. The experimental approach provides an opportunity for students to seek information using experimental procedures. These procedures call for careful observations and interpretation of data. It has the qualities of questioning, investigating and confronting the unknown.

Omiko (2015) observed that laboratory teaching is sometimes used in conjunction with large lecture courses so that students may acquire technical skills and apply concepts and theories presented in the lecture. Omiko (2015) stated that “hands-on experience encourages students to develop a spirit of inquiry and allows them to acquire scientific skills and the right attitude to handle scientific tools and materials. Science laboratory provides students with the richest experiences which they will transfer to the society and their various places of work. It helps in providing the students the opportunities to practice science as the scientist do. In order for the laboratory to be effective, students need to understand not only how to do the experiment, but why the experiment is worth doing, and what purpose it serves for better understanding of a concept, relation, or process.

Practical work plays a central role in teaching of chemistry (Fuhrman, Lunetta and Noviek, 2012). The main aim of practical work in chemistry is to make accurate observation and description of chemical phenomena, develop specific manipulative skills, practice seeing problems relating to chemistry and seeking ways to solve them, develop a logical reasoning method of thought, develop self-reliance, verify principles and facts already learnt, develop certain disciplined techniques, develop a critical attitude and be able to comprehend and carry out instructions (Okebukola, 2009).

The practical experience also contributes an integral part of chemistry science, the subject consist of many topics that can be verified experimentally with an objective to create an enabling environment to stimulate student learning about chemistry that is commonly presumed as abstract, quantitative, and boring Read and Kable (2007). The availability of laboratory equipments, chemicals and materials, laboratory personnel, working conditions in the laboratory and safety measures, substantial recommended textbooks and accurate periods allocated for the teaching of the subjects when studied and carefully controlled, then effective teaching of chemistry could be achieved, which will in turn create a scholastically rich, rewarding environment (atmosphere) for the students to learn the basic tools of science (Frank & Saxe, 2012).

Laboratory approach is regarded as an indispensable element of chemistry education and students subjected to constructivist learning theory-based laboratory instruction exhibit higher achievement scores, deeper attention, and more frequent participation in chemistry course (Koseoglu and Tumay, 2010) However, it is obvious that learning environments adopting and applying constructivist learning theory should be supported with activities facilitating cooperation and interaction which require more time (Baki, 2008).

Laboratory activities as students’ learning experiences to interact with materials and/or with models in order to observe and understand the connection between science and the natural world are of valuable importance in science and chemical education (Hofstein & Lunetta, 2009). These activities have a potential to enhance students’ conceptual understanding, development of some affective dimensions such as motivation and attitude with respect to science learning, scientific practical skills and problem solving abilities, and understanding of nature of science (Hofstein and Lunetta, 2010). In addition, students have a chance to construct social relationships in a laboratory environment because they work cooperatively in small groups in this environment (Lazarowitz & Tamir, 2014).

Utilization of laboratory facilities and academic performance in Chemistry seem to be relatively limited and scanty. Utilization of laboratory facilities is the frequency with which the available laboratory facilities are used during laboratory experiments. Laboratory facilities can be available, adequate but not utilized during science teaching. The experiences gathered so far indicate that there is still much research to be done on the extent of utilization of laboratory facilities in secondary school science teaching and learning.

The performance of students in science based subjects like chemistry is closely related to their theoretical and practical knowledge while some are taught in isolation from the process of discovery or the conceptual applications. This however, depends solely on the subject at various classes and also on particular factors within and without the teaching and learning environment (Felder *et al.,* 2013).

Bajah (1994) noted that, poor academic performance among secondary school students in science is due to poor utilization of laboratory facilities by teachers. The utilization of laboratory facilities has been an issue of great concern to science stakeholders in educational system (Uche & Umoren, 2008). Bajah, (2009) observed that the utilization of laboratory facilities in chemistry teaching enables learners to develop problem solving skills and positive attitude, interest towards science learning.

## 1.2 Statement of the Problem

The rate at which students fail in science examinations (Chemistry inclusive) pose a lot of threat not only to science teaching and learning but also technological development in Nigeria both now and in future. Some factors may be responsible for the massive failure of students in these science examinations. These factors could be in the area of man power needs, quality and quantity of staff; the nature of our laboratories in terms of materials and equipment for effective teaching and learning of science and extent to which practical are conducted. This therefore, calls for urgent attention and solutions by Government and all the stake holders in the science education. Olotu (2009) also observed that in the senior secondary schools in Nigeria where basic principles of sciences are taught in preparation for further education, many students are not interested in the practical aspect of the sciences. During the theory lessons, students may like to participate fully but when it comes to practical aspect of the subject, they become reluctant and often has to be persuaded to participate. This behaviour according to Busari (2009), and Ali (2007) is traceable to inadequate number of materials and equipment available for the teachers to conduct practical for students at the appropriate time.

Practical chemical science implementation is a practical teaching activity which is implemented in classes and labs. Directing activities of teaching is the teacher of the student in conducting experiments, doing observation on students in experimentation and analysis of laboratory findings and outcome-evaluation practice. Good research consists of processes and products with scientific method (including concepts, principles, theories and laws), both of which must be a component of science learned in school ([Van Heuvelen, 201](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280178_ja)0). Evaluation in education and teaching including practical teaching Chemistry that can use several approaches. An approach commonly used in the evaluation of cognitive, constructivist ([Dunham *et al*., 2012](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280106_ja)) and behaviorism theory can be applied in practical Chemistry evaluation essentially intended to measure the real physical behavior in the performance of the chemical laboratory experiment activity which can be observed directly. The prominent characteristic of this study is to acquire more preferred strategy compared to how much knowledge students acquire and recall. This theory is very well applied in practical teaching Chemistry because these assessment characteristics match to the characteristics and purposes of practical Chemistry lessons ([Brooks, 2011](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#123200_b)).

Building a practical design is a process of chemical science internship program restructuring the related components of other practical material components, learning completeness, organizing practical preparatory measures, the implementing practical, practical evaluation, determining the chemical science practical purposes, allocating the time, the organization of internships and other environments (Marks and Eilks, 2009). Practical chemical science preparation is the process of providing equipment, place or materials used before the implementation of the experiment. Practical evaluation of chemical science includes practical observations of the overall process in the achievement of the purpose of learning as well as other practical assessments in experimentation, organization of systematic, practical work and practical results. As it can be seen, the four aspects of design, preparation, evaluation and implementation are interrelated. This study aims to identify the teachers’ perceptions of the aspects of design, preparation, evaluation and implementation based teachers’ background such as gender and location. The study also determines the relationship between and among these aspects.

Chemical science teaching and learning is not only done in the classroom but also in the laboratory ([Byers, 2012](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280074_ja)). This has long been a belief in science education laboratory that has the potential to become a place in which the theory is tested in a practical truth. The bulk of the teaching and learning takes place in a science laboratory ([Mokhtar, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "18270_tr)). In schools, science laboratory is the most appropriate place for students to learn how to research, organize, clarify and measure all the sciences. Most researchers agree that practical work is an important activity in school science but there are variations in the importance of the role and purpose of practical work done in the classroom. A number of teachers highlight the importance of conducting practical Chemistry science in schools in line with students’ achievement in the field of Chemistry science ([Edelson, 201](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280107_ja)0; [Kapenda](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280200_ja)*[et al](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280200_ja)*[., 2012](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280200_ja)).

Effective science teaching requires that teachers have the knowledge, skills, attitudes and ability to apply science in the lab in better way. This view supports that teachers should have the scientific competence (cognitive) and manipulative skills associated with psychomotor ([Aktamis and Acar, 2010](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280183_ja)). Effective teaching happens if teachers have the knowledge and skill because the concept of proof in the form of laboratory Chemistry science is done through observation and performance analysis. Chemistry science teachers competencies are seen as scientific experimentation in the laboratory. To improve the quality and quantity of the adoption of practical Chemistry learning, Chemistry teachers are required to master in the skills of competency IPA process, the skills to use the equipment in the laboratory and laboratory management skills and the spirit of strong will and motivation to apply practical methods in learning Chemistry.

The teachers have not been able to implement practical evaluation in an objective Chemistry science to the provision of the information which is necessary to make alternative decisions, not fully established ([Mehrens and Lehmann, 2009](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "119173_b)). In addition, lack of availability of teachers who master the teaching material, lack of teachers’ ability in using evaluation instrument and performing assessments are collecting reports from the implementation of practical evaluation of Chemistry science ([Worthen and Sanders, 2010](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "119185_b)).

In the process of implementation of practical evaluation, science teachers often experience different problems and constraints that need to be solved. Teaching issues, among others, form slight efficiency in performance and reporting the results of the practical evaluation of Chemistry science. This problem needs a serious solution so that teachers’ proficiency can be improved ([Grounlund, 2010](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "119182_b)). The problem of practical implementation of a practical Chemistry science as part of the science of Chemistry is prevailing. Practical processes ranging from how science teachers make practical design of science, how teacher preparation is done before the practical work is carried out and how the practical work is carried out under the guidance of teachers (implementation) and accordingly evaluation of their performances and students’ achievements are vital for teachers. Science education should be regarded as “education through science” rather than “science through education” ([Holbrook and Rannikmae, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280184_ja)). This shows the importance of practical implementation of practical Chemistry which is the focus of the current study. Literature reports that very few studies on the practical implementation of practical Chemistry have been conducted in Indonesia ([Copriady, 2013](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280091_ja)). Therefore, the current study is undertaken to address the problem and the research gap.

In conducting the literature review, the aspects of design, preparation, implementation and evaluation were taken into consideration. In addition, the effects of teachers’ location and gender, in past studies, on practical chemistry teaching will be discussed.

**Problem-Based Learning (PBL)**

Given the importance of practical teaching of Chemistry, problem-based learning is discussed. Problem-Based Learning (PBL) refers to a teaching and learningmethod rooted in the medical sciences, first introduced in 1969, is increasingly popularizing in other academic disciplines including education, psychology as well as business (Coombs and Elden, 2004). Also, this method is becoming increasingly popular in science including Chemistry (Belt et. al, 2002). Here, the development of PBL approach concerning a traditional Chemistry laboratory module through examining the traditional laboratory format to explore the rationale for a change. Accordingly, PBL will, then, be elaborated on to see how this method can solve this problem.

**Traditional labs:** Laboratory classes normally involve students carrying out teacher-structured laboratory exercises or/and experiments, where each step of a procedure is vigilantly prescribed and students are supposed to follow and keep on the procedures precisely. Generally, the students cannot be thinking and creative. This kind of laboratory activity is frequently known as a ‘recipe lab’ (Domin, 1999), in which little student involvement with the content is required. Likewise, Johnstone et. al. (1994) expounded, “students can be successful in their laboratory class even with little understand of what they are actually doing”. Nevertheless, the student may have little option but to accept this passive approach whilst, they deal with new techniques and/or equipment, particularly when the lab preparation involves no more than reading and understanding the laboratory manual. In this vein, Johnstone (1991) commented that the laboratory is regarded as an information overload place, resulting in students with little ‘brain space’ in order to process information and consequently, they blindly and thoughtlessly follow the instructions. In addition, they seldom interpret their observations or/and the results obtained during the experiment.

Hence, it is significant to emphasize the expense of running and administering laboratory sessions in school and university. First, it is costly to build, equip, maintain and uphold specialized laboratory space. Second, technical and academic staffing plus postgraduate demonstrators are required. Furthermore, laboratory work is time-consuming and lastly, there is ongoing and constant expense of consumable apparatus and chemicals (Bennett and O’Neale, 1998). However, the advantage of such laboratory sessions for students is questionable. Also, Also, it is not clear if the usual and typical recipe lab format is justifiable concerning such expense.

The design of recipe labs activities is prearranged, as technicians, demonstrators and staff, all obviously knowing what is the activity and resulting outcome. Therefore, the teaching staff can clearly identify and rectify the errors for the students before continuing with the laboratory work and consequently the students get little problem-solving experience in the laboratory. Furthermore, all the students are usually performing the same experiment which can cause students to be only concerned with obtaining the same findings as their laboratory neighbor. Nevertheless, recipe labs enjoy the great merits that let the inexperienced student to have the same attitude towards laboratory work like professional scientist. Also, the recipe lets the student to dedicate all his/her attention to the method and not to be concerned at all about theory ([Garratt, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280145_ja)). They take advantage of opportunities to directly improve manipulative as well as technical skills which maximize students’ practical experience as well as maximizes the validity of the results the students can potentially obtain. Contrariwise, the students do not care about matching their laboratory learning to previous experience. On the same note, [Johnston (2011)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280191_ja) declare “Consolidating their learning by asking themselves what is going on in their own heads”, despite the professional scientists and researchers conducting the laboratory work for a specific purpose which is meaningful for them. Another problem associated with recipe type labs is that the real practical aspect of any experiment shows only a small portion of the entire process of experimental science ([Garratt, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280145_ja)), whereas in recipe labs only the practical aspect is covered.

[Hunter *et al*. (2009)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280188_ja) argues that the recipe lab deletes the planning and design stages” and it focuses on ‘data processing’ instead of ‘data interpretation’. [Garratt (2008)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280152_ja)suggests that there are various steps that can take a research scientist prior to dealing with the practical phase of the experiment:

* What questions are we trying to answer?
* What observations would provide an answer to the questions?
* How can we best create conditions for making the desire observations?
* How will we process and evaluate the observations?
* What will we do next?

These issues comprise practical problem aspects that students have no connection with, as the laboratory technician and instructor decide on these issues long before the students embark on the experiment. Obviously, the recipe labs have their own merits and with some modifications, can be much more efficient and effective in the process of teaching and learning science. Integrating student ownership, connecting experiments with previous experiences, as well as helping students using higher order cognitive skills, can provide authentic and genuine investigative processes ([Johnstone and Al-Shuaili, 2011](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280213_ja)). Laboratory sessions should provide the proper opportunity for students to hypothesize, criticize, analyze, explain and evaluate arguments and evidence. Likewise, [Bailey (2010)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280055_ja) emphasized the significance of transferable or broad-spectrum skill development in a UK context, recommending that a stress on transferable skills at the third level is greatly desirable.

**Problem-based learning (a learner-centered approach):** PBL perceives a shift in educational and learning focus from a teacher-dominated approach to teaching/learning to a student-dominated one, in which students create meaning for themselves through connecting new concepts and ideas with previous knowledge, an alternative approach to teaching/learning, encouraging dynamic and active engagement of the learner ([Tan, 2004](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280193_ja)). As a learner-centered approach, it demands the learner to take a gradually increasing responsibility for his/her own learning. Therefore, PBL is in line with the constructivist theory ([Coombs and Elden, 2004](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280087_ja)). Moreover, it also concentrates on anther aspect of constructivism that is associated with learning via social interaction, recognizing the influence of others’ views on the way of learners appreciate things ([Harlen, 2005](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "119183_b)).

The purpose of PBL is developing reflective, self-directed and lifelong learners who are able to integrate knowledge, work collaboratively with other students and think critically ([MacKinnon, 2009](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280095_ja)), hence enhancing the chances of students emerging with some of the skills, highly desirable and useful in the work place. Besides, by employing unstructured real-life problems instead of the content as the hub of attention, students are provided with opportunities to truly learn how to learn ([Tan, 2004](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280193_ja)).

In this vein, [White (2010)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280195_ja) claimed that PBL could be perceived as an alternative to traditional method of education. Practical PBL, in which the problem is the focus of the learning, provokes lengthy collaboration among groups which leads to conceptual learning. Students automatically need to activate their prior knowledge to contemplate and start thinking, concerning the problem facing them and accordingly build new knowledge that is the main premise of constructivism. This has been demonstrated to augment learning which is in sharp contrast with traditional labs which make use of tasks with obvious procedures and true answers, related to limited exchange of information among students which leads to simple explanations plus routine learning ([Wilkerson, 2006](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1309154_ja)). Correspondingly, [Belt *et al*. (2008)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280058_ja) claim that problems are considered as the context as well as the driving force for learning. Thus, the achievement of new knowledge is carried out through these contexts. Practical PBL is different from the familiar case-based and/or problem-solving methods, as in PBL, the problems are faced before all the pertinent knowledge has been obtained and acquired ([Albanese and Mitchell, 2013](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280047_ja). Nevertheless, there are many implementation issues that need to be addressed. Similarly, [Woods (2007)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#44371_bc) has listed the key issues with PBL implementation approach in relation to a traditional chemical lecture course as follows:

* Providing the students with the prerequisite skills
* Students must be enthusiastic to take the responsibility of their own learning and to deal positively with the attitudinal changes that happen when they undergo change.
* Enabling the students to act as their own facilitators
* Selecting and training teachers to handle PBL courses (known as the facilitators)
* Encouraging student’s attendance and participation
* Selecting and formulating the problem, as well as preparing resources and placing the student in groups

Moreover, facilitators need to be eager to take risks as they take the responsibility of their own learning ([Woods, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#44371_bc)). The important factors useful for practical problem based learning include:

* Problems were developed according to existing experiments
* Problems were designed to guarantee that students dealt with a pre-defined area of knowledge and also to assist students in learning a set of vital concepts, skills, ideas and techniques.
* Form that the problems typically take are descriptive statements.
* Students work either individually or in group
* Students take part in a pre-lab, in which the students’ original answers to the problems are discussed with the instructor of lab who provide supplementary context and/or Chemistry support and also who highlight potential drawbacks
* Prior to embarking on the lab work.
* **Theoretical background:** The core aims of practical PBL comprise of the development of skills (general and technical), knowledge and understanding and chemical concepts. An alternative teaching and learning environment which combines pre-labs, group work, discussion, practical as well as alternative assessment, can help to achieve theses aims.
* **Skills:** In the development of the practical PB laboratory, the first stage is to reflect on the favorite learning outcomes in relation to skills and scientific method developed from laboratory work. [Garratt (2007)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280145_ja) and [Bennett and O’Neale (2008)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280060_ja) depict the range of skills that should be developed via laboratory work as illustrated in [Table 1](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#t1). Laboratory work must also provide the students with the experience of designing an experiment, the process of science and combining subject knowledge with practical experience ([Garratt, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280145_ja)). There are clear similarities between the skills associated with practical PBL proposed by these authors.

**Table 1: Skills to be developed through practical work.**

|  |  |
| --- | --- |
| Garratt (1997) | Bennett and O’Neale (1998) |
| Technical skill | Manipulation |
| Confidence in lab work | Lab know-how |
| Observational skills | Observation |
| Awareness of safety | Experiment design |
| Recording skill | Data collection |
| Data manipulation | Processing and analysis of data |
| Data interpretation | Interpretation of observation |
| Presentation skills | Problem solving |
| Report writing | Team work |
| Oral communication | Communication and presentation |

Skills including technical and observation skills, data collecting and confidence in practical work, are fundamental parts of most laboratory sessions. Nevertheless, as a result of reviewing the traditional module, it is revealed that skills like data interpretation, teamwork, problem solving and communication of findings are missing. Thus, it is crucial for the students to appreciate the opportunity to develop and use all these skills.

**Teaching and learning environment:** After determining the skills, techniques and concepts, the next phase involves designing the teaching/learning environment to cover pre-lab work, group work, discussion as well as alternative assessment.

**Pre-lab:** The use of pre-lab session prior to the laboratory to brain storm the learners is not a new issue. [Johnston (2009)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280191_ja) defines the elements of an efficient and effective pre-lab exercise as follows:

* Revision of theory
* Re-acquaintance with skills
* Planning the experiment to some degree
* Discussion with peers
* When the abovementioned elements are combined with elements of ownership together with relevance for the students, consequently the pre-lab could be very effective for preparing the learner mind ([Johnston, 1991](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280191_ja)). In addition, if students associate the laboratory experience with real life examples, they will be motivated to actually do the experiment.
* [Johnstone *et al*. (2008)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1309145_ja) expounded on the application of pre-labs to physics: “The aim of the pre-labs was to prepare students to take an intelligent interest in the experiment by knowing where they were going, why they were going there and how they were going to get there”. Furthermore, [Sirhan](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1309152_ja)*[et al](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1309152_ja)*[. (2009)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1309152_ja)commented on pre-lectures in Chemistry being “a useful tool in enabling students to make more sense of lectures, the effort being particularly important for students whose background in Chemistry is less than adequate”. Likewise, [Allen *et al*. (2006)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1262557_ja) reported how problems in practical PBL can be put forth with mini lectures.
* **Group work:** Being involved in small-group co-operative learning, students can pursue their own learning within the context of the group. Also, they can refer to others for the purpose of support, validation and feedback. Interaction can become champion learning between group members, if it is suitably structured to permit discussion and consideration of different views ([McManus and Gettinger, 2006](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1309146_ja)). Group work is an integral part of practical PBL in and out of lab.
* **Discussion:** Another important element in practical PBL is discussion. Discussion is referred to, broadly speaking, as a wide spectrum of informal situations in which talk between people occurs. Specifically, it is associated with a special arrangement of a group interaction in which members work collaboratively to address a question of common interest, while exchanging different viewpoints to build a better understanding of the issue in question ([Bahar, 2003](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280053_ja)). Likewise, discussion before the lab class as well as during the pre-lab session is recommended in practical PBL. [Nicol and Boyle (2003)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280159_ja)demonstrated that students who have discussion in small groups not only their conceptual understanding is developed but also a strong motivating force is created. It was also stated that students indicated a preference for contemplating about the problem before the discussion. Accordingly, students would be more likely to involve in dialogue and to provide reasons for identifying gaps in their thinking. The purpose is to engage students to think creatively and critically and questions need to be posed to support these demands ([Bahar, 2003](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280053_ja)).
* **Assessment:** According to [Savin-Baden (2004)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1309151_ja), currently assessment appears to be one of the most challenging and controversial issues in practical PBL. She declares “many of the concerns about assessment in higher education seems to relate to the unintended side-effects that undermine staff intentions to encourage students to learn effectively”. Her study revealed that students have following main challenging issues with assessment in practical PBL:
* **Unrewarded learning**
* Disabling assessment mecahnisms

The effect of assessment on group work through PBL allows for more alternative and diverse assessment tools, such as written reports, oral and poster presentations and peer assessment, etc. The issue of undervalued and underrated learning in groups is a challenging one to address. Correspondingly, [Overton (2001)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280175_ja) expounded on various assessment tools employed in case studies:

* “Assessment tools which have been successfully used include oral presentations to other scientists, oral presentations to a lay audience, written reports, summaries of data collected, peer assessment of group participation and individual reflection on skills development.”

Many supporters of practical PBL encourage the implementation of oral presentations in different disciplines ([Allen and Tanner, 2003](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1179202_ja); [McGarvey, 2004](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280099_ja)). Likewise, [McGarvey (2004)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280099_ja) has reported the application of poster presentations for Chemistry subject. He heightened the advantage of posters as he claims that, it triggers creativity and accordingly offers another platform for assessment, taking into account the students who might have been overlooked and unnoticed in the traditional assessment designs. In addition, due to their limited size, posters emphasize the significance of precise and concise information. Besides, they can promote collaborative work which cannot be supported by written lab reports. Lastly, he reported a positive attitude toward posters both by students and instructors.

Moreover, the written report is still advocated and has its benefits that it combines the method with results and allows students to report, analyze and draw conclusions concisely and informatively. Consequently, written reports constitute a fundamental part of the practical PBL, however, the stress is on the outcomes and conclusions drawn by the students as well as associating the findings with the original problem in hand.

**Higher Order Thinking (HOT) legacy in international science curricula and assessment:** Higher Order Thinking (HOT) has been used consistently in science education in terms of reform agendas internationally ([Osborne and Dillon, 2008](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#69054_an)). Suggestions for promoting science education all over the European Union (EU) encompasses the following. Science courses that engage students in higher-order thinking includes constructing arguments, asking questions, making comparisons, establishing causal relationships, identifying hidden assumptions, evaluating and interpreting data, formulating hypotheses and identifying and controlling variables ([Osborne and Dillon, 2008](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#69054_an)).

**Higher order thinking in Chemistry:** [Osborne and Collins (2001)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1309147_ja)claim that assessment has remained part of the “forgotten landscape” or unaddressed asspect of science education research due to the capacity of assessment to champion or block a curriculum’s intent for Higher Order Thinking (HOT) by specifying the pedagogies used in school science classrooms ([Fensham, 2006](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "63924_con); [Liang and Yuan, 2008](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280092_ja)).

Comparing the curriculum guidelines of 12th grade Physics with the test content of the exit examinations in China, shows the stress on low levels of knowledge remembering and application ([Liang and Yuan, 2008](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280092_ja)). In fact, it was explored that the curriculum as well as examinations did not propmote or demand creativity, critical thinking or the capability to carry out scientific enquiry which are the skills generally associated with HOT. In China, there is a system called ‘the merit pay system’ which potentially reinforces a concentration on such low levels of cognitive demand in pedagogy along with learning since, it rewards teachers who train high achiever students in terms of examinations. These findings are consistent with research studies that have been done recently across two countries, namely New Zealand and Northern Ireland which explored that high-stakes summative assessment plus accountability measures blocked the students to develop thinking skill in terms of curriculum intent ([Gallagher *et al*., 2012](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280133_ja); [Liang and Yuan, 2008](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280092_ja)) studies reported a comprehensive model of measurement-driven instruction designed precisely to employ assessment to modify and improve teaching practices. If standardized instruments focus on lower order thinking, then teachers are most likely going to focus their pedagogy on these goals. On the contrary, it can be anticipated that if assessment is designed to promote HOT, then this should influence teaching practices due to the “teaching-to-the-test” effect in standardized high stakes assessments.

[Fensham and Bellocchi (2013)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280117_ja) drew on a number of international examples in which teacher-generated assessment instruments provided the scope for attaining various HOT aspects of science curriculum intent that included connecting science and technology, involving students in decision making and developing knowledge about the nature of science. [Zoller (2003)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280203_ja) has also reported success in examination questions requiring Higher Order Critical Thinking Skills (HOCS) through the use of appropriate teaching strategies in undergraduate Chemistry classes. From these two sets of examples, it is evident that assessment regimes have the capacity to support or hinder any reform agenda for HOT or curriculum intentions for HOT. Furthermore, they suggest that the inflexibility of externally designed assessment instruments is more likely to hinder HOT, whereas the flexibility that is possible with internal instruments can support HOT.

In the context of this study, internal assessment refers to assessment instruments developed by school teachers and external assessment refers to assessment instruments (typically examinations) that are developed by assessment and curriculum organizations and administered to all students within a state or territory. The instrument inflexibility in an external test enables achievement scores to be compared norm referenced measurement. The flexibility, that internal instruments can have, makes such numerical comparisons difficult but the students’ performances can be assessed and compared against a commonly described set of criteria on standards-based measurement.

A degree of internal assessment is a key feature in the study, therefore, it is useful to indicate that we mean that the Chemistry teachers in a school take responsibility for the design and grading of their students’ work on a set of tasks that are carried out during the course of study. In the high stakes assessments , the nature of these tasks is externally prescribed in broad terms, as are the criteria for the award of the different grades. This type of teacher responsibility extends the assessment practices that science teachers regularly undertake in their classrooms to check the various learning tasks they set their students. A long-standing example of one of these tasks in science is practical investigative skills. These can only be assessed in a balanced way by the classroom teacher as argued by [Black (2004)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#119161_b) and [Yung (2006)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#119186_b), who has described how biology teachers in Hong Kong carried out this role in high stakes testing with reference to the issue of fairness and comparability. The intended learning outcomes that are now expected in contemporary science curricula extends more of this assessment responsibility to the classroom teacher ([Fensham and Bellocchi, 2013](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280117_ja)).

**A shift from the curriculum to the student:** Prior to about 1975, the Chemistry education community was concerned essentially with the subject matter in terms of “What should we teach?” The implication was that the ‘answer’ for chemical education lay in the selection or design of the ‘right’ content for the curriculum. It was taken for granted that those who taught Chemistry knew the subject matter well.

Since then, there has been a surge in research into the question “What is learned?”. The focus has shifted from the curriculum to the student and reflection has given way to experimental investigation. Probing students’ understandings (‘misconceptions’ research) became an industry. The findings support the view that formal learning often constitutes little more than an ability to reproduce symbols and words and to apply algorithms.

Now we have encyclopedic collections of student misconceptions but usually no more than bland, general statements about preventative or curative actions. We have an enhanced knowledge of the conditions for effective learning, based upon which a range of student-centered teaching methodologies, such as cooperative learning, have become fashionable but little guidance as to how teachers might apply these to the teaching of particular Chemistry topics such as reaction kinetics or stereochemistry. Educational research has had little impact on science teaching.

Perhaps, this is partly because much of chemical education research has used Chemistry subject matter simply as a vehicle to develop ideas and theories of pedagogy, such as constructivist approaches to learning, co-operative learning, the purposes of laboratory work, metacognition, questioning, styles of learning and online learning, all of which can be considered independently of particular subject matter. I suspect that in many institutions, the emphasis of the teacher education programs are on the pedagogical issues that are the central objects of such research.

Commenting on pedagogy-based criteria commonly used for evaluation of teaching, [Shulman (2006)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "587576_ja) asked “Where did the subject matter go? And what happened to the content?”. Perhaps, what is a productive path for us to travel ([Shulman, 2007](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "776884_ja)) has labelled Pedagogical Content Knowledge (PCK). While, content knowledge refers to one’s understanding of the subject matter and pedagogical knowledge refers to one’s understanding of teaching and learning processes independent of subject matter, pedagogical content knowledge refers to knowledge about the teaching and learning of particular subject matter, taking into account the particular learning demands inherent in the subject matter.

The rationale for doing this is aptly put by [Geddis (2008)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280156_ja).

The outstanding teacher is not simply a ‘teacher’ but rather a ‘history teacher’, a ‘Chemistry teacher’ or an ‘English teacher’. While in some sense, there are generic teaching skills, many of the pedagogical skills of the outstanding teacher are content-specific. Beginning teachers need to learn not just ‘how to teach’ but rather ‘how to teach electricity’, how to teach world history’ or ‘how to teach fractions’.

Hence, in order to be able to transform subject matter content knowledge into a form accessible to students, teachers need to know a multitude of particular things about the content that are relevant to its teachability. There is a vast difference between knowing about a topic (content knowledge) and knowing about the teaching and learning of that topic (pedagogical content knowledge). Some knowledge about teaching and learning Chemistry is specific to the particular subject matter; the skills of teaching stereochemistry, for example, are different from those of teaching thermodynamics. In this study, selected examples from the topics of chemical equilibrium, thermodynamics and reaction mechanisms in organic Chemistry are used to illustrate the critical importance of PCK.

The profession of science teaching is afflicted with amnesia in the sense that the understandings that drive the strategies of competent teachers are seldom recorded, so new teachers need to develop their abilities ‘from scratch’ through experience, rather than stand on the shoulders of those who have gone before them. The chemical education enterprise is crying out for investigations that probe and report the topic-specific PCK of competent teachers, thus creating records from which new teachers can gain insights into their complex task. This can be regarded as applied research.

Part of PCK is an understanding of the various levels of operation engaged in which practising engage chemists. A more refined model than the famous macroscopic-submicroscopic-symbolic triangle of [Johnstone (2012)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280204_ja) is developed and presented. This includes the view that people engaged in thinking, imagining and musing (i.e., modelling) are at the heart of the Chemistry enterprise and that the courses in the subject ought to reflect this. [Samuelowicz and Bain (2010)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1309148_ja) conducted two case studies on the academics’ beliefs about teaching and learning. [Table 2](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#t2) illustrated the results of two case studies.

They provided two stories to illustrate the nexus between belief and practice and to demonstrate that the differences between teaching-centred and learning-centred orientations are substantial.

The first of these is teaching-centered, whereas, the second is learning-centered, as the stories presented earlier clearly illustrate. While in both cases, the academics want their students to gain a thorough understanding of the subject matter, their beliefs about the nature of understanding and learning and about their roles in knowledge organization and teacher-student interaction vary substantially. In the first case, the academic provides readymade understandings and methods for students, shows them how to apply the knowledge and interacts with them to ensure that the understanding has taken place. In the second case, the teacher assists the students, through extensive interaction, to personalize their understanding of the material and to use their new understanding to interpret the world in an altered way. These two orientations share only two of nine beliefs.

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| --- | --- |
| Table 2: | Comparison of the two illustrative cases organized by belief dimensions |
| http://docsdrive.com/images/ansinet/ajsr/2015/tab2-2k15-22-40.gif | |
| [Samuelowicz and Bain (2001)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1309148_ja) | |

**Teacher’s gender:** [Abuseji (2007)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280124_ja) reported that teacher’s gender has direct influence on students’ achievement in Chemistry. The direct effect was responsible for 0.97% of the total effect of all the seven independent variables on student’s achievement in Chemistry while, its indirect effect accounted for 3.37% of the total effect. In total, teacher’s gender accounted for 2.40% of the total effect of the seven independent variables on students’ achievement in secondary school Chemistry. This finding is consistent with the studies of [Orosan](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280169_ja)*[et al](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280169_ja)*[. (2007)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "1280169_ja), [Reap and Cavallo (2005)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#65935_con) and [Smith (2003)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#1280189_ja), who claimed that gender could predict academic achievement. However, this finding contradicts the studies of [Onocha (2005)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40" \l "17517_tr) and[Miller (2004)](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#119174_b), who found that gender alone has no effect on academic achievement but could act in conjunction with other variables to affect learning outcomes.

## 1.3 Objectives of the Study

The objectives of this study were to determine:

1. The students interested in handling laboratory equipment and apparatus themselves?
2. The attitudes of the students toward the utilization of chemistry laboratory equipment in senior secondary schools in Abeokuta South Local Government, in Ogun state.
3. Whether the availability and the effective utilization of chemistry laboratory motivate students’ in learning chemistry in senior secondary school in Abeokuta South Local Government in Ogun state.

## 1.4 Research Questions

The following research questions were answered:

1. Are the students interested in handling laboratory equipment and apparatus themselves?
2. What is the attitude of the students toward the utilization of chemistry laboratory equipment in senior secondary schools in Abeokuta South Local Government , in Ogun state?
3. Do the availability and the effective utilization of chemistry laboratory motivate students’ in learning chemistry in senior secondary school in Abeokuta South Local Government in Ogun state?

## 1.5 Research Hypothesis

There is no significant difference in students’ academic performance in senior secondary school certificate due to availability of laboratory equipment present in the selected secondary schools in Abeokuta South Local Government in Ogun state.

There is significant difference in students’ academic performance in senior secondary school certificate due to availability of laboratory equipment present in the selected secondary schools in Abeokuta South Local Government , in Ogun state..

## 1.6 Significance of the Study

The study will be important to teachers as it will help them to understand the effective utilization of Chemistry Laboratory Equipment. The findings of this study will also be significant to Educational Policy Makers because it will help them in formulating new policies. It will also be important to those that want to conduct similar research because it will add to the existing body of literature.

## 1.7 Scope of the study

The study is aimed at investigating the availability and the effective utilization of chemistry laboratory equipment on students’ academic performance in secondary school in Abeokuta South Local Government , in Ogun state. Ten public secondary schools were selected for this study. The study was also concerned with the attitudes of the students toward the utilization of chemistry laboratory equipment in senior secondary schools and whether the availability and the effective utilization of chemistry laboratory motivate students’ in learning chemistry in senior secondary school in Abeokuta South Local Government in Ogun state.

**1.8 Operational Definition of Terms**

The following terms were operationally defined as used in the study:

**Availability:-** The presence of the equipment for practical in chemistry laboratories.

**Effective Utilization:-** Appropriate use of the chemistry laboratory for practical with students.

**Chemistry Laboratory:-** Refers to as a place where chemistry practical are conducted by the chemistry teachers for the benefit of the students.

**Academic performance:-** Scores of students obtained from senior secondary school certificate examination (SSCE).

# CHAPTER TWO

**REVIEW OF RELATED LITERATURE**

**2.0 Introduction**

The review of the related literature will be discussed under the following subheadings:

2.1 Theoretical framework

2.2 Availability of chemistry laboratory

2.3 Attitude of students toward science laboratory

3.4 Effective lab utility and students motivation to learn

2.5 Relationship between laboratory equipment and students academic performance.

2.6 Summary of Review of Related Literature and Uniqueness of the Study

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## 2.1 Theoretical Framework

This study will be based on experiential learning theory by American Educational Philosopher, (John Dewey, 2008). A most famous proponent of hands-on learning and one of the first to formally defined and advocate experiential education. He regards experience as an essential component of the educational process. Dewey notes, “I assume that amid all uncertainties there is one permanent frame of reference: namely the organic connection between education and personal experience”. Dewey’s model of experiential learning consists of a logical sequence which involves perceiving a problem followed by its articulation, Dewey believed that the meaning of a given experience is the result of interaction between what the learner brings to the given situation and what happens there, for Dewey continuity and interaction are the two fundamental criteria determining the quality of experience and its implications for education. John Dewey emphasized practical ideas in both his philosophical and educational theories, always striving to show how abstract concepts could work every day life. He emphasized hands-on learning, and opposed authoritarian methods in teaching. He also advocated education that will fulfill and enrich the current lives of students as well as prepare them for the future. His ideas prompted a drastic change in United States education beginning in the 20th century.

This theory can be applied to teaching and is relevant to this study, because the theory emphasized hands-on learning. Chemistry is a subject which is inclined to practical, and demonstration method is a method commonly used by teachers in teaching practical lessons that also encourages hands-on learning to develop manipulative skills. Effective teachers design situation that allowed students to learn by doing. These situations promote students’ thinking and psychomotor development. Teachers listen, watch and question students to help them gain better understanding. The teacher asks relevant questions to stimulate students’ creative minds and potentials. There is more emphasis on “how we come to know” and less on “what we know”.

## 2.2 Attitude of Students Towards Science Laboratory

Laboratory activities as students’ learning experiences to interact with materials and/or with models in order to observe and understand the connection between science and the natural world are of valuable importance in science and chemical education (Hofstein & Lunetta, 2004). These activities have a potential to enhance students’ conceptual understanding, development of some affective dimensions such as motivation and attitude with respect to science learning, scientific practical skills and problem solving abilities, and understanding of nature of science (Hofstein & Lunetta, 2004). In addition, students have a chance to construct social relationships in a laboratory environment because they work cooperatively in small groups in this environment (Lazarowitz & Tamir, 1994).

Omiko (2015) and Ufondu (2009) were of the same opinion where they observed that laboratory teaching is sometimes used in conjunction with large lecture courses so that students may acquire technical skills and apply concepts and theories presented in the lecture. Omiko (2015) stated that “hands-on experience encourages students to develop a spirit of inquiry and allows them to acquire scientific skills and the right attitude to handle scientific tools and materials. Science laboratory provides students with the richest experiences which they will transfer to the society and their various places of work. It helps in providing the students the opportunities to practice science as the scientist do. In order for the laboratory to be effective, students need to understand not only how to do the experiment, but why the experiment is worth doing, and what purpose it serves for better understanding of a concept, relation, or process.

One of the aims of secondary education is to equip students to live practically in this modern age of science and technology, (Federal Republic of Nigeria, 2004). To this end, students at the senior secondary level of education are required to study one or all of the basic science subjects (biology, chemistry, and physics) as core subjects: chemistry is required as a prerequisite to the study of courses such as Medicine, Engineering, pharmacy, Science Education and other related courses (Omiko, 2015). This gives chemistry unique position indeed. Besides, the study of chemistry as a subject helps to develop in the learner such process skills as critical observation, analysis, experimentations, manipulation of variables and equipment which are very important in scientific investigations (Arokoyu & Juliana, 2014).

However, the performances of students in chemistry in the senior secondary school certificate Examinations (WASSC, NECO and GCE) have not been encouraging, probably due to ineffective teaching and learning of the subject. Documented research reports suggest a number of factors to that effect students’ academic achievement in Senior Secondary School Certificate. According to Ayodele (2002), obstacles to effective teaching and learning of chemistry include negative attitudes of teachers and students, lack of requisite mathematical skills and the nature of the curriculum. The presence of too many topics to be taught and the inadequate periods allocated with other factors impart on the teaching-learning strategies. In the bid to cover syllabus, teachers resort to tradition of lecture method which involves mostly the cognitive domain of learning to the detriment of the affective and psychomotor domains (Ayodele, 2002).

Chemistry teaching can only be result-oriented when students are willing and the teachers are favourably disposed, suing the appropriate methods and resources in teaching the students. With the current increase in scientific knowledge the world over, much demand is placed, and emphasis is laid on the teacher, the learner, the curriculum and the environment in the whole process of teaching and learning of science (Adesoji & Olatunbosun, 2008).

Despite the importance of chemistry to mankind and the efforts of researchers to improve on its teaching and learning, the achievement of students in the subject remains low in Nigeria. Among the factors that have been identified outcomes in chemistry are, poor methods of instruction (Osuafor, 2009) teacher’s attitude (Aghadiuno, 2002), laboratory in-adequacy (Adeyegbe, 2005), and poor science background (Oshokoya, 2008).

Laboratory adequacy which is a school environment factor has been reported to affect the performance of students in chemistry (Adeyegbe, 2005). Farounbi (1998) argued that students tend to understand and recall what they see more than what they hear as a result of using laboratories in the teaching and learning of science (Adeyegbe, 2005).

Science cannot be meaningful to students without worthwhile practical experiences in the laboratory (Hofstein, 2004). Volumetric analysis (titration) is a quantitative technique of measurement. This technique is used to standardize a solution with the help of a standardized solution.The poor performance of students could be attributed to a number of reasons including poor participation of students and poor level of exposure in the practical aspect of science especially Chemistry, it is against this background the study was carried out to determine the availability and effective utilization of chemistry laboratory equipment on Students’ Academic Performance in Senior Secondary School (Adeyegbe, 2003).

Students’ attitude toward the learning of chemistry is a factor that has long attracted attention of researchers and there is a great agreement among science theorists and practitioners on the importance of students’ attitudes toward chemistry lessons in school (Osborne, Simon, & Collins, 2003). Koballa (2008) noted that “affective variables are as important as cognitive variables in influencing learning outcomes, career choices, and use of leisure time”. The development of students’ positive attitudes toward chemistry as a school subject is an important issue. Unfortunately, research has established that much of what goes on in chemistry classrooms and laboratories is not particularly attractive to students across all ages (Stark & Gray, 2009).

Enhancement of students’ positive attitudes to chemistry is very important due to two main reasons. First of all, research on the link between attitudes and academic achievement discovered that these variables were closely related to each other. For example, in a meta-analysis study (Weinburgh, 2005) it was found that the correlation between attitude toward science and achievement is 0.50 for boys and 0.55 for girls, indicating that attitude can account for nearly 30% of the variance in achievement. Similarly, Freedman’s (2007) study demonstrated that there was a positive correlation between attitude toward science and achievement. On the other hand, Salta and Tzougraki (2004) reported that the correlation between chemistry achievement and positive attitudes toward chemistry ranged from 0.24 to 0.41. Bennett, Rollnick, Green and White (2010) also determined that undergraduate students who had a less positive attitude to chemistry almost invariably obtained lower examination marks (Cheung, 2009). The second reason that makes attitudes important is that attitudes predict behaviors (Glasman & Albarracín, 2006).

Since chemistry is a science based on experimentation, doing an experiment in aLaboratory is an important part of chemistry learning. Besides, in order to develop interest, curiosity, positive attitudes toward chemistry, creativity, and problem solving ability in science and to improve students' understanding of science concepts and scientific process, laboratories are essential (Azizoğlu & Uzuntiryaki, 2006). However, although there a lot of important studies for improving chemistry teaching and learning, and chemistry is very important for students’ academic improvement, the achievement level of students in the subject still remains low. Therefore, affective dimensions of learning such as anxiety, attitudes, and self-efficacy are perceived as important predictors of student performance in laboratory situations (Bowen, 2009).

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## 2.3 Relationship Between Laboratory Equipment and Students Academic Performance

Jatau (2008) analyzed the extent of utilization of laboratory facilities and students’ academic performance in secondary schools in Pankin. The finding was that science teachers possessed adequate knowledge of the utilization of laboratory facilities for teaching science in secondary schools. Oriade (2008) in a separate study investigated the utilization of laboratory facilities in Biology. Results revealed that most laboratory facilities were not adequately utilized during Biology teaching and learning in secondary schools, while some of the facilities were seldom adequate in schools.

Mathew (2008) examined the utilization of laboratory facilities and students’ academic performance, and discovered that utilization of laboratory facilities had a positive relationship with students’ academic performance towards science teaching and promotes good academic performance in the subject. An earlier work by Adeniyi (2003) drew attention to the relationship between utilization of laboratory facilities and students’ academic performance in Chemistry and found that the utilization of laboratory facilities was not significantly related with students’ academic performance in the subject.

Olarewaju (2004) working on the extent of utilization of laboratory facilities and students’ academic performance, explained that utilization of laboratory facilities as a process of “doing science” through practical procedures, was a manipulative process of learning which promoted good academic performance in Chemistry teaching and learning. Olarewaju, added that among other factors, when laboratory facilities were adequately utilized by students, it elicited desired behavioral change in the learners. Utilization of laboratory facilities is an activity-oriented instruction student centered and leads to self-reliant instruction.

Edet (2008) investigated the influence of utilization of laboratory facilities and students’ academic performance in Biology. Using a sample of two hundred (200) Senior Secondary School one (SS I) students taught by utilizing laboratory facilities and the control group taught without utilizing laboratory facilities during Biology teaching. The results showed that students taught using laboratory facilities frequently achieved higher than those taught without utilizing laboratory facilities during Biology lessons. The recommendation made based on this finding was that utilization of laboratory facilities should be encouraged at all levels of the education sector.

Opara (2008) examined the utilization of laboratory facilities and students’ academic performance in Chemistry. The findings, using analysis of co-variance (ANCOVA), revealed that the 26.4% of the laboratory facilities were utilized during Chemistry teaching and learning while 74% showed that laboratory facilities were never utilized during Chemistry teaching. The finding also revealed that laboratory facilities had a significant influence on the students’ academic performance in Chemistry.

The laboratory-based mode of presentation of concepts has been consistently found to be an important strategy in Chemistry teaching and learning in secondary schools. Ihuarulam (2008) investigated the perception of Chemistry teachers and students based on the utilization of laboratory facilities in secondary schools for Chemistry teaching. The findings, using a total of one hundred and fifty (150) students, showed that 41.2% of the total respondents agreed that laboratory facilities were adequately utilized during Chemistry teaching. More than half (58.9%) of the respondents said that laboratory facilities were never utilized during teaching.

Chukwuemeka (2008) examined the efficacy of utilization of laboratory facilities in teaching basic science in junior secondary schools and revealed that pupils who were allowed by their teachers to manipulate laboratory facilities by themselves did better academically than those who were not allowed. Moreover, it showed that the extent of utilization of laboratory facilities during teaching of basic science had a significant influence on the students’ academic performance in basic science. Maduabum (2008) investigated the utilization of laboratory facilities and academic performance in science and found that students who utilized laboratory facilities during science teaching and learning achieved higher than those who had no experience in laboratory activities in science. In a similar vein, Chukwuneka (2010) findings based on utilization of laboratory facilities/equipment in secondary schools showed that 74% of the science teachers utilized laboratory facilities during science teaching and learning, while 26% of the teachers never utilized laboratory facilities. The findings also revealed that laboratory facilities significantly influenced students’ academic performance in science. Igboabuchi (2010) investigated the utilization of laboratory facilities in secondary schools in Nsugbe.

Findings showed that Biology laboratory facilities were seldom utilized by both teachers and students during Biology teaching. The results also revealed that the use of Biology laboratory facilities had a significant relationship with the students’ academic performance in Biology. Etiuben (2010) investigated the effect of utilization of Chemistry laboratory facilities and academic performance in Chemistry. The findings revealed that utilization of Chemistry laboratory facilities has no significant influence on students’ academic performance in Chemistry. A review by Benedict (1994) showed that utilization of laboratory facilities has a significant relationship with students’ academic performance in science.

Brewton (2000) analyzed the effect of utilization of laboratory facilities on students’ academic performance, and discovered that the teaching of science concepts is more effective and meaningful when laboratory facilities are well utilized during science teaching. Brewton concluded that effective utilization of laboratory facilities during classroom interaction influenced students’ academic performance in science.

The continuous record of students’ poor performance in SSCE examination is a serious indication that all is not well in the Nigeria educational system, most especially at the secondary school level. Several assertions, Eshiet (2006) observed that not much attention has been given to the issue of enriching the science laboratories for effective teaching and learning of science. A lot of research has been carried out on students’ poor academic performance in science. Jegede (2010), Ivowi (2009) and Bajah (2004) noted that poor academic performance among secondary school students in science is due to poor utilization of laboratory facilities by teachers. The utilization of laboratory facilities has been an issue of great concern to science stakeholders in educational system (Uche and Umoren, 1998).

Ivowi, (2013); Okebukola, (2010); and Bajah, (2009); observed that the utilization of laboratory facilities in chemistry teaching enables learners to develop problem solving skills and positive attitude, interest towards science learning. Scientists and researchers like Oyekan (2009) saw science and technology as basic tools for industrial and national development. These if properly harnessed could bring about economic and social happiness by providing and improving the welfare of the citizenry. Consequently, the teaching and learning of science has become a great concern to scientists and researchers.

As people think about the teaching and learning of science in our schools, the picture of the state of Science and Technology in a country like Nigeria becomes glaring. This was expressed in the annual conference proceedings of Science Teachers Associations of Nigeria (STAN) in 1998 on the theme “winning more students for Science and Technology”. This theme came as a result of poor performance by students in science examinations. This poor performance often resulted in poor enrolment of students in science at the secondary and tertiary institutions.

The poor performance of students could be attributed to a number of reasons including poor participation of students and poor level of exposure in the practical aspect of science especially Chemistry. Agbo and Mankilik (2009) quoted the then Minister of Education in Nigeria as saying that the performance of students in the sciences was not encouraging in spite of the huge amount of money expended on the purchase of science materials and equipment. Dajili (2011) also expressed his concern about the poor performance of students in science examinations. This concern arose from the increasing realization that the nation could not develop as rapidly as she aspired to without adequate tools of scientific and technological man power at all levels in her working populace. He (Dajili, 2011) maintained that the state of science at the secondary school level was very important. This is because the performance at this level determines the quality and quantity of intake into the tertiary institutions in the country. This is why the performance in science examinations at this level as observed by Agbo and Mankilik (2009) and Dajile (2011) should be investigated.

The natural sciences (Biology, Physics and Chemistry) have two components, the theory and the practical aspects which make the teaching and learning of science real. Over the years report shows that candidates do not perform well in practical aspect. Ministry of Education (2001) and WAEC Chief Examiner‟s Report (2002) attributed the poor performance especially in practical aspect of Chemistry to their non-familiarity with the use of simple laboratory equipment, imprecise statement, spelling errors, inadequate exposure to laboratory techniques, lack of observational skills, inability to determine mole ratio from stoichiometric equations, omission of units in calculated values, inability to write symbols properly and assign correct charges to ions, among others.

**2.4 SUMMARY OF REVIEW AND UNIQUENESS OF THE STUDY**

Related literatures were reviewed on the attitude of students towards chemistry laboratory, relationship between chemistry laboratory and students academic performance in senior secondary school certificate examination. The theoretical framework used in this project was experiential learning theory by American Educational Philosopher, John Dewey (2008).

The study is unique in the sense that it was design to determine the availability and the effective utilization of chemistry laboratory equipment in senior secondary school students’ academic performance in Maiduguri Metropolis, Borno State. So many studies were conducted by different researchers for example (Hofstein & Lunetta, 2004) conducted similar study but they used descriptive statistics in their data analysis while in this study, frequency counts and percentages were used and also one way analysis of variance was used.

Studies conducted by (Omiko, 2015; Ufondu, 2009; Omiko, 2015 and Ayodele, 2002) conducted similar studies in either Pakistan, Ogun or Edo while this study was carried out in Maiduguri Metropolis, Borno State. Another uniqueness of the study was on the choice of research design. Adesoji and Olatunbosun (2008) conducted similar study using quasi-experimental design while this study used survey research design.

# CHAPTER THREE

**METHODOLOGY**

**3.0 Introduction**

This chapter deals with the research design, population and sample, instrument for data collection, procedure for data collection and method of data analysis.

## 3.1 Research Design

The survey research method was adopted for this study. Survey according to Nelson and Thomas (2010) is a technique of descriptive research that seeks to determine present practices or opinions of a specified population on one or more variables. This can take the form of questionnaire, interview or normative survey. A well validated instrument titled Availability of Chemistry Laboratory Equipment Checklist (ACLEC) and a profoma were used for data collection. The profoma was used to obtain the results of the students under study.

## 3.2 Population and Sample

The sample of the study will be 200 students from five (5) public schools under study (i.e. Abeokuta Grammar School, Lantoro High School,Nawair-Ud-deen High School, Lisabi Grammar School, Rev. Kuti Memorial Grammar School) 40 students from each school.

## 3.3 Procedure for Data Collection

The researcher went to all the five (5) public secondary schools under study with a checklist to assess the availability of Chemistry Laboratory equipment in their various Chemistry laboratories .The exercise lasted for 5days that is the researcher spent one day at each of the five schools under study.

## 3.4 Method of Data Analysis

The statistical tools used for the analysis of the data includes: frequency counts, percentages and one-way analysis of variance (ANOVA).

**3.5 Validity Test**

All research question will follow a list wise procession in the administered questionnaire thus it will indicate accurate validity of the research method to highlight the research hypothesis.

**3.6 Reliability Test**

The Cronbach’s alpha value will be derive as .209 which will show reasonable reliability on the data used in analysis of this project work due to the large size of the sample population.

# CHAPTER FOUR

**RESULT, CONCLUSION AND DISCUSSIONS**

**4.0 INTRODUCTION**

This study was conducted to determine the availability and the effective utilization of Chemistry laboratory equipments in senior secondary schools on academic performance in Abeokuta South Local Government Area, Ogun State. Five public schools were sampled and the results were analyzed as follows:

## 4.1 RESULTS

**Research question one:** What is the attitude of the students toward the utilization of chemistry laboratory equipment in senior secondary schools in Abeokuta South Local Government Area, Ogun State?

**Table 4.1.1: Availability of laboratory equipments in the five secondary schools**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **ITEM** | **SA** | **A** | **DA** | **SD** |
| 1 | The use of chemistry laboratory for practical motivate students in learning chemistry |  |  |  |  |
| 2 | The use of chemistry laboratory for practical arouses the interest/curiosity of students in learning the subject |  |  |  |  |
| 3 | The use of the laboratory in teaching chemistry make students skeptical of things they do not see |  |  |  |  |
| 4 | I am always honest by using the laboratory in learning chemistry |  |  |  |  |

**Source: Field survey, 2019**

The result from table one above shows that, 80.34% of the respondents agree that, the use of laboratory for practical motivate students in learning chemistry. Also 77.16 of the respondents agree that the use of chemistry laboratory for practical arouse the interest of the learner in learning the subject and 90.83% of the respondents believed that, the use of laboratory in teaching chemistry make students skeptical of the things they do not see, while 93% of the respondents are of the opinion that, they are honest by using the laboratory in learning chemistry.

**Research question two:** Do the availability and the effective utilization of chemistry laboratory motivate students’ in learning chemistry in senior secondary school in Abeokuta South Local Government Area, Ogun State?

**Table 4.1.2: Responses of the students on whether chemistry laboratory practical help them understand the subject**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S/N** | **ITEM** | **SA** | **A** | **DA** | **SD** |
| 5 | By using the laboratory in learning chemistry, I learn how to observe |  |  |  |  |
| 6 | By using the laboratory in learning chemistry, I learn how to classify things |  |  |  |  |
| 7 | I learn how to interpret result by using the laboratory in learning chemistry |  |  |  |  |
| 8 | I always learn how to measure because I use the laboratory in learning chemistry |  |  |  |  |
| 9 | By using the laboratory in learning chemistry, I learn how to conduct an experiment |  |  |  |  |

**Source: Field survey, 2019**

The result from table two above shows that, 77.5% of the respondents agree that, by using laboratory in learning chemistry, they learn how to make observation by themselves and 71.66% also agreed that, through the use of practical in laboratory, they learn how to interpret practical result. Also 84.17% of the respondents believe that, they learn how to classify things while 80% of the respondents agree that, they always learn how to measure because I use the laboratory in learning chemistry and finally 75.34% of the respondents believed that, they learn how to conduct an experiment when taught chemistry practical in laboratory.

**Table 4.3: Summary of the one-way analysis of variance on the performance of the students in the five schools under study**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Source of variation** | **Sum of squares** | **df** | **Mean square** | **F-ratio** | **P-value** | **Decision** |
| Between Groups  Within group |  |  |  |  |  |  |
| **Total** |  |  |  |  |  |  |

The result from the table above shows that, the test is significant that is there is significant difference in the mean performance of the five schools under study because the p-value (0.002) is less than the level of significant ( Therefore, the null hypothesis is rejected. A Post-Hoc test (Duncan) was also conducted to determine which of the school(s) caused the rejection of the null-hypothesis and the results are as follows.

[Table 4.3](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#t3) shows that there is no significant difference in practical designs (t = 1.480 and sig. = 0.140, p>0.05), practical teacher preparation (t = 0.254 and sig. = 0.254, p>0.05), practical implementation (t = 0726 and sig. = 0.469, p = 0.469) and practical assessment (t = 0.214 and sig. = 0831, p>0.05) based on gender.

The results show that male students have a higher mean compared to female students for every aspect of the study. However, there is no significant difference in the design, preparation, implementation and evaluation based on gender. This is because teachers have the same advantage in the teaching and learning process. Chemical science instructional design guidelines have brought teachers together in the Assembly Subject Teachers (MGMP). Practical Chemistry science tools and materials are appropriate to the students’ and teachers’ needs to be performed by male and female teachers.

[Table 4](https://scialert.net/fulltextmobile/?doi=ajsr.2015.22.40#t4).3 shows that there are differences based on the practical preparation with the value of t = 3.128 and sig. = 0.002, p<0.05, while there are no significant differences in the practical design with value t = 1.200 and sig. = 0.232, p>0.05), practical implementation (t = 1.025, sig. = 0.306, p>0.05) and practical assessment (t = 1.044 and sig. = 0298) based on location. It means that there is no significant difference in SMA teacher competency in Riau on the urban and rural areas. Regarding practical preparation, this indicates that the chemical science teachers who have taught more in urban area can prepare tools and materials which are better than those of rural teachers.

**CHAPTER FIVE**

**SUMMARY, CONCLUSION AND RECOMMENDATION**

This chapter is intended to give a summary of this research and it is meant to give some conclusion and recommendation on some points on effective utilization of chemistry laboratory equipments on academic performance in Senior Secondary Schools.

**5.1 SUMMARY**

Correlation analysis shows a significant relationship between and among instructional designs and teaching preparation, implementation and evaluation as the strength of the relationship is moderate. This shows that the better the Chemistry teaching design, the better the preparation, implementation and evaluation activities. Furthermore, there is a significant relationship between the preparations and the implementation and the evaluation and the strength of the relationship is moderate. Moreover, there is a significant correlation between the implementation of the evaluation.

Practical design has a major function in the practical implementation of scientific and practical design which reflects all the processes. Correlation analysis shows a significant relationship between and among instructional designs and teaching preparation, implementation and evaluation as the strength of the relationship is moderate. This shows that the better the Chemistry teaching design, the better the preparation, implementation and evaluation activities. Furthermore, there is a significant relationship between the preparations and the implementation and the evaluation and the strength of the relationship is moderate. Moreover, there is a significant correlation between the implementation of the evaluation. Practical design has a major function in the practical implementation of scientific and practical design which reflects all the processes performed in the practical chemical science lessons. Teachers need to make a comprehensive design, appropriate material, determine tools and materials as well as determine practical teaching procedures and practical evaluation methods.

The importance of teaching in the laboratory is generally defined as inquiry which involves a range of activities in making observations, asking questions, examining books and resources that are already in the know, planning investigations, observing what has been demonstrated in experiments which clearly show the evidence, filing an answer, explaining, predicting and communicating the results.

**5.2 CONCLUSION**

This study was conducted to identify differences in the practical implementation of practical Chemistry teaching based on teachers’ gender and location. Practical implementation encompassed the aspects of the design, preparation, implementation and evaluation. The study used a survey approach using questionnaire. Moreover, the study determined the relationship between teachers’ competency concerning design, preparation, implementation and evaluation. The results showed that there was no significant difference in learning practical implementation of practical Chemistry science regarding the aspects of the design, preparation, implementation and evaluation based on gender and location. Furthermore, Pearson correlation analysis showed that there were significant correlations between all abovementioned aspects.

Based on study findings and discussion, it is recommended that that there should be further study on the curriculum and learning standards for practical laboratory Chemistry science. In addition, in-depth study of teacher competence in the teaching of practical Chemistry based science, teacher profile analysis and competency is suggested.

**5.3 RECOMMENDATION**

In order to have effective utilization of chemistry laboratory equipments on academic performance in Senior Secondary Schools and to properly channel the attitude of students toward the learning of chemistry subject, these recommendations were given by the researcher:

However, some studies have highlighted the importance of gender and school location but in the current study, gender and location are not important. It is knowledge that is important. Practical implementation among teachers in design, preparation, implementation and evaluation based on gender and location is almost the same. This shows that the design of practical Chemistry science is a significant concern for chemical science teachers with a variety of demographic backgrounds

1. It is recommended that training and workshops for chemical science teachers be implemented by different organizations including the Ministry of Education, the Board of Education Quality Assurance as well as Center for Development and Empowerment of Educators for science teachers in making instructional design.

2. Collaboration is also emphasized for experienced teachers to be able to train and teach practical skills to novice teachers, especially in preparing tools and materials needed for practical activities.

3. Teachers are also required to provide the student teachers with the practical results which are implemented in the theoretical knowledge of chemical science to avoid failure in achieving the learning objectives.

4. Since the main aim of practical work in chemistry is to make accurate observation and description, therefore, teachers should develop a logical reasoning method of thought, develop self-reliance; verify principles and facts already learnt.

5. Government should motivate chemistry teachers for the enhancement of students’ positive attitudes to chemistry