Comparative Effectiveness of Actual Practical and Alternative Practical Chemistry Teaching Models on Students' Achievement in Volumetric Analysis

By

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Dedication

This study is dedicated to my mother Kebete Kassa, my late father Albejo Doelaso for all the devotion and commitment, which they have made to me throughout my education, even though they were not educated.

Declaration

I declare that comparative effectiveness of actual practical and alternative practical chemistry teaching models of learners' achievement in volumetric analysis is my own work and that all the resources that I have used, have been acknowledged by means of complete references.

24/2/2021

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Bekele Albejo Doelaso Date

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Acknowledgments

I will like to thank my God and my lord Jesus Christ…

I sincerely give all honour and praises to the eternal God, rock of ages, immortal, invisible and the only wise God in strengthening and sustaining me to complete this programme successfully.

I express my appreciation to officials of Dilla University who gave me the opportunity to study this doctoral degree at the University of South Africa (UNISA). I acknowledge and express with my heartfelt gratitude to my supervisor Prof. Harrison I. Atagana for his guidance. My gratitude also goes to all assistant teachers, school directors, chemistry teachers and learners who participated in giving suggestions, responses for all my queries in the study.

List of abbreviations

ICT- information communication technology

CM-Conventional materials

CAL-computer-aided learning

ATQ- Achievement test Questions

SQCL- Student questionnaire on chemistry laboratory

TQ-Questionnaire administered to teachers

AP-Actual practical

ALP-Alternative practical

TM-Traditional method

LAM-Locally available materials

TOS- table of specification

ANOVA-analysis of variance

ANCOVA-analysis of covariance

QA-questionnaire administered

MD-mean difference

TPHA-tukeys' post hoc analysis

fa1-category-1 QA after treatment

fa2n-categry-2 QA after treatment after reversing the negatively stated statement

fa3n-category-3 QA after treatment after reversing the negatively stated statement

fa4n-category-4 QA after treatment after reversing the negatively stated statement

fa5-category-5 QA after treatment after reversing the negatively stated statement

faTn-overall-QA after treatment after reversing some negatively stated statement

fb1-category-1 QA before treatment

fb2n-categry-2 QA before treatment after reversing the negatively stated statement

fa3n-category-3 QA before treatment after reversing the negatively stated statement

fb4n-category-4 QA before treatment after reversing the negatively stated statement

fb5-category-5 QA before treatment after reversing the negatively stated statement

fbtn-overall-QA before treatment after reversing some negatively stated statement

NAS-National Academy of Science

"Live as you were to die tomorrow. Learn as if you were to live forever."

Mahatma Gandhi

Table of Contents

List of Tables

List of figures

List of graphs

Abstract

This research attempts to compare the academic achievement of learners who were taught practical lessons in volumetric analysis using conventional materials in schools with equipped laboratory facilities and practical lessons in volumetric analysis taught using improvised materials as an alternative approach in schools without well-equipped laboratory facilities in Sidama zone, SNNPRS, Ethiopia. A control group was taught with the traditional method. Two schools were assigned in each group based on the purposive sampling technique, on the criteria whether the school had laboratory facilities and/ or not. The quantitative research method was employed in generating data through the blueprint of quasi-experimental non-equivalent group research design. Three instruments were used for data collection such as achievement test(ATQ),SQCL-questionnaire and TQ-questionnaire. SQC-questionnaire was administered to two hundred learners in both actual and alternative practical chemistry teaching models schools' groups. It compared the perceptions of learners for only after an intervention.TQ-questionnaire was administered to sixty five teachers found in all groups. The scores of the three instruments were analyzed by using descriptive and inferential statistics. Five hypotheses were set based on five research questions and tested at a 0.05 significance level. According to the result of the findings that existed among after the three interventions for academic achievements $F(2,297) = 3.875$, $P=0.022$, partial eta squared = .0254 is significant in difference. thereby using Tukey's HSD post hoc multiple comparisons (1) MD=4.911, $P = .357$, $P > 0.05$ indicate that there was non-significant difference in academic achievement between practical lessons in volumetric analysis who were taught using conventional and improvised materials as an alternative method.The hypothesis set based on the research question one was accepted; and (2) there was a significant difference in academic achievement between learners who were taught practical lessons in volumetric analysis using conventional materials and traditional method. The hypothesis was also accepted since MD =1.491, $P = 0.016$, $P < 0.05$, this difference visualized as that conventional materials (Mean=59.630, SD=10.86) and traditional method(Mean =55.48,SD =10.16) (3) there was a non-significant difference in academic achievement between learners who were taught practical lessons in volumetric analysis using traditional method of teaching and who were taught with improvised materials. Thus, the hypothesis of the research question three was not accepted. since the Tukey's HSD post hoc MD =1.491 $P = .336$, $P > 0.05$,and (4) Based on the findings for linearly combined all items after intervention $t(198) = .246$, $P = .004$, $P < 0.05$ indicate a significant difference of learners' perception between learners who were taught practical lessons in volumetric analysis using conventional materials and improvised materials. The hypothesis was rejected. The mean and standard deviation value indicates the differences in learners' perception that existed between groups were taught practical lessons in volumetric analysis using improvised materials (M=3.5, SD=0.421) and Conventional materials (M=3.3, SD =0.453). This difference inferred that learners perceived teaching practical lessons using improvised materials is a good alternative in the absence of conventional materials due to occurrence of financial constraints or other factors.(5) Finally, based on the finding for linearly combined mean values of all items, the ANOVA test result $F(2,62) = 10.653$, $p = .000$, $p < 0.05$ was significant in teachers' perception. thereby using Tukey's post hoc multiple comparisons teachers' perceptions between the groups who were taught practical lessons in volumetric analysis using improvised materials and traditional method MD = -0.220, STD error =0.160, $P = 0.354$, $P > 0.05$, is non-significant. Improvised materials versus conventional materials MD =.44545, STD error .15, $P = .013$, $P < 0.05$ is significant; conventional versus traditional method MD =.669, STD error =.141, $P = 0$, $P < 0.05$, significant. Further, the mean and standard deviation values for significant results indicate the differences in teachers' perception that existed between practicals were taught by improvised materials (M=4.161,SD=0.541) and conventional materials (Mean=3.72,SD=0.435); traditional method (M=4.385,SD,0.497) versus conventional (Mean =3.72,SD =0.435). In conclusion, teaching practical lessons of volumetric analysis using improvised materials is a good strategy in the absence of conventional materials or in conditions where financial constraints would not permit the use of conventional materials or some other factors.

KEYWORDS: alternative practicals, conventional methods, improvisation, perceptions, traditional method, volumetric analysis.

CHAPTER ONE

1. Introduction

This chapter described (1) background information of the research work,(2) statement of the problem, (3) justifications of the research work (4) the significance of research work 5) the objective of the study (6) research questions and the hypothesis of the study(7) operational definitions of key terms, (8) Contributions of the research work for the scientific community(9) Scope and delimitation,(10) ethical considerations and(11) chapter divisions of the research work.

1.1 Background of Study

The objective of practical lessons is to increase and improve the value of science education and learners' understanding of chemistry concepts by using the laboratory activities listed in the curricula to meet the intended learning outcomes of sciences and other science-related fields. Laboratory facilities are used in the lesson to impart knowledge effectively and found in the acquisition of science process skills by performing practical activities in the laboratory during the instructional process by manipulating equipment alongside the lessons' theoretical aspect (Hofstien and Lunetta, 2003). Science process skills that are obtained through practical teaching activities in chemistry reduced some misconceptions, which caused learners to low achievements (Centigul & Geban, 2011). Moreover, learners equipped with science process skills can also implement different business ideas to alleviate poverty in real society (Nbina, Viko & Biravil, 2010). In the end, the learners become the founder of some business organizations that also related to their field of study after subsequent use of effective instruction. Furthermore, they play a role model in unemployment reduction by expanding small-scale enterprises and some other large-scale factories to benefit society. As described in Zudonu & Njoku (2018), there are multiple benefits of practical teaching for national development. These are directly entailed in chemistry learning, and its' practical activities in the laboratory, such as the fundamental roles it plays in production, clothing, housing materials, medicine and transportations. Aledejana & Aderibigbe (2007) tried to describe the most valuable benefits of laboratory-based teaching as, activity-based learning that makes the subject matter more comprehensible and increase retention of appropraite concepts. Furthermore, it guides the transfer of more likely knowledge and attains a favourable mindset towards a particular concept. The benefits of the laboratory-based teaching approach also emphasized by Abungu, Okere and Wachanga (2014) that teaching chemistry in real society is used to solve everyday life problems, contributing to national development in different perspectives like school environments and some other work areas. Thus, to increase the level of importance among the society, teachers have often-preferred suitable instructional contexts for teaching chemistry using the laboratory approach, which is well equipped and exactly fit practical lessons to cope up a required purpose in the curriculum (Muhammad, 2014). Furthermore, they identify and introduce clear direction or blueprint to facilitate learning activities in chemistry to acquire scientific knowledge and the appropriate science process skills. Ankibobola & Afolabi (2010) also overemphasized as a conclusion in their study that the laboratory approach improves the acquisition of science process skills, which further increases a positive impact on learner's achievement score. However, chemistry's' instructional goal as a subject may not be achieved as planned in Ethiopian schools' designed curricula. This is due to ineffective teaching strategy of the lessons concerning practical lessons; those are included in scientific study, and teachers' ineffective utilization of practices to impart the knowledge of the subject matter to the learners. Laboratory activities should not only aim to support the theoretical aspect of instruction in acquiring knowledge but also allow learners to discover their knowledge through the regular practices of experimental activities that are incorporated within the lessons those are designed for particular instructional purposes (Burck & Towns, 2009; Feyzioğlu, 2009). In line with this discussion, in general, Njelita (2008) explained that chemistry teaching is one of the laboratory-oriented subjects, which helps learners to address an appropriate exhibition of good activities in their study for successful analysis and interpretations of information gathered through learning certain observable facts.

The lack of practical activities and inappropriate utilization of resources in the laboratories by chemistry teachers and learners have resulted in poor communication with regards to chemical language and observation skills acquired, which in the end, it leads to a negative impact on learners' achievement in chemistry in general. According to the recommendations of different scholars, practical activities in chemistry can also develop scientific thinking, performance and participation in all scientific endeavours, which are also related to other science fields even if they are rarely exposed to practical work in the class (Hofstien, 2004; Akpan, 2010; Alam, Oke & Orimogunje, 2010). The ultimate advantages, those expected to be obtained from the learners' laboratory works, include enhancing and improving education quality by changing the teaching styles. Furthermore, these learning activities lead learners in scoring high achievement results in chemistry subject. Generally, according to Centigul et al. (2011) laboratory works are used to improve learners' achievements result in chemistry subject through the acquisition of appropriate science process skills, which further reduces misconception and incapability of problem-solving skills.

Furthermore, the laboratory activities assist learners boost their interest and curiosity in chemistry in particular and positive perceptions towards scientific approaches of teaching science education objectives in general (Hofstien & Mamlok- Naaman, 2007). According to the scholar in science education, laboratory activities, particularly in chemistry will also contribute in improving learners' conceptual understanding, scientific thinking, observation, creative thinking, application with skills, practising numerous laboratory techniques, and ability to analyze relationships of inter-related variable, including chemical analyses and syntheses as well as a problem-solving strategy (Burak et al, 2009; Ikeobi, 2004). Finally, in short, this study needs to use appropriate laboratory equipment and chemicals that are fit for experiments that are designed in chemistry subject areas, particularly, volumetric analysis and some other related topics as an alternative teaching strategy. Thus, learners are partaking actively in the laboratory to enhance their research skills and other important skills, containing both basic and integrated scientific skills in common. The higher-order integrated science process skills such as problem analysis, research plans, research management, data recording, and interpretation of the findings in experiments are also further resulted from learning by doing activities (Feyzioğlu, 2009; Abungu et al., 2014). So far, the lack of opportunity to obtain important scientific skills due to the absence of equipment, also gave rise to poor performance among learners, further affecting learners' achievement in chemistry in general and volumetric analysis.

In the preparatory stage and the higher education programs as well, currently at the university level in Ethiopian, learners are also expected to learn and acquire some vital principles and basic areas of knowledge in chemistry in general before completing their stipulated level of education. It is important to note that volumetric analysis is a quantitative analysis involved in acquiring science process skills. Practicals in acid-base, redox and precipitation titrations are examples of volumetric analysis (Skoog, West, Holler & Crouch, 2004; Dower, 2008), which further participate in providing the quantified results after a reaction occurred in chemical analysis of samples. It is defined as in different perspective views depending on the type of matter used as solids, liquids and gaseous substances. The specific applications of chemical analysis in chemistry that benefits the society among different activities include found in the state of both liquid and gases phase of substances. In general, based on the types of substances used to be studied in chemistry, volumetric analysis is also defined as a quantitative analysis method to measure the volume of liquids and gaseous substances. The Volumetric analysis used in conducting the experiments, containing only gaseous substances require reacting or absorbing of the substances to be determined in graduated vessels over mercury.

Finally, the volume changes measured; and it involves a titration technique for liquid substances to determine the quantity of the unknown substance in the solution (Dower, 2008; Ackerman, 2005). Volumetric analysis techniques have numerous benefits that have been used in different perspective areas in science development. Studies on the advantage of volumetric analysis were published in scientific journals such as space sciences which examined the occurrence of volatile materials in cavity volume, in environmental studies to decide the relationship that exists between brain assembly and sensory ecological aspect of marine animals, and in the stepwise inquiry of hard water to determine its' purity, and in several other areas of scientific endeavour s (Ackerman, 2005; Lisney, Bennett & Collin, 2007; Kakisako, Nishikawa, Nakano,Harada,Tatsuoka & Koga, 2016) in that order. It is one of the parts of science that man cannot do things without giving attention to the volumetric investigation provided us with the scientific information to be used by the society (Alam et.al., 2010). Thus, it is mandatory to learn volumetric analysis due to its’ numerous fate for the society.

Furthermore, it is also found in giving attention to the improvement and development of societal healthy and wealthy life conditions. Even though all these are about using of volumetric analysis, according to the context of developing countries like Ethiopia, it is difficult to teach learners about volumetric analysis because of the absence and shortage of laboratory facilities used to acquire science process skills effectively. Experimental activities also result in hands-on practices for the teachers and learners when they are directly engaged in doing practical activities during laboratory sessions in chemistry lessons in particular and other sciences in general. Thus, several alternative approaches have been studied worldwide to effectively address the scarcity of facilities. These alternatives were used as a substitute in the absence and scarce of laboratory facilities during chemistry concept teaching in particular and other science fields in general (Hofstien, 2004; Kelly & Finlayson, 2007). Some of the instructional methods were reviewed worldwide for teaching all experiment-related science subjects in general, in the absence of real materials.

Although there are, many alternatives used to be replaced in the absence of conventional materials to teach the experimental activities in science subjects in general, because of that, the brilliant science teachers find out the most and tangible teaching methods fit in to their instructions based on the situation allow them to process the learning. Regarding these explanations, there are many alternative practical approaches reviewed worldwide and recommended for teaching chemistry in particular like simulation, ICT-based instruction, teaching using videos and the use of local materials are some of the strategies that teachers must use in the absence of laboratory facilities (Aksela, 2009; Hofstien, 2004; Millar,2004). There is also a visible need for practical lessons to be considered in the laboratory about chemistry teaching in general to halt the inhibitions in acquiring science process skills by doing experimental activities in their overall scientific endeavour. On this occasion, DomNwachukwu & DomNwachukwu (2006) also tried to report issues regarding laboratory facilities that hamper the teaching and learning process in chemistry. Furthermore, they forwarded solutions for the lack of resources for experiments designed in prescribed contents, which look like an actual problem in teaching and learning sciences and science-related subjects in developing countries. Consequently, they provided the blueprint for those resourceful teachers to discover an appropriate alternative line of action to solve the existing problem, which was suggested by different researchers in education and can help them in doing the experimental work (Hofstien, 2004; Hofstien et al., 2003). Alternatives for practical chemistry teaching in the absence of real materials are discussed briefly by the writer of this research work in chapter two under the topic 2.5.

1.2. The Statement of the Problem

The research identified the problems during the practicum course that was taught for final year learners and from school placement programs, which were held for teaching practicum by the Dilla University staff members in Chemistry Department, Ethiopia in the last ten years. Researcher has also identified it during practicum through observation while working on the small-scale project together with other chemistry teachers as the community service in recent years. According to the view of chemistry teachers in the small-scale project in government secondary schools, high school teachers did not have enough skills for practical activities to be taught and assist learners in acquire science process skills from the experiments in chemistry in grade twelve in general. Furthermore, the community services project workers observed and recognized that the high school teachers had not taught the learners effectively about the contents of chemistry. The project workers also observed that laboratory facilities that were not equally distributed in all schools even if they are located among the same ethnic group areas. Surprisingly, some schools with very highly equipped laboratory facilities and others with no laboratory facilities observed during both the small-scale project and practicum teaching held by chemistry department staff members at Dilla University in these stipulated areas. Some schools' teachers taught their learners also with limited laboratory facilities and using improvisations. Teachers in the other schools did not manage the scarce resources effectively while teaching practical activities as it designed for and incorporated in the objective of the curriculum by the subject specialists. Although it was known that facilities in the laboratory rooms were evenly distributed to process the learning activities of science subjects effectively. However, instructional activities were not handled as intended in the curriculum. In line with this assumption, Hofstien et al. (2004) recognized the function of laboratories in science teaching on the spot in the end; they discussed and concluded that researchers in science education have not comprehensively identified the effects of practical teaching on learners' learning contexts. In particular, they suggested that further studies about practical lessons should be conducted in chemistry to study and sort out its effect on learners' conceptual understanding and acquiring science process skills that help them become skilled with laboratory instruction.

Other scholars also mentioned some of the factors that result in handicapped academic performance of learners in chemistry subject are lack of teaching materials and inappropriate utilization of instructional aides like laboratory facilities by the teachers (Oladipupo, 2002; Hamisi, 2011, Yitbarek, 2012). These factors operated at the high school level as it was observed and extended to the university level, which is centred on minimizing learners' achievements in chemistry. In the specific illustration, the first-year chemistry and biology subjects' learners who enrolled at Dilla University faced a problem when they are taught about university chemistry and its' practical chemistry lessons as a freshman course, which deals with more about laboratory practicals related to volumetric analysis. This has happened in the school environment; the learners were not quite familiar with the practical activities, including suitable laboratory facilities such as chemicals and equipment related to volumetric analysis at the introductory level. Therefore, it is possible to alleviate the existing problem, which is poor achievement by teaching with investigated alternative materials with their properties by improvisation. It can be employed especially in schools that are located in the rural environment and for newly launched schools as well to increase learners' academic achievement in chemistry.

1.3. The Justification of the Research

Volumetric analysis has been taught and will be taught in the future unless the curriculum is changed in the grade 12 chemistry syllabus accompanied by practical activities that render its efficacy in acquiring science process skills. It can reduce the misconceptions, which further increases learner's achievement scores in chemistry in particular (Centigul et al, 2011). Even though learners are expected to perform experiments to substantiate, the knowledge imparted from the theoretical aspect of chemistry teaching by the teachers, there were problems identified that halt the expected outcome of learning objectives.

These were the absence of facilities in the laboratory and teachers' facilities to improvise materials for teaching purpose to bridge a gap that exist between practicals and the theoretical aspect of the lesson. Some of them were identified observing teaching experimental activities especially in volumetric analysis for first-year chemistry learners who joined the researchers' host university as freshmen and registered for the university chemistry laboratory practical course to be accomplished as the learning stipulated in that level. All the problems that might not be achieved in the preparatory level were sought and identified as the inhibitors of instructional process at the tertiary level such as lack of technical skills, observation skills, obeying laboratory ethics, handling chemicals, equipment and some others related issues about science process skills in chemistry. Oladipupo(2002) also identified these issues as problems caused inadequate facilities that resulted in learners with no experience in performing the experimental activities in the laboratory that are related to the topic of volumetric analysis at the introductory level before they come to start studying in the higher education level. It is known that experiments in grade-twelve chemistry curricula are aimed to support the theoretical aspect of the lessons to be taught by the teacher. Uzezi & Zainab (2017) also reported that doing practical lessons increase the potentials among the learners in the acquisition of science process skills if it was applied in a good teaching habit. However, the learners were not exposed to these practical activities in some schools as expected for teaching their chemistry curricula. Furthermore, the laboratory facilities were not equitably distributed to all schools. As a result, there were impartial treatments in quality of education with the conditions being other factors equal.

It is unambiguous to understand that the chemistry's intended knowledge can be imparted to the learners when teachers engaged in laboratory facilities for teaching practical lessons since it was an experiment oriented science subject. However, in the absence of real material system containing standard materials, teachers need to find appropriate alternative approach rather than trying to import conventional laboratory facilities with hard currency since they are too costly to afford, as well as with shortage of the financial need sought in the schools to purchase standard materials (Hofstien, 2004). Teachers often try to ready in their preparations with content knowledge and use appropriate facilities through improvisation to conduct practical activities for each experiment in the lessons to be done to make the learners skilled with science process skills that help to reduce misconceptions in chemistry, which further decrease the low academic achievements in chemistry in general (Taber, 2009). As a conclusion to wind up the case, finding the alternative methods like materials and chemicals through improvisation from resources in the environment in the absence of conventional materials can reduce any situation that may happen due to the inadequacy of facilities in the laboratory. In the end, learners must be well equipped with skills equally keeping the fairness in the quality treatment of the education in all schools whether they are urban and/ or rural school getting the same information about the final goal in teaching chemistry at the preparatory level before enrolling or attending higher education or universities as freshman learners.

1.4. The Significance of the Study

Chemistry is one of the experiment-oriented sciences and has paramount importance in developing livelihood situations and society's experiences. The theoretical aspect of chemistry teaching needs to be accompanied by the practical activities to achieve a better learning. Moreover, it needs appropriate facilities in the laboratory, which is suitable for the learners' instructional delivery mode of the contents to be studied in the class. From numerous experiments in a chemistry textbook, practical lessons within the volumetric analysis are more of experiment related activity-oriented content areas that assist learners acquire science process skills after analyses proceeding in secondary school chemistry curricula. Furthermore, it experiences the learners in doing calculations after recording the respective data as soon as the experimental works on. These experiences assist learner in acquiring the intended science process skills like recording abilities, the ability to interpret ideas, organizing principles etc. Practicals to be conducted in ongoing research were constructed from both the theoretical aspect of volumetric analysis, including practical activities and some other related topics in chemistry. The contents in the volumetric analysis were designed by the researcher (appendex-1) and guided the study in this research. In the end, learners were informed with some volumetric analysis concepts by teaching the text of contents in particular. Thus, it helps learners must be familiar with various aspects of techniques of volumetric analysis in chemistry before they come up to join higher education. Even though it still one of the most fundamental topics used in the acquisition of science process skills in general. However, the learners may not be familiar with the contents to be taught like titrations due to laboratory facilities' inadequacy. They may not have practised practicals based on chemistry curricula that pertained to be accomplished at the high school level, particularly in grade 12 to inculcate these skills. Ural(2016) focused on an enumerated discussion about the laboratory work that can be mentioned as developing understanding related to the scientific concepts, problem-solving skills, science process skills and understanding of the nature of sciences. Furthermore, dealing with practical work more effectively with facilities used to acquire process skills and reduces some misconceived ideas resulting in low academic achievements in chemistry. There are also several topics examined within the volumetric analysis, which contribute its' share in the acquisition of science process skills such as observations, manipulative skill and recordings skills included under the subtopics like acid-base, oxidation-reduction, the formation of compounds and complexes, and precipitation reactions' titrations (Ackerman, 2005; Dower, 2008,). All the above content areas mentioned are used to treat manipulative skills in volumetric analysis.

However, it is difficult to teach learners with laboratory activities-oriented works or activities, those are found within the chemistry textbook stipulated at the preparatory level for schools in rural areas and recently launched new schools. As it also described in Achimugu (2019) the inability to exploit the intended science process skills is due to scarcity of laboratory facilities and the appropriate skills that teachers may not have to improvise materials. Learners are not exposed in doing practical works to acquire hands-on activities as a result; they are bored in chemistry practical lessons, because of facilities' constraints to conduct experiments. Furthermore, teachers tie their hands together and sit in the class without giving attention to learners to avoid inappropriate learning process concerning the need for practicals for knowledge construction. As a result, the scholars recommended that using an alternative practical approach through improvisation in the absence of conventional laboratory facilities is mandatory to minimize the problems that halt chemistry teaching (Barely & Brigham, 2008; Chemistry L, 2012). From this, perspective, teachers at preparatory schools have to use an alternative method that involves improvised resources for experimental activities related to volumetric analysis to assure and promise the equity in quality education. Most of the resources for the current research work produced by the assistant teachers and the researcher, and the others produced from the principle how to improvise adopted from the work of Yitbarek in 2012 (Yitbarek, 2012). However, the study's main purpose is to evaluate the effectiveness of teaching methods in practical lessons of volumetric analysis were taught using improvised materials as an alternative practical approach by comparing teaching the same contents with conventional materials through the blueprint of the academic achievement scores of learners. Contextualizing all this, the current study used to introduce the alternative practical activity, which is teaching with investigated locally available resources with their properties like acidity, bascity and indicator behaviour of the study's materials. Furthermore, its' goal is in introducing the advantages of improvisation to schools in rural areas and newly launched schools. It also familiarizes teachers and the school principals as well as the concerned bodies in education centers like Wereda and Zonal level with the alternative practical approach, which is found in supporting theoretical aspects of the lessons with practical activities in chemistry textbook curriculum stipulated as per designed to accomplish the learning objectives predicted to be studied. All the mentioned stakeholders need to get feedback of the research report to use in their plan to cascade the study results presented in a final report of the research in the society. It also used to review the existing curriculum based on the ongoing study including the alternative practical approach inclusive of the environment's resources. The study is also used to upgrade the learner's knowledge level as effective as striving to achieve on the higher learning standards at the university level. The teaching and learning process of practical chemistry lessons halted due to the occurrence of financial constraints to afford conventional materials or absence of laboratory facilities can be safely done using the knowledge of improvisations at the preparatory level. It also used as a guideline and references for the next researchers on related topics. Furthermore, it would enable the society to get a quality education. In the end, it would suggest possible solution for the problems cited by this research material.

1.5 The purposes of the study

The purposes of the study were:

I. Comparing the effectiveness of volumetric analysis practical lessons taught with improvised locally available materials, as an alternative approach against those taught with conventional laboratory materials on the achievement of Grade 12 learners in preparatory schools in Sidama zone, Snnprs, Ethiopia.

II. Comparing learners' and teachers' perceptions on laboratory facilities, practical activities and science process skills in volumetric analysis that were acquired using conventional materials and those acquired using alternative materials.

1.6. Research Questions and Hypotheses

1.6.1 Research Questions

The study provided answers to the following research questions:

1. Would there be any significant difference in the mean scores of the post-test for academic achievement of learners who were taught practical lessons in volumetric analysis with conventional practical chemistry materials and those who were taught using improvised materials, as an alternative practical chemistry teaching model in volumetric analysis?
2. Would there be any significant difference in the mean scores of the post-test for academic achievement of learners who were taught practical lessons in volumetric analysis with conventional practical chemistry materials and those who were taught the same contents using traditional method as a control group?

3. Would there be any significant difference in the mean scores of the post-test for academic achievement of learners who were taught practical lessons in volumetric analysis using improvised materials as an alternative practical chemistry teaching model and those who were taught using traditional method as a control group?

4 Would there be any significant difference in learners’ perceptions after treatment in the responses to the SQCL-questionnaire, between those who were taught practical lessons in volumetric analysis using an conventional practical chemistry materials and those who were taught using improvised materials as an alternative practical chemistry teaching model?

5. Would there be any significant difference in teachers' perception in the laboratory facilities and its’ practical activities among the three intervention groups (Actual practical chemistry teaching model, alternative practical chemistry teaching model and traditional method of teaching)?

1.6.2 Hypotheses

The Null hypotheses that were tested at a .05 level of significance in the study were,

HO_1: There is no significant difference in the posttest mean academic achievement scores of learners who were taught practical lessons of volumetric analysis using conventional practical chemistry materials and those who were taught using improvised materials as an alternative approach in volumetric analysis.

HO_2: There is a significant difference in the mean posttest academic achievement scores of learners who were taught practical lessons of volumetric analysis with conventional practical chemistry materials and those who were taught using traditional method as the control group.

HO_3: There is a significant difference in learners' post-test mean academic achievement scores that was taught practical lessons in volumetric analysis using improvised materials as an alternative approach and those who were taught using traditional method as a controlled group.

HO4: There is no significant difference in learners’ perception in the post treatment scores of the SQCL-questionnaire administered to the learners who were taught practical lessons in volumetric analysis using conventional materials and who were taught using improvised materials as an alternative approach.

HO5: There is a significant difference in teachers' perception regarding laboratory facilities and its' activities in the score of TQ-questionnaire among the three intervention groups (Actual practical, alternative practical and traditional method)

1.7 Operational Definition of Terms

Model: Simplified representation used to explain the workings of a real-world system or event

Actual practical chemistry teaching model: Practical lessons in chemistry taught by using conventional materials as Experimental group I

Alternative Practical chemistry teaching model: Practical lessons in chemistry taught by using improvised materials as Experimental group II

Traditional method: Practical lessons in chemistry taught using normal teaching, using only theory as Control group.

Alternative to practical: The remaining option; something available after other possibilities has been exhausted

Constructivist: Psychological epistemology which argues that humans generate knowledge and meaning from their exercise.

Epistemological: Theory of knowledge, as a field of study; is about knowing or cognizing, as a mental activity.

Volumetric analysis: Branch of practical chemistry with a quantitative chemical analyses group involving the measurement of volumes of reacting substances in solution.

1.8 Contributions of the Research

The input of this research work or project to the scientific community

- ✓ No research work has investigated volumetric analysis in comparing the alternative practical model's effectiveness, which is taught using acids, bases and indicators from resources in the environment with that of the actual practical model, which is taught by using conventional materials.

- ✓ This research work alleviates the equity problem in quality education for schools in rural areas and newly launched schools.
- ✓ Since this research was done with low-cost materials, and their properties was investigated so that learners will get some extended tips, which is designing materials that help them in a future career.
- ✓ They are also more advantages for environment protection from pollution since most substances were constructed from plastics those introduced to the land and water as waste. Plastics and other materials, which are non-degradable, those introduced to land and water must be reused for the laboratory purpose in the school with no facilities after reconstruction. Therefore, this strategy also ensures the recycling of already used plastic materials for laboratory facilities.

1. 9 Scope and Delimitation

1.10.1 Scope

The study area of the current research is preparatory schools in Sidama Zone, SNNPRS, Ethiopia.

1.10.2 Delimitation

This study mainly delimited to practical lessons in volumetric analysis, which was taught in grade 12 chemistry classes as a school curriculum in Sidama zone preparatory schools stipulated.

1.11 Study area

The study area of the research work was Sidama zone, SNNPRS, Ethiopia. All schools are approximately more than 40km far apart to each other. Thus, it reduced contamination existing among the schools. Six schools were selected using a purposive sampling technique from this zone.

1.12. Ethical Considerations

This research work was done only if with Sidama Zone education sector's permission with written documents in permitting to be handled the research in six selected schools; those were grouped into three experimental groups and participants in each school. To ensure the consent of schools for the project work or research work, written documents were attached as appendices at the end of the thesis. All participants enrolled in this research work signed to confirm their willingness. The intact class or the existing learners have participated in research work. All information gathered from the work of literatures were acknowledged in the references.

1.13 Chapter division

The followings were all six chapters that are concluded in the whole research work as outlined below.

Chapter-1 includes an introduction; justification of the study; research questions, the study's significance; finally, it presents the meaning of terms.

Chapter-2 illustrates the literature review that ascribes practical lessons in chemistry giving attention to how it relates to the research problem.

Chapter-3 describes the research methodology, the instruments used to collect data, how to employ it in this study and the statistical data analysis methods.

Chapter-4 presents data analysis and discussion.

Chapter-5 presents discussions of the results

Chapter-6 presents the winding up and suggestions derived from data, investigation and comparative literature studies.

CHAPTER TWO

2. Review of Related Literature

Chapter two is a review of related literature and, is structured as follows: Introduction (Section 2.1); Theoretical framework of the research work (section 2.2), The need for low-cost equipment for science education (section2.3); Improvisation of science education materials for effective chemistry teaching (Section 2.4); Alternative approaches that are needed for practical chemistry teaching(section2.5); volumetric analysis, its nature and importance (section2.6); and Some learners misconceptions in chemistry, which was briefly studied under (section 2.7).

2.1 Introduction

All science subjects have practical importance and have many multipurpose applications in this scientific world. However, instead of appreciating the use of sciences, learners think of it as a vague, complicated and not linked to their day-to-day life activities (Colen, 2013). The difficulty of science subjects was out shined due to inadequacy of laboratory facilities that indicate its' advantage of giving further information and do not forfeit in solving problems among learners to improve their' achievements. Practical works in the laboratory can be accomplished by using the cumulative efforts of the teacher's skills, the knowledge of other professionals, the use of appropriate materials and chemicals in the laboratory as well as learner's interest. If not, the teachers and other professionals in chemistry education used experimental activities well, so that instructional objectives have not been achieved as planned in their teaching plan. Since practical activities are a fundamental part of the teaching and learning process of sciences (Baser & Durmus, 2009), employing different approaches for doing practical activities of the same experiments based on theoretical aspects of the lessons fosters chemistry teaching in particular. It imparts both the scientific knowledge and science process skills among learners. Laboratory facilities also play a vital and typical role in teaching and learning sciences in general (Lagowaski, 2002; Hofstien, 2004). Thus, the arguments that are deduced in favour of practical lessons to be done through appropriate facilities entailed these vital roles that include the acquisition of cognitive knowledge, manipulative skills and positive perception in an academic environment as well as the practical experiences of certain phenomena in the laboratory (Hofstien; 2004). It is also mandatory to follow up with an appropriate instructional method to develop final intended solution to attain the learning objectives in chemistry teaching. In this regard, teachers have many options to use and elaborate on the teaching and learning activities in sciences particularly in chemistry. Based on the contribution of some research works that were examined by different scholars (Hofstien, 2004; Lunetta, Hofstien & Clough, 2007), an adequate evaluation was done on experiment-related subjects to show the unambiguous routes for laboratory instruction which is not yet available for all nations in worldwide. Inadequate teaching styles of sciences were also found, which could not solve the problems as expected by relating the theoretical aspect of the subject matter with experiments that were designed in the context of the curricula. Because of these contradictory issues that existed due to inappropriate dissemination of the research results, science educators must consider the fallacies that may happen in teaching, and act on them to show the necessary route to teach learners with recommended alternatives by different scholars who researched on the laboratory issues (Lunetta et al., 2007; Temechegn, 2012; Yitbarek, 2012). Since laboratory activities are typical elements of science-related fields at all teaching levels (Adane & Adam, 2011). To assure these at hand, teachers offer important component credits about practical works using laboratory facilities that involved skills learners acquired in doing practice, since it is the origin of using laboratory methods in science teaching a long time ago (Hofstien & Lunetta, 2003 & 2004). Furthermore, teachers have to be interested in doing practical activities that are related to the theoretical aspect of the lesson.

These days, it is atypical to get a science course without teaching organisations practical lessons (Olutola, Daramola & Bamidele, 2016). As a result, suitable learning is attainable from the given practical activities if learners are allowed to handle equipment and materials that are small and portable to hold in the laboratory during experimental activities to assist them in constructing their cognitive knowledge and observable facts as well as interrelated scientific concepts (Ikeobi, 2004). So, to be involved actively in doing practical activities, learners are provided with reading materials produced by teachers, who are expert in science fields specifically practical activities of the lessons, and some kinds of equipment which help learners to examine shortcomings resulted from procedures in identifying theories and principles in sciences (Olutola et al., 2016). Furthermore, they can get advantages from practical work through hands-on activities for practical lessons in science courses, which may include increasing of their awareness and develop abilities towards the scientific attitudes in the subject matter as well as their achievement in academic accomplishments indeed it is found in other laboratory-related fields too (Orimogunje, 2014, Pavesic, 2008). Many reports about experiment-related issues that were disseminated like the benefits it gives to the society and skills that learners acquired help the teacher to emphasize practical activities that involve learners to be in an active position, more enjoyable and motivating than teaching similar areas through discussions and lecturing method (Skoumios & Passalis, 2010). Moreover, teaching science subjects in general and chemistry in particular also requires learner's active participation to do practicals with their hands-on activities, which increase the interest and curiosity, and positive perceptions among learners (Omiko, 2015). In the absence of any facilities at all and teachers incapability to improvise materials from resources in the environment, demonstrations can also be used to fill a gap instead of conventional materials as an alternative strategy for practical lessons to consolidate the theoretical aspect of teaching the subject matter. In these situations, lectures have been given to the learners in classrooms using lecturing methods in schools found without enough facilities (Oladipupo, 2002; McKee, Williamson & Ruebush, 2007). However, some schools do not have any materials used even for demonstration purposes. Unfortunately, based on the research was done in secondary school science education numerous learners in different schools have not actively involved in performing such practical lesson with their own hands (Orimogunje ,Oke & Alam, 2010; Oladipupo, 2002). Thus, teachers have to identify factors that affect their planned objectives in science teaching in general. Based on the identified factors as a basis, they must try to solve the problems that hinder teaching and learning activities. Hamisi (2011) reported these concepts as factors that hamper performing practical activities at secondary school laboratories are,

- Many teachers do not have enough experience with the science experiments; on the whole, due to the absence of practical education when they were students.

Teachers training programs and the new chemistry teachers' guide seek to address these shortcomings.

- Lack of experience in doing practical leads learners gets not enough confidence in trying new experiments. Science can only be learned through experimentation just as learners must perform activities to understand the materials on the syllabus truly, so too teachers strongly encouraged performing every one of these experiments to deepen their fundamental understanding of chemistry.
- Most schools lack traditional laboratory facilities. Many educators, therefore, assume that this means hands-on activities are impossible.

According to scholars' view, in chemistry education, the experimental activities also demand materials that existed near to learners and teachers living environment (Yitbarek, 2012; Temechegn, 2012). These improvised laboratory materials, without doubt add values to science teaching particularly in chemistry for schools located at rural areas and for some other newly launched schools having no laboratory equipment and chemicals at all that may happen due to financial constraints in schools. For schools with no infrastructures including laboratory facilities, teaching with local materials through improvisation is an alternative approach and mandatory that used to guarantee the quality and equity of science education for all learners irrespective of their environment. Shitaw & Birhan (2017) related to the problems in practical teaching and the solution to minimize problems reported that teachers ascribed the quality of chemistry teaching through conducting experimental activities with improvised materials in all secondary schools even if they do not have access about the conventional facilities in the laboratory to conduct experiments. In these situations, this research reveals that many excellence applied science experimental works, which are feasible with indispensable laboratory facilities that immediately replaced by the material and chemicals in the laboratory from resources in the environment by improvisation.

2.1.1 Laboratory activities and their benefits in teaching science

Science subjects often embraces practical activities, which are typical of an indispensable factors used in promoting a positive perception and scientific main opinion among learners to be acquired in its stipulated curricula (Omiko, 2015). To achieve this targeted goal, the equipment and experiments must be selected with awareness by identifying materials to be used and designing the experiments to provide a relevant practical experience to the learners (Uzezi et al., 2017). Since laboratory activities are any activities that learners perform in the laboratory room to consolidate the theoretical aspect of the science teaching and learning (Omiko, 2007). Thus, learners' good performances in practical activities seem to indicate good knowledge of the subject matter resulting from doing practical works in the laboratory(Emoy, 2006). In its nature as one of the science subjects chemistry emphasizes practical work more than the theoretical aspect of teaching contents. From the experiments designed based on the lessons' theoretical aspect, educational values added to the learner, as practical skills among others are manipulative, physical, problem-solving abilities, and psychomotor skills. Its' effect cause further poverty reduction (Nbina & Viko, 2010). Moreover, Practicals can also cause the scientific attitude among learners that imparted through literal learning activities. Furthermore, practicals promote positive attitudes as long as they can develop important skills concerning issues like friendly communication, which further increases cooperative learning spirit among learners in doing experimental work (Colen, 2013; Hofstien & Mamlok-Naaman, 2007). Practical activities often require learners' comprehensive understanding of concepts in the experiments theoretical aspects to be conducted in the laboratory. It also demands pre-preparation and a good approach to follow up procedures to learn concepts with understanding. At the same time, it needs a visible guiding principle for building knowledge in learners by doing hands-on practical works to reduce the cognitive loads (Curtis and Smith, 2016). Furthermore, to this effect, scholars recommended that considerable learning objectives be achieved in the laboratory classes if learners are given a chance to manipulate laboratory facilities to construct their knowledge of observable facts and scientific concepts related to their intended, planned objectives (Millar, 2004; Abraham & Resis, 2012; Millar,2009). According to Lunetta et al. (2007), variables considered to make learning effective and meaningful in sciences in general as follows:

- Learning objectives should be practically obtainable;
- Clear instructions provided by the teacher and the laboratory guide;
- Availability of materials and equipment for use in the laboratory investigation;

- Harmonious learner-learner and teacher-learner interactions during the laboratory work;
- A good understanding by teachers and learners of how the learners' performance is to be assessed;
- The assemblage of learners' laboratory reports and
- Adequate preparation, appropriate attitudes, knowledge, and behaviours of the teachers should be adequate.

Based on some research that was disseminated for educational utility in society and scientific communities, the scholars indicated that the role of experimental activities that brought the technology transfer forth viewed as worldwide issues confronted through doing practicals in science subjects is an unambiguous situation (Hofstien, 2004). Moreover, the most successful learning takes place from beginning to the end in particular experimental works must hold as planned in the context of the lessons to solve the problems effectively, because of a basic need for 'doing' practicals to be also part of learning in sciences (Abraham & Millar, 2008; Hofstien & Lunetta, 2004). It is also vital to note that enhancing science teaching as an engine, improves ones country's development because of pragmatic advantages that sought as a good opportunity in the transformation of traditions to the technology aspect (Zengele, 2016). In line with this recognition, there is a similar trend observed in education that is changing the attainment of knowledge from an obsolete approach to scientific questioning and investigation, problem solving and application of the result of sciences within the school environment and among the society (Ali et al., 2000). Moreover, the curriculum developed in some developed countries recently dispatch practicals learning on a new innovative level that need sophisticated instruments. If it is not in our case, the traditional way of teaching can be reviewed in advance to be as effective as innovative approach by using like demonstrations to illustrate scientific principles, combined with learners' activities to work in the laboratory with subsequent use of recipe book guidelines in the absence of prescribed innovation in developing countries (Colen, 2013). A new teaching approach, which is rooted and updated on practical lessons, are inquiry and discovery learning methods deciding the quality of the lessons based on 'hands-on' teaching strategy via learning by doing habit (Hofstien & Lunetta, 2003). These strategies initially were adopted and broadly accepted in few countries. However, teaching learners at rural schools using this approach is not possible unless finding alternative action precisely or nearly fits that entails materials produced from inexpensive resources, which are found in the environment (Temechegn, 2012). The main target of the situation is to guarantee the availability of 'science education equally for all nations both with quantity and quality', meaning all learners at high school should take part in doing practical lessons in science subjects based on experiments designed for contents in a particular lesson in the topic to be studied.

2.1.2 The role of practical work, its effectiveness, importance and outcomes in chemistry education

The expression 'practical work' is alternatively used instead of 'laboratory work' while learners use at the time of conducting experiments in science subjects in general, because the location is not considered as a simple feature in characterizing the activities about practical lessons (Abraham & Reiss, 2012). Chemistry is one of the science disciplines with the laboratory-oriented curriculum so that learners must be in a situation of doing experiments exist in particular lessons. Practical lessons have been designed to support learning activities in chemistry based on the theoretical aspects of the contents to accomplish the planned instructional learning objectives to address the outcome of the lessons at the end of the learning process. Moreover, the outcome of the learning objectives continued to be used in further educational utility. In line with this situation, the researcher in laboratory education put forward that the rationale of practical lessons in teaching chemistry is to accompany the theoretical aspects of the lessons to be taught to provide hand-on skills to learners and shine its' importance among learners and in real society (Johnstone & Al-Shuaili, 2001). Practical lessons in chemistry could also be taught by using materials other than conventional or commercially available tools. Suppose someone is finding the variety of strategies available to fill a gap for practical work in the laboratory. In that case, he/she shall have to be informed about the fundamental principles that must be accomplished by the presence of facilities in the real laboratory to enable the teacher to settle the appropriate strategies (Oladejo, Olosunde, Ojebisi & Isola, 2011). Similarly, if the teachers are attempting to match the mode of evaluation to the effects of the objectives of teaching and then they will have to identify the outcomes observed that they proposed to achieve through the objectives designed to manage the activities at the end in their learners (Johnstone et al., 2001). This assures the final planned goal to be attained during instructions.

The noticeable information that is manifested in the laboratory with regards to Practical works involve the appropriate mode of action to be managed as a result of learners who are incapable to observe and operate genuine objects as well as chemicals used in sciences and other science related-fields to incur scientific developments(Abraham et al, 2012). Practical activities are also needed to strengthen the process of teaching and learning science subjects in general. Furthermore, they are employed in chemistry teaching to build the bridges that existed "between two ' domains ' of knowledge:- the domain of objects and observable properties, and events in one hand as well as the domain of ideas, on the other hand that Plays itself out in practice; and how it has been successful in any given practical activities depend on the intended learning objectives of the tasks required in the laboratory" (Millar, 2004 p13; Millar, 2009).Thus, practical activities often relayed on the learning objective of the study for particular experiments.

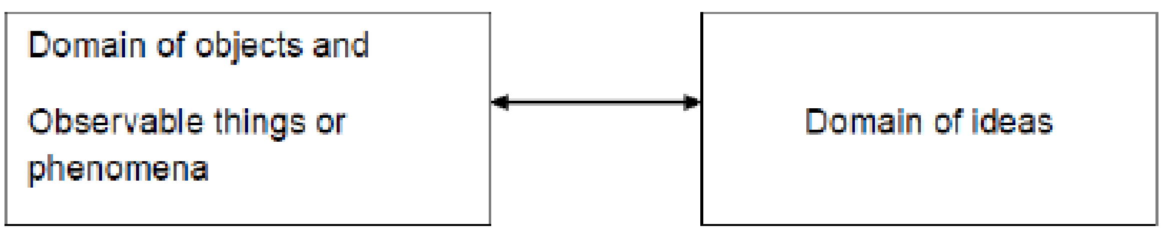


Figure2. 1 Practical work: Linking two domains of knowledge (source:-Millar, 2004)

Table 2.1Classification of objectives of a practical work in science contents

To help learners to:
1 identify objects and phenomena and become familiar with them
2 learn a fact (or facts)
3 learn a concept
4 learn a relationship
5 learn a theory/model

Source: Possible intended learning outcomes (learning objectives) from Millar (2004))

The effective utilization of practical activities improves the learning process of the science subjects in general, and learners' achievements in sciences, particularly in chemistry and their understandings about scientific illustrations used in resolving problems. "There were key approaches identified to improve the effectiveness of practical duties in a given science subject:- the first decision under consideration was helping teachers to realize, internalize and value that tasks, which required learners to formulate unambiguous bridge between the domain of objects and observable facts. Next, the domain of ideas that are challenging the achievement of the intended objectives; and then motivating teachers in designing practical tasks, which further encompass the relationship of objects and observable facts (phenomena) more evidently and completely to account the case’’(Millar, 2009 p4).

There are practical activities, which are not focused on hands-on activities but they are used as alternative methods employed for instruction based on computer-assisted teaching materials that contain activities like animations, simulations, and other forms of modeling activities (Reid & Shah, 2007, Hofstien, 2004). It can also help learners in doing the practical lessons to challenge necessary beliefs in the domain of ideas. However, these non-practical activities without hands-on activities are alternative to practicals. Teachers can teach learners who have an access to the technologies such as light and internet access etc. However, alternative to practicals lack material manipulations, objects to handle in the laboratory to experience hands-on activities or no manipulation of objects experienced in the laboratory to acquire skills (Curtis et al., 2016). For the countries in the developing world with limited technology, talented teachers have to improvise the appropriate laboratory facilities as an alternative to conventional materials to make the unambiguous association between the domain of objects and observable facts (Abraham et al., 2012). Thus, learners easily understand the concepts of chemistry by relating the objects with the facts that they observe during experimentation process.

Experimental activities could take place in a laboratory or outside the laboratory in any place where materials could be found to perform experiments so that learners have a chance to observe certain phenomena to experience hands-on activities (Omiko, 2015). So, effectively developed and implemented practical work must be accomplished in the laboratory by four stages."The four stages further described as Effectiveness 'usually means the link label led (2): do learners learn what we intended them to learn? However, to be effective in this sense, a task must first be effective at level (1), that is, the learners must do (and be able to do) things, to which task designer intended to do them. A common criticism of practical work is that it becomes 'recipe following', with the learners often not thinking about why they are doing and what they are doing. The provision of detailed 'recipes' is an indication of the teacher's or task designer's concern with effectiveness at level (1). Whilst this is a required condition for effectiveness at level (2), it is not an adequate one" (Millar, 2004 p 13, Abraham et al., 2012 p1037-1038; Millar, 2009). As discussed above, clear scheming characteristics are often entailing to assist learners to use their observations to illustrate the proposed conclusions.

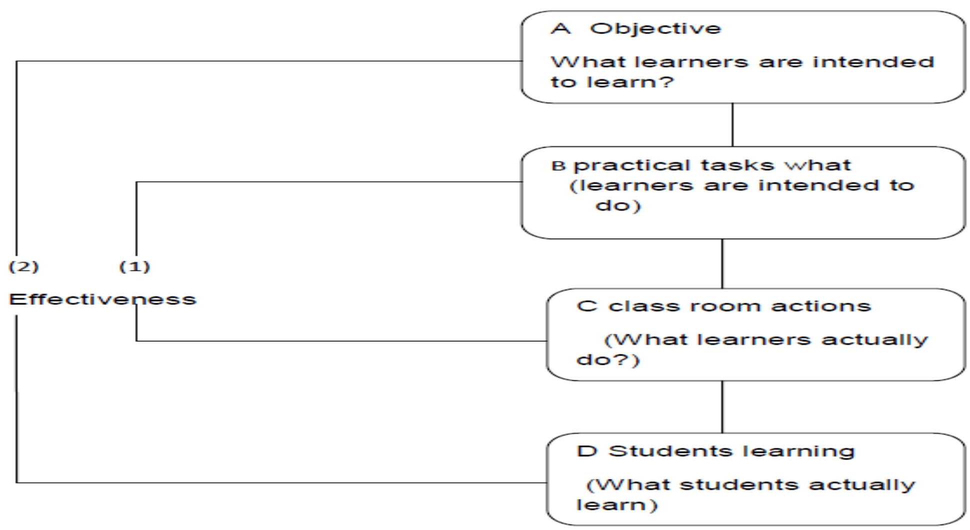


Figure 2.2 practical task developing, implementing and Evaluation process (Millar, 2004; Abraham & Resis, 2012)

2.1.3 Practical work as a basis for developing skills and its cause for unemployment reduction in chemistry

Learners were manipulating various scientific machines while doing practical activities in the laboratory during the teaching of sciences, in general, to provide important skills. These skills have been widely used in the livelihood of society for unemployment reduction. Thus, learners develop the confidence to create a job opportunity in their own effort after graduation due to their skills (Adebayo, 2018). They do not sit tiding their hands together. They try to solve any problems that may happen in society. It is also presented that practical lessons in science subjects are hands-on activities in which learners acquire skills through practices, and it further prompts learners to think about the world, we live in. Learning by doing maintain the development of science process skills through practical manipulations, and its effective utilization in teaching and learning help the learners to figure out their beliefs based on scientific ideas and observable facts (Abraham & Millar , 2008). Practical activities involve a kind of action that learners engaged in hands-on manipulations through various approaches such as handling equipment, demonstration of experiments and analyzing the results, as well as learners exposure to these situations, have important and lifelong practices, which related with upcoming livelihoods of the learners (Colen, 2013). Most practitioners would perceive the practical activities to be a good quality that can fit into the intended objectives. Practical lessons in chemistry enable learners to develop fundamental skills; assist them in spotting the process of scientific investigation; and developing knowledge with suitable ideas that involved practical lessons with practical activities related to issues (Woodley, 2009). In general, practical lessons can be taken as indispensable in skill development. Practical activities that were planned in good way and effective at various levels of inquiry allow learners to manipulate ideas as well as materials in the laboratory. It would requires learners to engage in physically and mentally to accomplish its' objectives that are impossible to achieve using other science areas of education (Lunetta et al., 2007). Learners involved in doing practical work with their physical action get confidences in developing of diversified skills among themselves. There are several functions readily recognized while doing laboratory work. First, it provides a chance for the learners to attain manipulative skills with a hands-on activity and secondly, it confers experience in decisive manner for building suitable observations without a vague impression in the working environment. At the same time, according to the scholar the learners may gain knowledge of diversified skills from experimental techniques, which are bench marked-skills from practical work that offer opportunities to develop other important skills among learners (Hofstien, 2004).The reporting, interpretation, analysis and the presentation of scientific-practical work results can all put in a realistic framework for the learner. After some experience developed, learners may take a larger competency skill in developing experiments by themselves for each topic, which is advisable to corroborate with the practical lessons as stipulated in the curriculum.

2.1.4 The Bridge that relates Laboratory, Environment and chemistry for effective teaching

A basic and major form of work in chemistry teaching is its' experimental activities that learners accomplish during their classes. During the practical works, learners train the physical skills, develop the ability to explain chemical changes observed, learn about physical and chemical properties of matter, and develop the understandings of concepts with regard to safety rules as well as practice some research abilities in the school laboratories (National academy of science(NAS), 2011). There is a road map needed for teaching the theoretical aspect of the lessons, and practical work that usually acts for strengthening the contents to be learned in the curriculum. To acquaint these, experimental approach as a form of research work procedure developed, and coupled together with other skills as well, help learners to strengthen the cognitive knowledge, abilities and skills produced from practical teaching in the laboratory (Herga & Dinevski, 2012). Experimental activities in the laboratory rooms also accomplished through the appropriate resources that are found in the environment to be designed and reconstructed for instructional purposes (Muhammad, 2014). Therefore, it is mandatory to use resources for practicals in the laboratory for effective teachings to ensure the sustainability of doing experimental activities in chemistry classes. Inline to this, Temechegn (2012) put forward that laboratory resources can be designed from some other cost-effective materials through improvisation, which is found in the school compound and learners residential environments. Moreover, doing practical works followed by the theoretical aspect of lessons in chemistry with environment resources were supposed to consolidate learning activities and it pledge learners to achieve the objectives and activities that to be accomplished in the curriculum (Skoumios et al., 2010). The practicals also allow learners to broaden and deepen their science literacy; fundamental skills in scientific exploration; complex thinking and illustrate relevant ideas specified by coupling the theoretical aspect of learning tasks with practice.

The application of practicals in chemistry in the scientific world provides scientific concepts to the learners, so it is essential to increase the number of experiments for theoretical aspects of contents those planned to be taught in the curricula. In addition to this, teachers would like to promote the frequency of doing practical activities that enclosed in the traditional teaching journey to develop with the final goal of the lessons to be taught in teaching chemistry (Herga et al., 2012). In this regard, science-teaching activities in general, are supported with practicals in their curriculum stipulated. It let learning activities in a learner-centred approach focus on group discussion between and among learners (Colen, 2013). It also helps learners to achieve instructional objectives on the fact that they can bring theories into practice by harmonizing with other appropriate practical activities. Finally, learners will easily grasp the ideas about practical lessons and apply them into their own lives. In the end, this observation strongly sustained by a learning theory of Kolb (Orey, 2010) as indicated in the figure below.

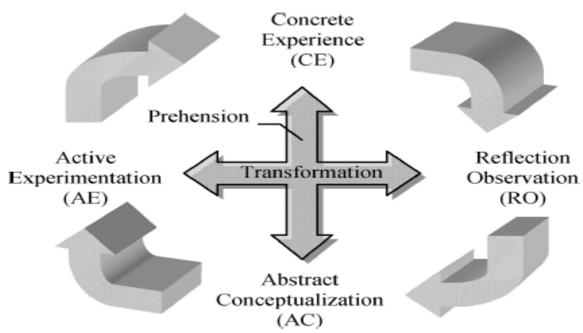


Figure 2.3 Kolb’s learning theory

As it is shown in fig 2.3 above the four stages of Kolb's experiential learning theory experiences as a source of learning and development.(Kolb, 1984 & 2013). it all starts with a concrete experience that learners possess either from past experiences or learning. *Furthermore, this learning theory explained briefly in Orey (2010) p259 “As the learners participate and experience these events, they must constantly reflect upon the truth issues that they are doing in class (Reflective observation, which depends on intentions). As they are doing project work, practical and group work these learners must constantly formulate ideas on how the world works for them, or at the very least, how the world works for someone else (abstract conceptualization). Consequently, these learners will take all the indicated ideas and apply them to experience that they have or might have in the future* *(active experimentation)*". Abdulwahed & Nagy (2009) discussed Kolb learning theory by connecting directly with experiences learning from laboratory indicating during the laboratory session, learners are mainly involved in the "Active Experimentation" stage of Kolb's cycle, because the emphasis is on experimenting. However, learning something from the experiment, or in other words, the transformation phase for constructing new knowledge through the experimentation first require the information to be grasped or depicted. In the case of close-ended laboratory session, the information grasped is mainly the experimental procedures and the theory behind the laboratory. The issues of the learners-centred approach in sciences can be secured learning by using laboratory facilities. Generally, teachers encouraged learners to practice experiments even in the absence of laboratory facilities, with existing environment resources from local materials, which further enhance the transferable skills such as communication skills, leadership skills, team works, and management skills as of the learners tried to design instructional materials and chemicals.

2.1.5 Importance of practical chemistry

Because of its enormous advantages that used among learners and other academic environments to get skills practical activities in chemistry class can also be conducted using suitable conditions such as laboratory room with sufficient facilities like equipment and chemicals and good teachers to accomplish the works. The facilities and talented teachers' existence any unfavorable condition that made obstacles to carry out practical lessons during teaching and learning process. According to Achimugu (2012:p2), educators in chemistry for centuries perceived that teaching practical aspects' of sciences is a vital process since it gives to learners a wide range of concepts. Some of them are listed here below,

- It helps learners develop science process skills such as observing, classifying predicting, measuring, drawing, recording data, hypothesizing etc.
- It promotes the development of scientific attitudes such as objectivity, honesty, curiosity, patience, open-mindedness etc.
- It helps learners understand and appreciate the spirit and methods of science such as problem-solving and analytic minds.

- It is used to reinforce what is learned in the theory class and hence encourages the spirit of experimentation.
- It arouses and maintains interest and curiosity in chemistry
- It helps learners to develop manipulative skills and proficiency in writing reports.
- It enhances learners' better understanding of concepts and principles and by so doing, significantly contributes to learners achievements in chemistry.
- It encourages learners to be active in the class, on the other hand, discourages abstraction, rote memorization and un attentiveness in the class.
- It leads to fundamental and applied for research works in chemistry at all levels of education.
- It helps to verify laws and theories that the learners have already learned.

The above mentioned and many advantages are identified concerning practical activities depending on topics studied within the chemistry subject matter. The importance of volumetric analysis and chemistry thoroughly described in chapter one and two in ongoing research, It has several values about the situations of human being living endeavour. Following these situations, Lukum & Parramatta (2015) also tried to put the functions of chemistry laboratory in four views in general 1) facility for education 2) research cases 3) quality tests and 4) in quality control.

2.2 Theoretical Frameworks of the Research

The constructivist theory of learning is a dominant paradigm in science education and appropriate for this research since it largely focussed on learning by doing the activities in the laboratory (Talti & Ayas, 2012). It is rooted in the cognitive theories of Piaget and Vygotsky, and embraces several learning aspects of both of those theories such as from Piaget the active learning schemes, assimilation and accommodation as well as from Vygotsky social constructivism, group works and apprenticeships (Muna, 2017p 97-107). The researcher expected that he thought of science teachers hold close this new paradigm for teaching the sciences, particularly, practical lessons in chemistry that should be learner-centred; competency-based, activity-oriented, and connect with learners' life experience (Hamisi, 2011; Colen, 2013). Constructivist's view of instruction, regarding experiment-related activities in scientific research also recommended the learners make a common good sense of groundbreaking circumstances in reference to the previous life experience they have already had in the past. It can be illustrated likely that what they acquainted with ontological impact learners perceive from what they are trained and how they become skilled with original concepts (Matthews, 2003; Colen, 2013). Sharma & Bansal (2017) merely tried to report the implications about the notion that teachers should give information, which supports their learners to be self-motivated on practical activities by using problem-solving strategies like hands-on activities to generate further knowledge to reflect on learner's activities to be understood in doing real situations. Subsequently with regard to what they are doing and how their attention took to details are changed by what they perform at the time of the study. The teachers ought to put the definite ideas together that he or she(they) understand(s) about the learners' already existing ideas and knowledge through taking the action on the issues that had already identified and also control the the problem that may happen currently, and then builds appropriate knowledge on the mind of learners (Colen, 2013; Mustafa, 2008).Thus,learners could easily understand the materials that they learn based on real experimentation process.

The alternative conceptions movement were also needed a theory to back and found in constructivism views of learning that was suitable and would be a successful approach for the sake of teaching experiment related sciences in general (Baker, McGraw & Peterson: 2007). Based on this view, the most dominant model regarding conceptual change occurs by considering every one child comes to the school with misunderstandings about natural observable facts to which, the misconceptions required, to be brought and confronted by elucidating with different examples in the schools. Furthermore, the assorted misconceptions can be changed by correction applying a more general concept that learners will accept and assimilate with their learning strategy and the intervention with appropriate academic environment (Mustafa, 2008). The aim is to guide learners toward accepting current scientific views and incorporating them into their own scientifically acquired cognitive scheme. This idea explained likely to assist learners in constructing their knowledge during instruction as much as it is possible to come up across for intended missions effectively for a constructivist teacher who can manipulate any method alone or in combination with other teaching methods during instructional process (Baker, McGraw &

Peterson, 2007; Awan, 2013). Thus, to know the learners understanding with regard to the concept of science teachings, teachers at the first glance need to understand the philosophical and theoretical rationale of constructivist views to act for suitable instructional purposes. In the presence of abstract ideas, while teaching chemistry, transmission of concepts does not process for the learners (Millar, 2004). The learners must play a dynamic role i.e. they have to actively involve 'taking on' the new knowledge to 'make sense' of the experiences. Furthermore, they found in and have more discussions on the science classes to be effective, and use it to make precise meaning of learning in sciences (Abraham et al., 2008; Millar, 2009). In this way, fundamentally, in the constructivist outlook of learning in sciences in general, however, the knowledge that someone would to construct have already been identified to the teacher's learners throughout the entire teaching and learning journey.

Every learner in developing countries like Ethiopia should have to perform practical exercises, not only just the small number of tested practicals for national examinations consumption and for the sake of achievements, but also the wide range of hands-on activities based on the frameworks of experiments designed in the curriculum to build a sense of understanding of concepts. However, the absence of this opportunity in teaching chemistry using hands-on activities with conventional materials to be used, teachers or another concerned educator can use an appropriate alternative approach that experiences learners in doing hands-on activities, which further help learners in the acquisition of other intended science process skills. This alternative approach may not be far away from material manipulations. It allows to experience manipulation of objects that must include the use of improvised local facilities suitable for teaching experiments found in the chemistry curriculum. As Hamisi (2011) stated every effort is already underway to overcome the lack of regular materials. This idea describes that teachers and learners by themselves, and the concerned bodies in education have to construct the suitable materials and participate in the preparation of chemicals and other suitable materials for teaching the experiments using resources found in the respective environment. Furthermore, any concerned bodies have to arrange an appropriate time to train teachers, learners and even any other management bodies found in the lower level of education, to come up and strive all with appropriate skills through the technique of improvisations (Aadland et al., 2017).Thus, all members in the school compound become with full of skills and halt the deterioration of learning activities.

This research was done using three models as per discussed earlier in chapter one. The descriptions of the diagrammatic representation of models in figure 2.4 below as follows.

Model A:-Practicals taught through improvised materials as an alternative approach

Learners gain cognitive knowledge, science process skills, and practices designing of materials and chemicals. Furthermore, learners try to design low-cost experiments based on local resources. All activities found in both the actual practical chemistry teaching and traditional teaching methods are also included in an alternative approach. There is also lecturing method; Learners follow up an inquiry and problems solving strategies; learners are psychologically ready to improvise materials to specific instructions. Furthermore, they develop a creative mind set up even for developing work tasks for other generation.

Model B :- Practicals taught through conventional materials

Learners gain cognitive knowledge, science process skills. Learners do not participate in designing materials. No low-cost experiments are designed; All activities included in the traditional teaching method are also found in this teaching model. There is also the talk and chalk method, learning depends on conventional materials; laboratory technicians set all experimental activities; sometimes, learners only follow up the procedure without hands-on activities. Learners are passive, in most chemistry experiments, which may happen due to some due to costly purchased chemicals and apparatus breaking.

Model C: - taught through traditional methods

Learners gain cognitive knowledge, only talk and chalk method used, learners do not participate in hands-on activities, no low- cost experiments designed, no materials designed,

C is the subset of B, B is the subset of A, and also C is the subset of A, which implies that activities all are done during instruction in C, are found in the activities in B and A as well as the activities found in B are all found in A. C<B<A, implies C<A.

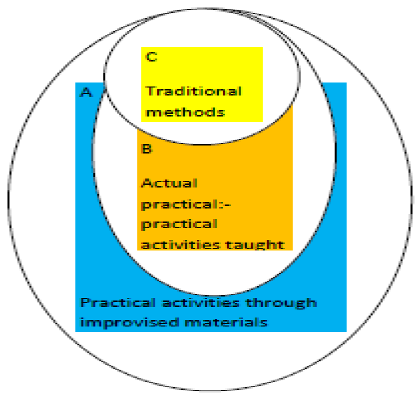


Figure 2.4: The diagrammatic representation of the three teaching styles as new model

2.3 The need for low-cost equipment for science education in general

Most developing countries import science equipment to their schools to facilitate the teaching process of science subjects in general, which brought a series of negative side effects in the country's economic conditions. Considering many schools found and with scarce foreign exchange and expensive equipment imported to the country like Ethiopia. It is difficult to address all schools with these scarce resources that are expensive foreign exchange. Since the laboratory materials imported are too expensive, and difficult to enrich for all schools, which result in uneven distribution of equipment and/or only incomplete supply of laboratory facilities to schools as well as no materials supply at all for schools in rural areas and newly emerged schools (Emendu, 2010; Tesfaye et al., 2010; Shitaw et al., 2017; Bank & Musar,1993). Moreover, most spare parts are imported and all are consumed, which means, not recycled, thus it is difficult to address science-teaching objectives as intended to transfer the knowledge imparted through effective teaching to the end learners. If the laboratory facilities may not exist at all or do not fit experiments for the existing curricula, teachers may not employ the ascertained facilities while teaching learners. The education sectors ought to train teachers to visualize how they use laboratory facilities from environment resources to replace or fill a gap of teaching materials. If teachers' training have been neglected concerning with solving problems existed so that any laboratory facilities might not be utilized in the class for their intended purposes. Even if the teacher knows what to do with the equipment, he/she might be averse to use it, because of terror due to some equipment, which is easily broken and too expensive apparatus (National Academy of Science, 2011). Because of all those factors, that make the teachers fear in doing with facilities in the laboratory as a result in, during experimental works they often need to prefer to use the materials for only demonstration purposes in stead of guiding learners to hands-on manipulation, and also would not let learners work directly with appropriate materials. Some schools stored equipment as a memorial park rather than require it after minimal repairs or some maintenance even if they are out of use in the laboratory (Bank & Musar, 1993).The teacher and laboratory technicians were not trained to carry out experiments effectively using the habit of repairing or reusing existing materials in the laboratory. Moreover, no centralized repair and maintenance services are available because of complicated management styles (Jonsyn-Ellis, 2002; Nbina & Viko, 2010; Gupta, 2016). In some cases, the equipment has not been used in the laboratory because of the shortage of indispensable chemicals consumed for doing specific experiments. Moreover, foreign support in the form of items regarding equipment sometimes affects the developing countries and consumes much money in the form of hard currency. As a result, it rarely meets more than a small part of the demand for secondary school teaching. Schools in developing countries often received equipment and chemicals from various donor countries in small quantities (Gupta, 2016), which is also the same for the study areas of the current research to make it difficult to equip all schools equitably with laboratory facilities.

One of the major approaches to triumph over the problems in providing laboratory facilities is repairing the existing materials and using the equipment by designing from locally available materials produced and employed for instruction in an alternative way (Igaro, Adjivon, & Oyelakin, 2011). It must call for attention that designed low-cost laboratory facilities are not necessarily the same as fabricated in science education. It is one of the remedies or undeserved approach to design low-cost equipment and practical lessons that are appropriate to be used when they are in the situation of inconvenience for teaching sciences, and which lead to sympathetically relevant to the objective and content of subject matter to address the planned objectives in science teaching. Teachers can also use local materials when financial constraints sought to purchase appropriate laboratory facilities (Shitaw et al., 2017; Khitab, 2012). The advantages of improvised materials are also seemed to be used as the burning issues in school science teachings, which must be employed in the place of the most suitable equipment for practicals those were designed in science curriculum (Yitbarek, 2012). According to the report of Gupta (2016), the local production of equipment for science education, particularly at a low cost, has a certain importance including, cost aspect, maintenance and repair, replacement with other materials that fit the original one, curriculum relevancy, higher local content, self-reliance and flexibility. The advantage of each is described under each factor as follows.

2.3.1Cost

Locally designed laboratory facilities in cost aspect are often, but not all the time become low when compared with that of imported laboratory facilities, which makes it reasonable in contributing enormous schools in a given developing country. However, it is impossible to produce every piece of equipment in our cases. Due to some experiments, Ethiopia may need sophisticated facilities that can be purchased with much money, and it needs complicated financial details to use for the intended purpose. Thus, according to some researcher, the teacher in his subject matter and learners focused on designing low-cost materials from locally available materials for practicals, those designed in syllabus as simple experiments, which cannot need sophisticated equipment (Gupta, 2016; Tesfaye et al., 2010). In designing local materials for laboratory facilities, Bank & Musar (1993) considers with regard to the cost implication of the equipment as factors.

- The durability of the equipment (expected lifetime),

- Additional installation costs,
- Estimated costs of spare parts during the lifetime of the equipment,
- Estimated costs of consumable materials, Service costs, and training costs used for teachers and technicians.

2.3.2 Maintenance and Repair of already existed equipment

In its' stipulation, laboratory facilities are simpler to be designed so that teachers, technicians in the laboratory and crafts men in the local environment are more likely to perform this miniature repairs. Teachers would hesitate to open equipment , to maintain and repair it even if it is made to practice from easily recognized common parts and materials (Gupta, 2016; Bank et al., 1993).Thus, training will be held for participating in designing or/and maintaining malfunctioned equipment in the laboratory. Moreover, training must include teachers and technicians who participate in science teaching, particularly at the high school level.

2.3.3 Substitution with locally available materials (Replacement)

It is commonly much easier to acquire standby materials required to replace from a local designer, which exactly fit conventional materials made in industries. Local crafts men can also make some parts of the equipment to be reused in the instruction. If the user provides the types of designs soon, those crafts men for instruction purposes readily provide the materials after improvisation. In conclusion, the school administrative bodies and teachers are often ready to provide the appropriate designs of materials for local designers when there is a shortage or absence of materials may happen for teaching specific experiments in science subjects, particularly in chemistry (Gupta, 2016).Thus, improvisations or reconstruction are low cost that can be used for replacement of materials that are incovenant.

2.3.4 Curriculum relevancy, Evaluation and Implementation process

Most of the time curriculum relevancy was assured by including responsible persons in the development stage before allowing it for effective teaching. Low-cost materials designers must be included from different organizations to evaluate and give suggestions from higher education staffs such as Universities, teachers training colleges, or secondary schools and some other institutions that they are well familiar with the existing curriculum to ensure its' relevancy (Yitbarek, 2012;Gupta, 2016). Designers of local materials for educational utilities have developed a tendency to criticize, manuals preparation for practical lessons and its' integrity with designing experiments based on the curricula to be low-cost experiments (Jonsyn-Ellis, 2002). They may also organize training for teachers, laboratory technicians and learners that is more probably to be highly appropriate for newly designed equipment.

2.3.5 Higher local content

Laboratory facilities produced from local materials are common to the learners, which are more probably designed to assist learners be aware of fundamental scientific principles. Learners are capable of recognizing relevant material in their environment and they are able to better use these materials in their future career. In this situation, several examples in day-to-day activities using local materials in rural communities in most developing countries like Ethiopia are closely related with standard materials, can be used for instructional purposes, and currently these are found in the application or practice in scientific endeavor (Temechegn, 2012, Chemistry L, 2012). For example, pottery's apparatus locally made for the distillation purpose is in use in developing countries like Kenya and Ethiopia in rural areas. This material employed to distil local arake with 75% alcohol by volume from grains after fermentation, is applicable in high school chemistry teaching and primary schools for integrated science teaching used for experiment manipulation procedure (Bank et al., 1993; Gupta,2016). Similarly, teachers may sense higher encouragement and inspiration when they can apply and relate a personal experience in diversified areas of the countries with local or low-cost materials in their teaching and learning process.

2.3.6 Self-reliance to develop confidence

The equipment developed locally is low in cost used for science teaching to promote self-confidence and provide skilled educators with societal benefits in development. The beliefs and perceptions that demand local materials from the existing resources are another fate, which boosts a good teachers' self-reliance in knowing the subject matter that he taught. It has been noted that teaching of sciences, is usually an expensive endeavour where workshop, workshop materials, tools and equipment required for effective learning and provides sustainable skills for developing self-reliance (Isaca, 2012). It may also be used as a gate or an opportunity to start new small-scale enterprises (Adebayo,2018). Moreover, handicapped personnel in the field can be employed and participate in the production. Furthermore, it ensures the attainment of adequate production with quality and quantity -wise altogether.

2.3.7 The flexibility of curriculum based on the need for a change of variable

Curriculum developers regularly need to update themselves with new ideas when the curriculum and some other factors changed based on the situation matters. They also update themselves with the necessary materials to impart the intended objectives that designed in the curricula in the national level of one's country and some other scientific attempt that may be changed directly to fit into the intended objectives of the learning. One more addition to the existing materials or reconstruction of a few new pieces of equipment from other unused but suitable with a new topic or/and modification of existing equipment together with some teacher training can facilitate the introduction of new topics in science teaching (Gupta, 2016; Stolk, deJong, Bulte & Pilot, 2011). Ethiopia's current example is the inclusion of some environmental factors in school syllabi at the primary and secondary school level. Using materials with modifications from existing materials for chemistry teachings are easier or the same as the school equipment fabricated by employing local knowledge from resources in the environment. The department of an education centre at the national level, often alertly changes the appropriate way to design the method based on the situation to incur suitable educational services to the learners or citizens in one's country.

2.4 Improvisation of science education materials for effective chemistry teaching

The philosophical perspective of improvisation incorporated in science education, in general, seeks to elucidate the objectives of learning that achieved through appropriate teaching. Improvised materials coupled with other techniques employed in science education also used to address effective learning. Improvisation requires a considerable development through imaginative planning, good knowledge and it is expected to learn though varying degrees regarding Perception, understandings, transfer of training, reinforcement and retention of the assorted skills (Nbina, Viko & Biravil, 2010). There are two aspects or views ascertained during improvisation:-one is concerned with teaching methods and the other with the equipment used for teaching purpose. However, the need for improvisation sums up the two aspects because the two aspects are closely interwoven (Aadland, Espeland & Arnesen, 2017). As it mentioned in Asokhia (2009), there are reasons to consider the need for improvisation including minimizing the cost of equipment, a curiosity challenge, and productive application of intellect. Professional scientists enable the teachers to consider improvisation in their research for easier, better and faster methods to make effective teaching and learning in educating learners. Hence, it promotes creativity and self-reliance, provides a cognitive connection to lead learners from having unclear concept so that the need for improvisation for science teaching and learning process can be over stressed (Ndihokubwayo, Uwamahoro & Ndayambaje, 2018). However, most teachers find it difficult to engage in improvisation due to time constraints with their overloaded work at hand and sometimes lack the skills to process improvisation. It is the only innovative teachers and learners with a positive attitude that can embark on improvisation. By way of economizing materials, most chemistry teachers wait until a week to final examinations before introducing practical activities to the learners, thereby robbing them, many opportunities to enrich their chemical knowledge and skills through improvisation and using improvised materials (Ochonogor, 2012). Because of that teachers become leading learners to ineffieciently participants and low performance in chemistry subject.

Due practical activities in science lessons, the value added has been evaluated as a fundamental issue in teaching learners at all education levels. To continue the teaching process and ensure the sustainability of experimental works, teachers must use the improvised cost-effective materials for doing practicals in chemistry (Ndihokubwayo et al., 2018). Furthermore, improvised materials must be well designed and presented adequately to stimulate learners' creative expressions to encourage active participation in practical activities to fill a gap that may happen due to the absence of facilities for doing respective experiments. As mentioned in Nbina et al.(2010) improvisation involves several skills such as observation, measurement skills and manipulative skills using various tools involved in activities like cutting, bending, joining, impelling wood and metals. In general, improvisation can be derived from either through substitution or reconstruction of materials from already existing materials. It is not often possible to find a suitable substitute for every piece of science equipment in the school. The construction form of improvisation has to be done, often from materials available in the environment. However, it is a more difficult form of improvisation in science than substitution with another material having low-cost. Construction form of improvisation requires modernization and creativity to produce low-cost materials (Okafor, 2001; Temechegn, 2012). It helps teachers to address problems in the laboratory due to financial constraints in the schools that may happen in the case and the schools cannot afford to purchase appropriate materials and chemicals.

2.4.1 Meaning of Improvisation

There are more than one definitions of improvisation. One of the definitions presented here likely that "to some, it is the act of using alternative methods for the actual thing that is not present as a resource in the environment" (DomNwachukwu & DomNwachukwu, 2006 p 297). By the view of other educationalists, improvisation also considered the use of substitutes of laboratory facilities, either equipment or chemicals where the genuine one is not available (Asokhia, 2009) and some others mentioned or employed any improvised materials as a teaching aid (Yitbarek, 2012). Samba & Eriba (2011) also tried to report on the issues of laboratory facilities inadequacy to equip the laboratory with available instructional material from readily existing natural resources in the environment for teaching learners with low-cost materials in the school's substitution form of improvisation. Local materials that have already existed, it can also be used without construction in a piece of equipment, which is not available in the laboratory room (Chemistry L, 2012). These views are alternative use of teaching materials instead of the standard facilities or/and instructional material that is not available in teaching and learning environments like schools and other institutions (Ndihokubwayo, 2017).Thus, learners ought to ready themselves to use this alternative approach as a teaching style for any inconvienance of facilities in the laboratories.

Teaching and learning activities in science subjects, particularly in chemistry involve doing things to practice a wide range of skills related to practical works like handling of materials and chemicals in the laboratory room. It is generally observed that no nation in the World has all the required teaching materials like equipment and chemicals in its institutions that satisfy the need for facilities in the laboratory (Ali et al., 2000). Moreover, most of the materials needed for teaching chemistry are from environmental resources through improvisation (Thomas & Israel, 2012). Furthermore, Construction and reconstruction methods are used for material production. These methods are sought as simple forms of improvisations to which resourceful sciences and integrated science teachers should be able to bear in mind to carry out in production them, and thus enriching the vacant space with things that replace appropriate facilities in the laboratory rooms at the time of laboratory activity sessions.

2.4.2. Improvisation and training teachers in Science Education

Improvisation in science education in general and chemistry, particularly aims to enlighten the technique that employed improvising materials, which incorporated and applied into the teaching and learning process (Otor, Ogbeba, Ityo, 2015). It allows learners to take threats and to learn to be as modernizers (Hains-Wesson, pollard & Campbell, 2017). As soon as the materials improvised for the science teaching process, they cannot be function immediately. They must be assimilated and rehearsed with the knowledge of learners effectively before to be used in classroom teaching. Some other concerned bodies also gradually informed about the technique used through training for the further implementation process. Assimilation is the systematic gradual presentation or application of improvised materials for science teaching. The newly introduced materials, which designed at a low-cost from the local resources those had already utilized, integrated, and assimilated in awareness creation. It also considerately assimilated with the lesson objectives as a guide throughout the instructions. As briefly explained in Maeland & Espeland (2017) to integrate and apply improvised instructional materials, certain basic steps should be considered and followed carefully for its' specific functions. Accordingly, they pointed out the steps to be followed in applying and integrating improvised materials for instruction including teachers' readiness (preparation), preparation of the learners, actual presentation and Presentation of the following-up activities. Effectively improvised materials applied for instruction after a consequent rehearsal of the following three steps are crucial to the objectives of lessons to be achieved in the teaching and learning process of sciences in general (Hains-Wesson et al., 2017). Therefore, the teacher has to

- Planning and integrate it into the lesson and following up the process(organizing)
- Consider how the material can help in achieving the objectives(Discussion)
- Process the materials well ahead of time, that is, prepare and test them before the lesson commences(presentation)

Similar view also considered getting learners psychologically ready to use and introduce some explanations concerning improvised materials by giving reasons for the particular materials to be used for instructions; finally, comprehensible guidance must be given to learner or trainers as to areas of importance to study. This includes introducing learners to aware of the systematic approach about what they need to do throughout the lesson and necessary. New words associated with the materials improvised must be defined before using for instruction and the clarifications attested to the learners to avoid bias leads to misconception. Moreover, all these and attentive follow up procedure starting from production up to the use of materials for instruction purposes have a concrete significance in decreasing learner's achievement in chemistry in particular and sciences in general. As noted in Hains-Wesson et.al. (2017), the improvised local materials or low cost must be applied at three stages

- preliminary stage
- Content presentation stage
- Summary stage

Teachers should be in control of every stage, directing and maintaining the learners' interest and attention. Learners should not be carried away at any stage whether or not they are directly involved in the manipulation of the material(s)

2.4.3 Importance and Limitation of the improvisation

Considering the cost implication, improvisation of instructional materials from local resources are cheap and simple alternatives compared to convectional materials employed by the teacher to progress teaching and learning activities in sciences (Tesfaye et al, 2011). There are both advantages and constraints identified and recommended to the end-user by the investigator concerning improvisation from local resources in science teaching (Momon, 2005). Both are mentioned and discussed below accordingly,

2.4.3a Advantages of improvisation

Improvisation helps to fill the instructional vacuum likely to be created, provides a frame of reference and makes teaching easier and effective. Furthermore, it tends to remove the abstract concepts of theories to be understood in science teaching. In this point of view, Thomas & Israel (2012) organized the roles played by improvisation includes as follows;

- If managed effectively and suitably, it will boost learning and allow the teacher to use more activities that are useful.
- It encourages the participation of teachers in curriculum design and development
- It allows for effective lesson plan preparation from the objective that determines and evaluates it.
- It encourages students' in partaking in the process of learning
- It makes room for individualizing education, as alternative paths and using the existing variety of resources based on its choice.
- Learning becomes genuine and immediate because improvised instructional materials utilization emphasizes understanding and practical activities. Improvisation provides a link for the world outside and outside the classroom

- Improvised instructional materials utilization makes the way into science education equal and plentiful for all learners since improvised materials can be moved to any place at a time.
- It provides various materials and procedure and therefore, it assists the student to discover himself/herself and he/she true ability
- Visual support helps teaching and consolidating vocabularies, which affects students' reading ability and helps the learner associate words of objects or comprehend what is happening in a particular concept or area of study.
- Improvisations are very useful and dependable in capturing students' imagination if used correctly. If effective selection is made, it will motivate students to learn and remember that it is learned, whenever there is a need for a recall.
- An improvised material can present the students with a more authentic picture of the real object than the teacher can ever describe or explain.

The use of improvisation can also facilitate the repetition of an idea without becoming tedious in presentaion(Kira & Nchunga, 2016).

2.4.3b Constraints of Improvisation

Improvisation facilitates as a motivation factor solely for the teaching and learning process in all experiment related subjects. Learners have to consider resources critically from the environment to enlighten the scientific investigation, observation and concepts acquired from the instruction. However, many barriers are encountered, which are associated with the exploitation of improvised materials in their implementation process. Science experiments in general also need accurate and precise measurements that play a role in the scientific investigation (Baeza et al., 2005). Because of the ineffective utilization of the techniques such error may be recorded during practical work; in the end, it renders the findings impotent, useless and unacceptable (Kira & Nchunga, 2016; Balogun, 1985). Problems associated with instrumental errors are also considered as technical factors, resulting from inevitable errors during the manufacturing process. The problem of inconsistency in the measurement of experiments will also result in a low level of reliability of the instrument, which is more crucial at the secondary and tertiary institutions where subject specialists have carried out sensitive experiments and observations in scientific investigations (Iwuzor, 2000). Human factors are personal errors that can also lead to a low degree of accuracy, affecting learners' achievement. These factors are identified as problems in teaching and learning chemistry subject matter, due to its' association with lack of equipment and chemicals which used in the acquisition of science process skills, and ensures teachers' professional competency, creative ability and commitments are some other factors to be considered (Nbina & Viko, 2010). Once the teachers commence recognizing the principle behind improvisation, they can also commence improvising diversified teaching tools by their creativity and passion as if many teachers develop confidence in their ability by designing their practicals and the respective necessary teaching materials through improvisation (Ezeasor, Opara, Nnjiofor & Chukwukere, 2012). It further increases motivation and interest for both teachers and learners being they are exploited low cost materials.

2.5 Alternative approaches that are needed for practical chemistry teaching

As one of the experiment-related science subjects, teaching chemistry is unquestionable since it brought a clue for the development of one's country. It is mandatory to employ the appropriate instructional techniques either alone or mixed in the field of chemistry education in general and volumetric analysis, particularly in the absence of real laboratory facilities (Ali & Ochonogor, 2000). When there is shortage of laboratory facilities, teachers must consider another suitable strategy that exactly or /and nearly fit to conventional materials in the laboratory while performing practical activities. On this occasion, teachers have fixed and decided to use appropriate materials for teaching purposes, which may exist in the school environment by focusing on the filling of the gaps; those were being seen as the shortage of facilities due to the occurrence of financial constraints (Temechegn, 2012). Maeland & Espeland (2017) also tried to emphasize the alternative teaching trend in education and they suggested teachers ought to improvise to handle challenges in the era of the 21st century, with a focus on creativity, critical thinking, innovation and problem solving by underlining learners as active participants and co-constructors of knowledge.

There were also many problems identified, which were resulted from inadequate teaching methods in the experimental part of the lessons in volumetric analysis in particular, and some other related topics, which further attributed to poor achievement among learners (Uzezi et al., 2017). Moreover, according to Achor, Kurumeh & Orokpo (2012), most of the problems that affect chemistry teaching were listed in a scholarly published paper, which its' inappropriate use further resulted in poor achievement among the learners as factors like,

- Their non-familiarity with the use of simple laboratory equipment,
- Imprecise statement formulation,
- Spelling errors,
- The tendency to crowed their answers together
- Inadequate exposure to laboratory techniques,
- lack of observation skills,
- Violation of the convention for IUPAC nomenclature,
- Poor spellings, definitions and diagram,
- Non-familiarity with some contents of the syllabus,
- Inability to determine the mole ratio from stoichiometric equations,
- The omission of units in calculated values,
- Inability to write symbols properly and,
- Assign correct charges to ions are some of the problems.

Among all the factors mentioned above that attributed to ineffective teaching, which result in poor achievement and do not underpin the understanding of the concepts in chemistry, the absence of laboratory facilities are remarkably resulting in a profound poor academic achievement among all groups' schools. Other factors being equal because of scarcity in a facility in minimum, which leads to poor achievement, learners are unable to acquire science process skills that imparted from the contents in the lessons as one of the intended objectives in chemistry (Abungu et al., 2014; Feyzioğlu, 2009). Thus, teachers must use alternative practical activities to clarify the topics to be taught in the class even if the schools have a shortage of laboratory facilities. From worldwide reviewed literature in laboratory education, practical lessons that are taught through improvised materials as an alternative approach in chemistry teaching are most probably appropriate and ought to be used in schools that are located in rural areas and in newly launched schools. Thus, improvised materials and chemicals provide an opportunity for learners to practice hands-on activities to boost the acquisition of science process skills in doing practical activities within the volumetric analysis in particular, which is more effective and ought to use in the absence of standard laboratory facilities (Temechegn, 2012; Yitbarek, 2012; Hamisi, 2011). Furthermore, it ensures equity in halting the deterioration of quality education among all schools in teaching science subjects for urban and rural schools.

The justification for adopting alternative methods rather than the traditional method for teaching volumetric analysis stipulated in chemistry also became specific situations, which further considers the background means of an operation of materials needed, and its overall advantages in the societal economy (Ali et al., 2000). It is also compulsory to use alternative means to practical lessons in chemistry to boost learners' academic achievements. Moreover, it introduces a right road map or blueprint for the teachers on how to conduct the existing laboratory activities because of lack of apparatus and chemicals that may happen due to financial constraints sought in the laboratory and with other problems; indeed it may exist among all the schools. In these circumstances, the notions about practical lessons explained that learners must be in an active position to replace improvised materials as an alternative approach to practical activities in the absence of conventional materials. Further equally treats the learners with the quality wise wing of education in irrespective of their environments (Thomas et. al., 2012). There is no single teaching method capable of satisfying all the objectives of a given topic, to use any of the alternatives that fit to replace the real system in science teaching. According to Ali et al (2000), some of the advantages among the others from alternatively adopted laboratory teaching method to fill a gap due to the absence of genuine teaching materials are as follows.

- Wider scope of the practical chemistry syllabus is covered alongside with the theory.
- Understanding the theory work is enhanced by the practical application, allowing practical demonstrations, using the group and cooperative learning methods.

- It enhances the maximum use of the few available apparatus and reagents for skill training of learners.
- Help learners to be more serious with their studies, which encompass practicals and the theory before any type of the examinations.

Here below are some of worldwide used methods in the place of conventional materials to practice experimental activities in chemistry in general.

2.5.1 Advantages of Simulations in Teaching Chemistry and other Science related fields' practical lessons

Incorporating alternative approaches that directly fit teaching practical lessons in chemistry and some other science-related fields reduces misconceptions. Simulations are an important alternative approach employed to elaborate on the lessons' theoretical aspects in the science subjects' curricula. Thus, they have used to pledge the effectiveness of the learning process for experiment related subjects. The chemistry teachers and science field specialists must effortlessly employ these alternative strategies when the shortage of laboratory facilities existed that affect the teaching and learning activities altogether (Hofstien, 2004; Plass et al., 2012). Using other instructional methods and simulations can also help learners understand the concepts of chemistry teachings effectively when the scarce of genuine materials sought in teaching and learning system that existed to assure the observable facts in sciences in general. It is recommended that different scholars in school settings, let learners use simulation for practical work to tackle and resolve problems (Lagowaski, 2005: Hofstien et al., 2003 & 2004). However, the debate is how to apply the simulation coupled with other approaches or alone felt under the question since it does not allow material manipulations during the experimentation process (Curtis & Smith, 2016). In general, trying to simulate in education is better than teaching with only traditional practices. For example, media applications during instruction, at least through the simulations in practical lessons in chemistry learners practice hypothetical hands-on activities.

It is also recommended that according to the research works done by different scholars, incorporating simulations in teaching and learning process used as an alternative approach for practical lessons to be taught in many science topics, also to provide meaningful representations of practices that are often not possible by using real materials

(Hofstien & Mamolk-Naaman, 2007). Simulations that learners engaged in practical lessons considered time-consuming, risky, and costly to use during instructions (Hofstien, 2004). Moreover, it is well set up to consider in general that facing learners or keeping them within appropriate simulation took noticeably less time and make learners more competent than engaging them in only a theoretical approach while teaching and learning on progress (Plass et al, 2012). Many researchers also conducted the research work on the subject of laboratory teachings using simulations carefully, and in the end, they provided supplementary information and summarized them for future use in the scientific community (Pyatt & Sims, 2007; Feyzioğlu, 2009; Johnstone, 2006). From the information provided in different research, it is plausible to assume that teaching and learning practices with simulations effectively promote valuable practical experiences. These also tend to be fitting with learners perception who are trying to explore good fun in simulating, the real material system.

Teachers and administrative bodies in the schools also must give their opinion for scientific communities concerning the use of suitable simulations by coupling with other appropriate teaching strategies or alone for their learners in education. It is convincing that the learning outcome that will result from attractive and well-conducted practically effective experimental experience quite different and add values regarding hands-on activities rather than the learning outcome that will result from only a good intervention with simulations. Even if resources, ethical consideration and other cultural issues are considered the significant elements in the school society, their environment to simulate science-teaching, decisions will be taken to confront learners to work with these simulations in targeted learning (Hofstien et al., 2003). This idea also fostered likely that simulations are used as a substitute for related activities in the laboratory sessions that should be made teaching effective mainly based on the outcomes of planned learning situations (Pyatt & Sims, 2007; Millar, 2009). Coupling of any teaching style with suitable simulations like multimedia and other appropriate teachings method are also good to utilize as an alternative instructional strategy for teaching chemistry in particular. Furthermore, teaching practical activities in this style considered as a harmonized teaching method. In line with this situation, the teachers mainly focus on locally improvised materials as an alternative approach for teaching chemistry with other appropriate methods as simulations or alone should be employed in schools in rural areas and newly launched schools. As described in Barely and Brigham (2008 p1) focusing on the importance of laboratory issues as of "Rural school districts may face special challenges in ensuring a highly qualified rural faculty" and for any newly emerged schools in developing countries. The problems may be happened and largely in common indeed in developing countries; for example; in Ethiopia, it boosts learners' year intake capacity in all universities to address education fairly equally for all nations in the country.

2.5.2 Multimedia Technology as an Alternative Approach for Practical teaching

Now a day multimedia technology boost without limit all over the world for teaching purpose of practical lessons in science education. Based on the manifestation of various innovative approaches in teaching science subjects, particularly in Ethiopia, the plasma teaching started in 2004 as instructional tools in the syllabus of science subjects focusing on giving attention for experimental activities. However, the acquisition of science process skills could not be achieved as expected from the practical lessons through plasma teaching approach due to the learner's inactive follow-up process even though it used as a form of instruction medium. Contrary to this idea, Solomon (2016p14) briefly described as a note by emphasizing the impact of plasma television on learners academic achievements in his correlation study. However, instead of acquiring knowledge and developing science process skills acquired through plasma teaching most learners only see or observe what has to be done in the plasma-like films and do not give attention to what is going on about practical activities inside the plasma. In some schools, there are no light, and some parts of plasma were stolen in different cases and become malfunctioned to teach learners using this instructional teaching method even if schools are located in urban areas.

Multimedia used in science education have to be found in advantageous position in educating learners only if learners and teachers are well informed without bias about its' function and limitations while using for instructional purpose. Before employing the multimedia for teaching purposes, teachers must identify and supply any materials that affect co-factors in its absence during instruction. It offers opportunities for learners and has brought a dramatic change concerning the teaching strategy employed in chemistry and other science subjects in general, which further influences the classroom and laboratory instructions altogether (Braun & Rummel, 2010). One good approach as an option held for teaching science subjects with laboratory-related instruction, in this case, which reported in Amosa, Ifeoma & Chogozie (2014) is computer-assisted instructional(CAI) strategies that have proven successful learning in integrating diverse kinds of media and bringing out the improved learning outcome in the class. However, during the experimentation process in rural environments, it has been observed they usually lack laboratory instruction based on written procedures and guidelines for making observations and interpretation of results to convey appropriate messages for the learners. For discovering laboratory-related works, learners have to be guided concerning the appropriate route of instruction and quite often, they possess an adequate conceptual framework (Baser et al., 2010). Thus, to ensure the active involvement of both teachers and learners, the concerned bodies in education make available the multimedia and other co-working materials and at the end, they can use it as a good means of the instruction transmission medium.

Even though the merit of technology pronounced to be used effectively in experiment-oriented science subjects, however, there are problems identified that made its use malfunctioned. Some of the identified problems, in chemistry instruction include the absence of light and spare parts (Solomon, 2016).Computer-aided learning (CAL) and interactive multimedia programs (IMMP) while teaching chemistry experiments by simulation science teachings curricula have become a challenge to educationalists, as schools are located in rural and urban areas. Therefore, it is difficult to distribute the quality of education fairly equally for all school learners. As a result, computer-aided learning style fosters unequal treatment of learners within the same society in the same country, because of the schools located two extreme areas of the economy, such as urban and rural areas. Thus, learners who are in urban areas schools benefited from this teaching style. However, those are found in rural areas are not benefited. There are discrepancies observed in learners' achievements since they were not treated equitably in this regard, which proven learners in unequal treatment conditions. Considerable research will be undertaken and devoted to developing a sound theoretical basis for their effective use of computer-aided learning. On this occasion, as suggested in Badeleh & Sheela (2011) ICT-based learning brought an increased tendency toward collaborative learning among learners and teachers, not only in a particular classroom but also in increasing societal relationship among people's respective environments. However, it is not worth enough to address the quality education equally for both urban and rural learners.

It is also unbelievable to note that the fast growth of information and communication technology (ICT) worldwide leads learners to acquire new knowledge through advanced learning due to the use of appropriate teaching styles in this matter. the information is electronically stored, processed, and presented using several media like computers and microelectronic devices built by the information and communication technology(ICT) department to work hard in diversified areas of everyday objects (Badeleh et al., 2011). However, there are questions thought by someone's mind about factors considered while using electronic devices for education purpose as instruction medium. The followings are questions raised; what could I do? And how I teach learners that are found at rural schools, and for newly commenced schools; what I do to boost the access of education in developing countries like Ethiopia as well as the question raised how I reduce the constraints in this teaching style are the leading problems, those hinder the use of multimedia technology as an alternative teaching approach. These questions are the only potential strategy for learners in schools found in urban areas or/and have an access to internet technology. However; for schools those are found rural areas or/ and for newly launched schools, the suitable way to substitute genuine system in teaching experimental activities are using low-cost improvised materials from already existing materials(resources) in the environment or from second-hand equipment that are found in the environment after reconstruction as new materials (Barley et al., 2008; Chemistry L, 2012). The effects of resources are to shine chemistry teaching when other factors are almost similarly affecting learners' achievements.

2.5.3 Improvised local Materials and Chemicals for Chemistry teaching

Improvisation of laboratory facilities in teaching and learning means that making decisions concerning a piece of materials that help learners to practice practical activities in the classroom to resolve scientific problems. The absence of standard materials and inappropriate manipulation of equipment further resulted in learners' poor achievements (Thomas et al., 2012). Improvisation is employed in finding an option that would still serve as the genuine environmental resource in teaching all science fields in general and chemistry in particular. This idea is supported more likely based on advantages that improvisation is taking action for using alternatively designed materials from resources in the environment to facilitate learning process whenever there is a lack of some specific actual teaching materials (Ezeasor et al., 2012). DomNwachukwu et al.(2006) also tried to report by elaborating improvisation as an important technique, which alternatively used in teaching learners in the absence of facilities such as equipment and some other apparatus as well as enough chemicals related to experiments in the existing curriculum, which designed in chemistry or/and other science subjects altogether. The objective of improvisation is to help teachers and learners practice how to design educational materials or resources from the environment to improve their roles in the absence and / or scarce of convectional facilities (Achimugu, 2019). It also supposed to produce a workforce with creativity and objectivity, which further help create the business idea in large scale to develop one’s country. Furthermore, it also increases confidence in learners for unemployment reduction (Adebayo, 2018). Thus, learners participate in creative and manipulative works that need their skills in different organizations.

As the researcher tried to assess all topics, volumetric analysis is a special topic in chemistry and some other related fields to which its practical activities often forfeit in the acquisition of appropriate skills. Thus, understanding the volumetric analysis by avoiding cognitive loads through practical teaching retains proper knowledge that helps learners in different perspective areas of societal benefits.

On the issues of learners' achievements in chemistry, learners practiced experimental activities and tried to work a few numbers of different calculations in model questions, exercises too, concerning volumetric analysis issues to achieve good score (Ali et al., 2000). Teachers must teach and practices these calculations by solving prepared exercises, employing suitable alternative strategies, and letting learners conduct practical lessons prescribed in volumetric analysis. Doing hands-on activities in precise titrations is possible only if there are laboratory facilities to do practical activities. Even though there are ineffective utilization and shortage of laboratory facilities, improvising chemicals and apparatus that are suitable for experiments in chemistry must be sought from locally available resources, thereby solving the problems in practical work in all sciences (Barely et al., 2008). It is also illustrated with these concepts in different scholars' findings; teachers ought to try to find solutions for the experiments to substitute appropriate materials alternatively in the absence of regular materials (Hamisi, 2011; Yitbarek, 2012; Temechegn, 2012). In this research, practical lessons of volumetric analysis performed with conventional materials like chemicals and equipment, which is ready from the industry as a standard resource and an alternative approach through improvised materials from resources in the natural environment. The traditional method of teaching also used as a control in the study.

2.5.3a Locally Available Improvised Chemicals

Improvised locally available chemicals and low-cost materials are used for laboratory teaching purpose in schools found in rural areas and with no laboratory equipment at all. Improvised materials are prepared from local resources such as indicators from rosella flower; acids (citric acid) from citrus fruits or sulphuric acid from the car battery, and ashes from charcoal containing metallic oxides, hydroxides, and carbonates as alkaline solutions in water are used for experiments in volumetric analysis and chemistry in general (Hamisi, 2011, Tesfaye et al., 2010). The dedicated teachers can easily conduct the existing practical activities in chemistry subject even if in the absence of chemicals and equipment made in the industry from the above locally available chemicals such as indicators, acids and bases. However, only accuracy and precession problems could be noted while doing the experiments with improvised materials but it can be resolved using the appropriate mechanism. Thus, the accuracy and precession problems can be resolved using the macro-level concentration of improvised materials, especially in the case of indicators (Baeza & Galicia, 2005).Inaddition to this carful follow up procedures of improvisations also be accounted for decreasing the accuracy and precession problems that may happen during experimentation process.

2.5.3b Improvised local Materials as equipment and their advantage in environment protection

It is known that chemistry is one of the practical activity-oriented science subjects, which needs hands-on activities of all learners, those are found in the same education level. From this perspective, while teaching chemistry as one of the science subjects, learners need the laboratory facilities that support or increase their understandings of some concepts in teaching the theoretical part of chemistry lessons. However, in the absence of such laboratory facilities, it is possible to use appropriate alternative strategies for schools found in rural areas (Ezeasor et al., 2012), and for those newly launched schools or/and for schools, which are fall in a situation of shortage of laboratory facilities due to financial constraints. Furthermore, it reduces biases that hamper the achievement score among learners even if they are less ability group learners. For schools, those are located in urban areas, other alternatives to practicals such as video teaching strategy, computer-aided learning, animations and some other appropriate methods employed in teaching experiment related subjects in addition to, improvised materials, and two or more methods coupled can be used for the teaching process. Hamisi (2011) agreed on alternative methods and forward suggestions to use locally available materials after improvisation to fill a gap due to the absence of conventional apparatus in the laboratory. There should be taken care while utilizing improvised materials in preparation, awareness creation and assimilation. Some of these materials include common plastic water bottles; different water bottles, plastic syringes instead of burettes, the pipettes and materials to conduct experiments in chemistry in general.

The use of low-cost materials is also advantageous for protecting the environment from pollution since most substances were employed those constructed from plastic materials, which are be able to be introduced to the land and water as waste after use. Plastics and other materials, which are non-degradable, introduced to land and water bodies should be reused for the laboratory purpose in the school with no facilities after reconstruction. Aydinili & Avan (2015) tried to report that one of the popular debates is the usage of plastics and their supposed environmental pollution. Therefore, this strategy ensures the recycling of already used plastics for laboratory facilities, which further protects environment pollution.

2.5.4. Exploration of Local and Commercial resources in teaching chemistry (Volumetric Analysis)

In this research, the apparatus and setups were improvised to be used for instructional purposes from resources in the school environment to motivate teachers and learners in secondary schools without conventional materials. Some of these, materials were improvised for the teaching and learning process by Yitbarek (2012) in Ethiopia. However, the researchers in secondary schools about a volumetric analysis did not study their effectiveness by comparing its advantages with the conventional materials. Some improvised materials including titration equipment, heating devices, and common apparatus used in the laboratory room such as separation funnel, beakers, stirrer, funnel, stand, test tube, test tube holder, test tube rack, evaporating dish, models, wash bottle, spatula, measuring cylinder can be used in the schools (Temechegn, 2012; Tesfaye et al., 2010). For the current research, the researcher used both already improvised materials and the others, which the researcher improvised then assistant teachers were also trained with these techniques and improvised materials accordingly to use in the current research.

2.5.4aExploration and Preparation of some Chemicals from Local Materials for teaching volumetric Analysis

2.5.4a1 Indicators from local materials for controlling Titration experiment equivalent point

Flowers are plants that impart colour when dissolved in water and some other appropriate solvents. The extracts of plants have been used for many purposes. One of its advantages was in alkali and acid titrations experiments. The titration results of the indicators flower extracts have been compared with industrially produced indicators such as methyl orange and phenolphthalein (figure 2:5). Experimentally, It has been established, that the flower extracts can be effectively used for titrations in place of phenolphthalein and methyl orange for acid or alkali titrations (Singh & Singh, 2015; Baeza et al., 2005). The presence of compounds like Anthocyanins has been used in imparting pH-sensitive colour dependence, comparing the indicators that existed in nature (Singh & Singh, 2015). As it is also suggested and well explained in supporting their effectiveness for titrations experiments in Hamisi (2011), flowers used to prepare indicators are colourful flowers, those imparting lots of colours such as pink, red, orange, and purple colours. The papers often act as red litmus when made in a cool extract of the flower and as blue litmus paper when made in boiling extract (Hamisi, 2011). The extract of flower imparts red in acidic solution and blue or green in basic solution (Bekele, Trial experiment). In general, red flowers particularly imparts useful colour that used in a place of indicators. Most contain a pigment known as Anthocyanins, which can be changed in to different colours red in acidic and blue in basic solutions (Horbowicz, Kosson, Grzesiuk & Debsk, 2008).Thus, in the absence of industrially produced indicators,teachers can employ as equivalence point determinant for titration experiments in chemistry.

According to grade twelve chemistry curricula in Ethiopia, and it is also known from the analytic chemistry book Skoog et al. (2004), acid-base indicators are defined as, the chemicals that impart different colours in both acids and bases. Methyl orange, for example, imparts red colour in acidic solution and yellowish in basic solution. Indicators are very useful substances because they give us information about whether a substance is an acid or a base. Baeza et al. (2005) indicate that low-cost equipment with locally available materials is equivalent to those obtained from macro-scale conventional conditions to precision parameters assayed for volumetric titrations results; those are monitored by using the extract of these colored local materials as indicators instead of standard indicators. They are also used during chemical reactions to show the end and equivalence points. A solution changes from acidic to basic and vice versa in a titration experiment, which is dealt with under the topic of volumetric analysis.

Scientifically, for example, since the indicator molecules are weak acids or weak bases, so, in the case of weak acidic nature, the ratio of HIn to its ion In- governed by the H_3O^+ of the test solution.

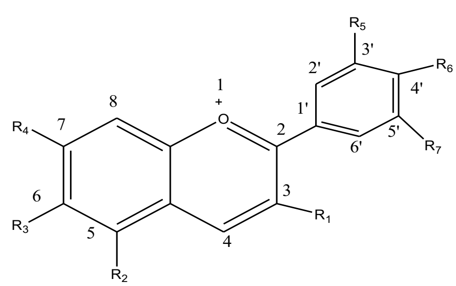
$$HIn\,(aq) + H_2O\,(l) \longrightarrow H_3O^+\,(aq) + In^-(aq)$$

$$K_{In} = \frac{[H3O+][In-]}{[HIn]}$$

By rearranging, $$\left[\frac{HIn}{In-}\right] = \left[\frac{H_3O^+}{K_{In}}\right]$$

From this relationship, one can conclude that in the acidic PH region, the indicator found as HIn and it changed into In- when the solution became basic or contained OH- ion.

However, the principle for colour change of anthocyanins confirmed due to eight conjugated double bonds that carry a positive charge. Anthocyanins are red or orange under acidic conditions (below pH value 2) but in higher pH value, they are colourless and in alkaline condition change their colour into bluish (Horbowicz eta al., 2008). There are seventeen known naturally occurring anthocyanins, but only six of them are common in higher plants. These are cyaniding (Cy),peonidine(pn),pelargonidin(pg) , Malvidin(mv) ,delphinidin(DG), and petunidin(Pt).



R1 = O-Sugar (Glucose, Arabinose, Galactose)
R2, R4, R6 = OH
R3 = H and R5, R7 = H, OH, OCH3

Figure2.5 General Structure of Anthocyanins, Source: (Azza, Ferial & Esmat, 2011)

Anthocyanins can be extracted from a rose flower by three methods, using a methanolic solution of 0.1%HCl, citric acid and tartaric acid used in the quantitative analysis of standardization of NaOH and HCl solutions (Azza, Ferial & Esmat, 2011). The anthocyanidins were used as, a natural acid-base indicator. "The intrinsic pH of the extract was 2.88. The colourant present in the rose flower mainly consists of cyanidin, pelargonin, peonidine, or the mixtures of these pigments. In acidic aqueous media (pH 2-6), there are three forms of cyanidin: the flavylium cation(AH+), the carbinol B, and the quinonoidal base A. Equilibrium between the two neutral forms occurs exclusively by way of the flavylium cation. Hydration of the flavylium cation involves the formation of a C-O bond and a proton transfer." (Horbowicz et al., 2008 p8). Co-pigmentation enhanced the stability of anthocyanins. Acylated anthocyanins containing two or more aromatic acyl groups may affect the colour through a mechanism called intermolecular co pigmentation (Harborne & Williams, 2001).It sustains the colour formation.

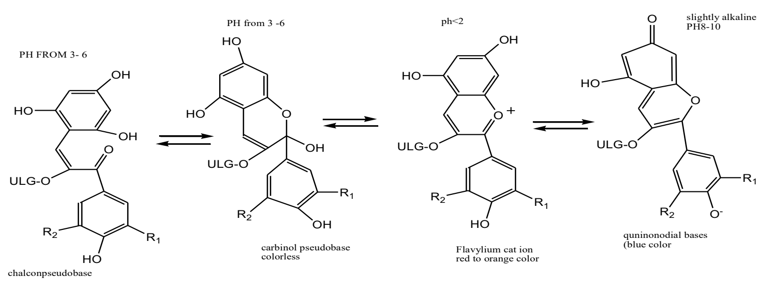


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Figure2.6: Effects of PH conditions on the colour of anthocyanins or products its conversions

(Source: Horbowicz et al., 2008)

For titration experiments, we habitually use indicators, and five indicators among all the indicators in Table 2.2 below commonly used in titration experiments in grade twelve in Ethiopian schools. These indicators include methyl red, methyl orange, phenolphthalein, Litmus and methyl yellow. Indicators from local materials are also used for titration purposes since they are not interfering the chemical reactions existing between acids and bases. They only indicate the pH and the media of the reaction, so it is possible to use them in titrating acids with bases from local materials. Local indicators also used to signify the equivalent point while titrating acid with a base produced from the industrial manufacturing process. The purpose of locally produced indicator as industrially manufactured was to indicate the end of the reactions at certain pH range.

Table2.2 show examples of indicators used for titration experiments

SN	Indicator	Acid colour	Base Color	PH change of colour change
1	Methyl Violet	Yellow	Violet	0.0-1,6
2	Methyl Orange	Red	Yellow	3.2-4.4
3	Bromocresol Green	Yellow	Blue	3.8-5.4
4	Methyl red	Red	Yellow	4.8-6.0
5	Litmus	Red	Blue	5.0-8.0
6	Bromothymol blue	Yellow	Blue	6.0-7.6
7	Thymol blue	Yellow	Blue	8.0-9.6
8	Phenolphthalein	Colourless	Red	8.2-10.0
9	Thymolphathalien	Colourless	Blue	9.4-6.0
10	Alizarin Yellow R	Yellow	Red	10.1-12.0

(Source: Grade 12 chemistry book, Ethiopian curriculum)

A B

Figure 2.7 the colour change of phenolphthalein in a basic solution (a) and in acidic solutions (b)
(Source: Grade 12 chemistry textbook, Ethiopian curriculum)

Figure 2.8 water extract indicator from reddish-rose like a flower (Bekele, 2015).

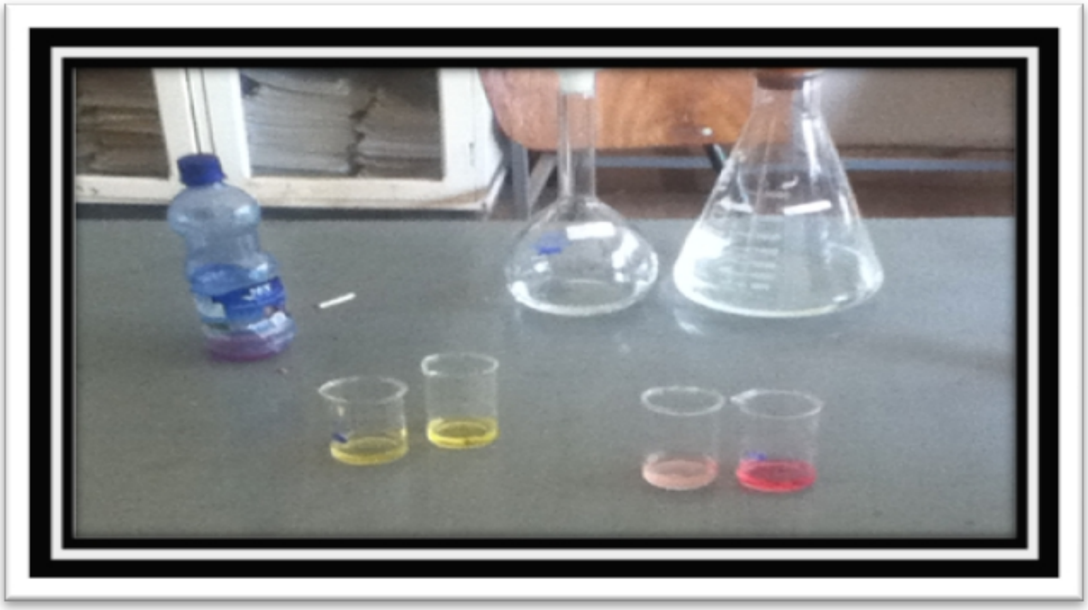


Figure 2.9 Comparison of water extract Indicator from a Red colored flower with industrially prepared methyl red in acid and base reaction.

(Bekele, 2015 used during assistant teachers training)

2.5.4a2 Acids and Bases from daily life Materials used for Titration Experiments

Teaching and learning activities, particularly in chemistry requires a lot of chemicals and materials consumed while learners perform the experiments, which are designed for even in specified single content to be learned. Most of the chemicals usually washed out and then they are percolated in to unwanted wastage materials after accomplishing the practical session of the lesson. Because of the high cost of standard chemicals, it is impossible to use them in all schools at all time in these costly-purchased conventional materials. They are also early finished in the laboratory and due to not being reused as well, for any experimental works. It is possible to find an alternative option and continually practice experiments stipulated in the curriculum by improvising appropriate resources from the environment (Aadland, Espeland & Arnesen, 2017). An acid-base titration is an aspect of practical activities taught in secondary schools, and higher institutions, often by requiring appropriate chemicals. Moreover, they are an essential part of the lessons used in the preparation of senior secondary school certificate examinations (Ochonogor, 2012). When teachers use environment resources to substitute the scarce standard materials and chemicals in volumetric analysis, learners are motivated to expose themselves for improvisation to produce materials and chemicals related to the stipulated experiments. Furthermore, these materials also boost the learners' achievement by reducing misconception in science subjects in general. In the establishing teaching materials for chemistry experiments, an effective chemistry teacher often considers the opportunity to exploit materials, as one who maximally utilizes available resources; those are found in his environment in bringing acceptable changes in the learner's behaviour (Emendu, 2010). Furthermore, it was also explained likely that a science teacher must be innovative to the local materials and their properties within the environment in teaching his subject matter (Skoumios et al., 2010). Teachers' readiness is mandatory with both the knowledge of contents for effective instruction and the materials used for doing practical lessons to substantiate the lessons' theoretical aspect in a class presentation to convey the message of learning objectives for the end learners.

Acids and bases used in titration experiments in volumetric analysis can be extracted from all parts of plants like leaves, stems and roots. There is a list of examples that peoples can extract acids and bases from daily life foods and eat fruits such as vinegar, citric acid from lemon, ash after the burning of charcoal and banana plant, pure Water are some examples among others(Hamisi, 2011; Chemistry L, 2012). Each activity used regarding the means of how to extract indicators, acids, bases, and the respective experimentation process in the volumetric analysis presented here below.

2.5.4a3 Bases obtained from the ash of burned charcoal after dissolution in water

Charcoal is black with its' colour, is a substance formed after burning wood with an insufficient amount of oxygen further it burns with a sufficient amount of oxygen to produce ashes and carbon dioxide. As it reported in Babayemi Adewuye, Dauda & Kayode (2011) describe plant wastes, which could be reduced in volume by combustion resulted in ashes to exploit for potash production. These ashes dissolved in water. So, the water solution of ashes of the charcoal has basic properties, tested and confirmed with neutral litmus that turned in to blue (appendix-32) used for practical testing to training assistant teachers). In their works of plant materials, Taiwo & Osinowo (2001) tried to report, because of the focus of agricultural application of wood ash due to the presence of nutrients and the alkali identified from the wood ashes, mainly the substances were carbonates of sodium and potassium. There are also elemental compositions that were tested and confirmed after water extraction, carbon (5 to 30%), calcium (7 to 33%), potassium (3 to 4%), sodium (0.2 to 0.3%) while other also metallic ions constituting about 2% Ca2+, Cr2+, B3+, Zn2+, Fe3+, Pb2+ and Ni2+ (Naike, Krause & Siddique, 2003). They are separated from soluble hydroxide by filtration. However, the hydroxides of these elements are not water-soluble so that they do not have a considerable effect during titration experiments. Since only potassium and sodium hydroxides are soluble in the water, and the others are insoluble. For example, the water extract of burned charcoal ash contains considerable KOH and NaOH in addition to carbonates and bicarbonates of sodium and potassium (Kuye & Okorie, 1990).

It is confirmed experimentally that the neutral litmus paper changed into blue colour in a water solution of the ash indicates that the water solution of ash of charcoal is basic (appendix- 34). Babayemi, Dauda, Nwude & Kayode (2010) also tried to report the basic nature of water solution of ash is due to hydroxide ion concentration increment produced because of carbonate ion traps hydrogen from water molecule producing hydroxide ion, which dominates or decrease the hydrogen ion concentration available from self-ionization of water. Further, the net ionic ions in the solution become,

$$K^{+}(aq) + OH^{-} \longrightarrow KOH$$

The total concentration of a base in the solution can be determined by titrating with the appropriate mineral acid (preferably HCL)

a) $H_2O(l) \longrightarrow H^{+}(aq) + OH^{-}(aq)$

b) $K_2CO_3(aq) \longrightarrow 2K^{+}(aq) + CO_3^{2-}(aq)$

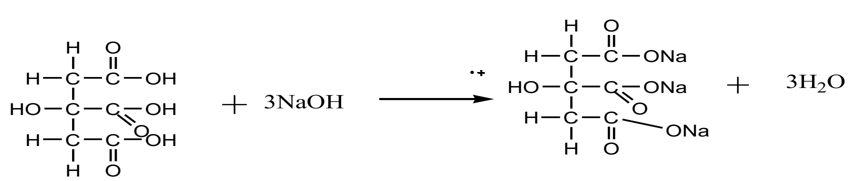
c) $H_2O(l) + CO_3^{2-}(aq) \longrightarrow HCO_{3(aq)}^{-} + OH^{-}(aq)$

d) $H^{+}(aq) + CO_3^{2-}(aq) \longrightarrow HCO_{3(aq)}^{-}$

2.5.4a4 Acid from the lemon juice (citric acid)

Lemon (Citrus Limon) is one of the vital citrus fruits used for enjoyable flavor. It has incredible food qualities. It belongs to the family Rutaceae. It is a rich source of a group of secondary metabolites like flavonoids, vitamin C, Citric acid and minerals (Sindhu & Khatakar, 2018). The juice of lemon fruit contains acids, largely citric acid(8%) and sugars, essential oil from the outer layer of lemon (6%) citral found (5%) plus traces of citronellal and limonene(90%), α-terpinol, geranyl acetate and linalyl (Chaturvedi & Shrivastava, 2016). According to the writers about the basketball benefit of citrus Limon, the lemon juice contains 5% acidity, which gives lemons a sour taste at the range of pH value 2-3. The percentage composition may be different for plants collected from different areas depending on the type of soil, weather condition or some other parameters as different percentage value reported with different researchers. It is acidic fruit due to having three carboxylic acid functional groups with a pH level of around 2(two). Since citric acid is an acid with three hydrogens to be ionized and called triprotic acid due to having three carboxylic functional groups. It can donate three protons. It reacts with a strong base (NaOH) via a neutralization reaction to form salt and water. The end of the reaction usually determined with the appearance of colour from another group of substance that is non-interfering to reacting species called indicators. When all of the acids have been reacted completely to become a neutral solution, adding, one additional drop of a base solution, which is a titrant, causes a solution to become basic. In the case of the citric acid titration, a known amount of Lemon juice sample by volume can be used and, which is titrated with a known concentration of a base(NaOH in this case) after diluting the lemon juice sample with water. In the end, confirming the reach of the equivalent point, the number of moles of an acid can be calculated. Finally, the % (mass/volume) in the sample determined.

The reaction proceeds as follows,



2.5.5 Actual practical versus practicals that are taught through improvised materials in chemistry and their comparisons

Actual practicals are practical activities taught through conventional materials in the experimental classes of science subjects that require many activities in general. It can be done before, during and after the laboratory session. Teaching materials are ready for learners in a well-prepared and structured manner by the teacher. Each step through the entire processes organized attentively simultaneously, learners anticipated to follow up the procedures based on the order, which the teacher told them to do so. All the laboratory activities that the teacher has already structured require little learners' commitments to all the contents to be taught. Already structured laboratory activities often referred to as a 'recipe' laboratory session (Singh, 2014). As a result, learners can be effective enough in their practical results having little understanding of what they are doing in the laboratories. They may also have little choice to manipulate the laboratory sessions' necessary equipment when they are involved in laboratory works. There is no more active participation in designing required equipment except reading laboratory manual prepared by expertise (Abraham et al., 2012). In the recipe laboratory the activities are determined before what learners are going to do?; they are ready before the experimental work starts by laboratory technicians, and laboratory attendant all aware of in an evident way what is expected to happen in the class. The teachers and co-instructors can identify errors. Furthermore, the teachers often put right enough information for the learners before they continue with the laboratory work, with the result that learners get a little experience in solving problems and without getting appropriate intended science process skills, but adopting this passive approach become undeserved until the learners tackle with new techniques and equipment.

When we come to an alternative approach, which is teaches practicals through improvised materials and chemicals that require hands-on experiences like practicals performed the actual practical chemistry-teaching model. It also addresses all science process skills including the skills provided through teaching with conventional materials in an actual practical teaching scenario. Moreover, there are other extended skills that learners acquired having a chance to design the materials required for the experiments stipulated in the curriculum from local material or construct low- cost materials from resources in the environment (Tesfaye et al., 2010). During designing the appropriate materials for the experiments, learners must develop the necessary science process skills even before they do experiments. With an alternative laboratory teaching with improvised materials (LAM) or by using low-cost materials from already utilized second-hand materials, the teacher could not identify errors in a visible way to the learners. Learners often try to design experimental procedures and materials that will be utilized as well, and identify errors before experiencing problem-solving skills in the laboratories, and they have already informed about the whole skills gained through instruction by designing materials to equip laboratory facilities for science teaching (Temechegn, 2012; Bank & Musar, 1993). In contrary to an alternative approach that learners are taught through improvised materials, recipe laboratories have the great advantages that allow learner having no experience to acquire the same perception to practicals in providing science process skills as if it is in use by the professional scientists those impart the instruction with guided materials (manuals). Furthermore, the cookbook allows the learner to devote all his or her attention to the technique without hands-on experience and not to be concerned at all about the theoretical aspect of the practicals (Garratt, 2002). Learners attain straight forwarded opportunities to develop manipulation and technical skills without handling laboratory facilities. Moreover, learners become idle in handling materials and become in fear regarding instruments to avoid breaking. Furthermore, learners are not engaged in laboratory activities trustfully alone using their hands-on activities. Conversely, the learners are not killing time with matching their learning of practicals with previous experience as an alternative approach for practicals. Learners are consolidating the instructional process by asking themselves what is going on in their heads unlike the thinking of researchers and professional scientists who are doing the laboratory work for a particular purpose (Bruck & Towns, 2009; Ojediran, Oludipe & Ehindero, 2014; Orla, 2005). There are setbacks encountered with the cookbook-guided mode of laboratory teaching, which is the real practical aspect of any experiment stand for only a small part of all the complete process of science practical lessons (Bailey & Garratt, 2002). At the same time in alternative approach (by using improvised materials), all practical aspect is covered alongside the theoretical aspect of learning and besides, learners gain further knowledge about practical skills, which are uncovered by actual practical activities those were conducted with spoonfeed laboratory procedure. Scholars in their research work advocated the recipe laboratories encourage 'data processing' rather than data interpretation. However, it lacks the stages of planning and designs in manufacturing alternative materials (Hunter, Wardell & Wilkins, 2000). Garratt (2002) tried to report steps of a research work that researchers would develop and take action before involving in practicals as follows:

- 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 desired observations?
- How will we process and evaluate the observations?
- What will we do next?

All those mentioned above are the aspects of a practical problem that learners have no association with them. Therefore, the laboratory instructor and technician make decisions for the problems long before the learner gets to the part with practicals.

2.6. Volumetric Analysis, its Nature and Importance

2.6.1 Volumetric Analysis and its' definition

At first, the French chemist, J. Baptiste Andre Dumas, studied Volumetric analysis and introduced it to the scientific community (Chastain, 2021). He used volumetric analysis to decide nitrogen by mixing it with other elements in organic compounds. Ultimately, Dumas (1999) used to burn a sample of a compound with known weight in a furnace under several conditions that ensured the conversion of all nitrogen into elemental nitrogen gas. According to his experiment, the nitrogen gas was carried out from the furnace in a stream of carbon dioxide that was passed into a strong alkali solution, which absorbed the carbon dioxide and allowed the nitrogen to collect in a graduated tube. Further, he calculated the mass of the nitrogen from the volume it occupies under known conditions of temperature and pressure, therefore, the proportion of nitrogen in the sample was determined (Skoog et al., 2004). The volumetric analysis technique has been used extensively in chemistry practicals, laboratories, industries and some other related research laboratories. The volumetric analysis also has lots of advantages in its application for humans in different scientific endeavours. The processes in determining the concentration of substances in volumetric analysis in chemistry subject matter involve both gaseous and liquid phase substances. Gaseous substances can be collected in graduated containers over mercury through either reaction or absorbing,then the volume changes measured and it also involves the common titration techniques for liquid substances that allowed, each other's reactions in the solution. It can also be said to be a method of determining chemical differences and principles of redox (reduction-oxidation) reactions between molecules, and; chemicals under this topic are classified based on the results obtained from titration (Alam et al., 2010).Thus, volumetric analysis is amethod used in the analysis of chemicals in all physical states inclusive in science studies.

Volumetric analysis is an essential topic that used in the operation of quantitative analysis of certain reactions of compounds in their solutions. It is also defined as an unknown chemical, which is dissolved in an appropriate solvent and form a solution, which is titrated with the quantity of known concentration and volume to determine the amount of unknown substance either the concentration or number of mole of the substance (Skoog et al., 2004). A large amount of quantitative analysis, which is found in analyzing the number of substances have been performed in the laboratory using reactions between two substances in solution. In the titration experiment, while analyzing the concentration of the liquid sample, one must know the volume and concentration of one solution, and the appropriate procedure is used to come up across the exact volume of the second solution required to react totally with the first (Skoog et al., 2004; Kassahun, 2015.). In broad-spectrum assumption, volumetric analysis is the so-called acid-base titration reaction analysis in chemical analysis of certain substances, the equation can be written as:

$$\text{Acid + Base} \longrightarrow \text{Salt + water}$$

Acid-base reactions are the type of chemical reactions that involve the technique of volumetric analysis. It is a familiar topic at the senior secondary school level specifically in grade-twelve chemistry teaching curricula. Since it has been defined in many books and journals are that the process of creating a balanced chemical equation 'in vitro' is called titration (Alam et al., 2010; Dower, 2008). It typically uses a volumetric flask; hence, the name volumetric titration was given for the titration experiment. Furthermore, from volumetric analysis experiments learners have a chance to acquire several science process skills. It benefited the learners in resolving many different problems in their environment as it was also articulated in different research works with regards to its' advantages, which the scholars explained (Hamisi, 2011; Shitaw et al., 2017) in chapter one of the current research. Accordingly, the objective of teaching the chemistry subject in the current education systems are to observe and explore the environment; develop basic science process skills, which are the main components of the skills acquired in such as observation skill, experimenting, manipulation, classifying, communicating, inferring ideas, hypothesizing, interacting with data and formulating models (Abungu et al., 2014). It is also used in boosting practical knowledge of science concepts, principles and competencies among learners; give details to simple natural observable facts; develop scientific perception, including interest, critical reflection and objectivity (Emmanuel, Nyia & Elton, 2017). All these can be obtained effectively through practical activity practices in chemistry.

Based on their reaction rates, titration in the volumetric analysis was classified into three different areas of titrations (Skoog et al, 2004). These three-titration techniques exploited are "(1) direct titration method (DTM) is a one-step titration process. (2) Indirect method (ITM) involves a two-step titration process(3) back titration method (BTM) uses a three-step titration process"(practical Analytical chemistry manual, Dilla university; Orimogunje et al., 2010 P325). Volumetric analysis is a better and faster technique with that the unknown concentrations easily determined in the case of substances involved are acids and bases to which ultimately better quantitative results obtained in quantitative experimental analysis. It addresses the achievement of the intended science process skills effectively in chemistry.

Table2.3 Types of reactions, descriptions and examples in the volumetric analysis (Source: Alam et al, 2010 p 1327)

Reaction type	Description	Examples
Acid-base	The acid reacts with a base. the colored dye can be used as an indicator and they are sensitive to acid/base or pH electrode to determine the equivalence point	a) Strong acid + strong base HCl(aq) + NaOH(aq) $\rightarrow$ H2O + Nacl(aq) b) Weak acid + strong base CH3COOH(aq) + NaOH(aq) $\rightarrow$ CH3COONa(aq) + H2O c) Weak base + strong acid CH3NH2(aq)+HCl(aq) $\rightarrow$ CH3NH3 + Cl^- (aq) + H2O
Precipitation	Reagent and analyte combine to form an insoluble compound. the colored reagent can be used as indicators the electrode of some type	a) soluble ionic compd 1 + soluble ionic compd 2insoluble ionic compound 3 $\rightarrow$ Nacl(aq)+AgNO3(aq) $\rightarrow$ AgCl(s) + NaNO3(aq)
Complexation	Reagent and analyte form a coordination Compound. Colored dyes can be used as indicators or electrode.	Complexation agent (ligand with multiple electron pairs to donate) + metal cation (–O2C-CH2)2N-CH2CH2-N(CH2CO2-)2 [called EDTA4– + Ca^{2+} $[Ca(EDTA)]^{2-}$
Redox	Electron transfer (Oxidation-Reduction) colored dye can be used as indicators or electrode.	Many types are possible. Some examples include a) $Ce^{4+} + Fe^{2+} \rightarrow Ce^{3+} + Fe^{3+}$ b) $MnO4^- + C2O4^{2-}$ (oxalate) $\rightarrow$ Mn^{2+} + CO2 (not balanced)

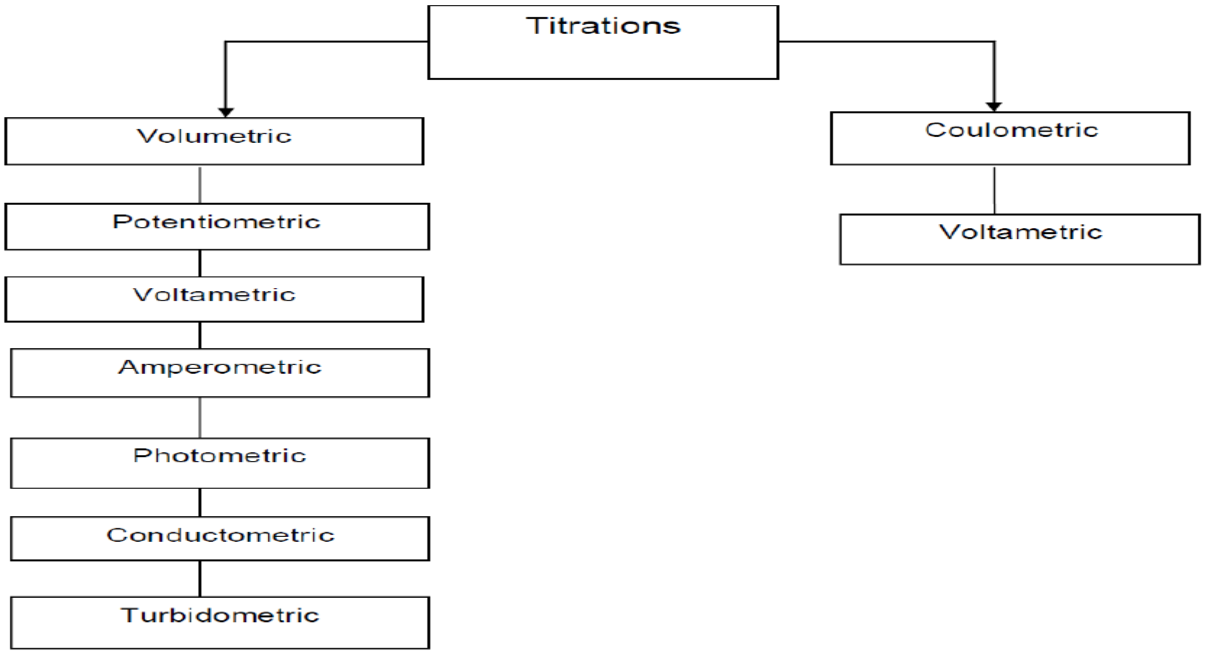


Figure 2.10 an overview of the different titration Techniques

2. 6.2 The importance of Volumetric Analysis

Two substances react with each other when they are in contact with their solutions. The relationship of one substance with the other substance on further employed as important conditions to chemists in chemical analysis involving the solutions that they formed. In the end, the quantitative techniques used to determine the amount of one substance, which is in contact with the other in the solution. The volumetric analysis looks a better and faster technique in comparison, especially if the substances involved are acids and bases. Acids and bases can be titrated against one another for better quantitative results (Alam et al, 2010; Orimogunje et al., 2010; Achimugu, 2012; Emendu, 2010). The volumetric analysis employed in many diversified areas like in the laboratories of high school, college, university level and some other research centers used to determine concentrations of unknown substances. The titrant (the known solution), is added to an unknown quantity of analyte (unknown solution) and a reaction takes place while they are in contact with each other in the reaction vessel. Knowing the volume of the titrant allows the learner to determine the concentration of the unknown substance or analyte (Ochonogor, 2012). There are also many scientific applications of volumetric analysis identified. They are explained briefly based on their advantages. In this regard, medical laboratories and hospitals use automated titration equipment for the same purpose. Besides these, the process has found ample use in analytical laboratories to investigate the properties of substances in drug, food and petrochemical industries etc (Orimogunje et al., 2010). For example, in the bio diesel industry, it is used to determine the acidity of a vegetable oil sample (Dower, 2008). In the analysis of a sample of vegetable oils, the researchers use to neutralize the precise amount of base needed and scientists know how much base must be added to the entire amount of oil. In this situation, employing volumetric analysis experiments is the only mandatory technique for chemists efficiently to analyse the sample of vegetable oils.

2.6.3The acquisition of Science Process Skills through teaching Volumetric Analysis in Chemistry Education

The practical activities in volumetric analysis enable the learner to practice appropriate intended science process-skills stipulated in the curriculum. Science process skills that are equipped from experimental activities in the laboratory through effective utilization of facilities in chemistry by the teachers and learners reduce misconception and proven high achievement in their learning. To enrich learners with these science process skills by implementing all experimental activities procedures; teachers first must own those skills adequately (Feyzioğlu, 2009). Practical works and promoting the acquisition of science process skills facilitate the indispensable learning environments like active participation of learners in educational practices, assimilation to their well-being and significant learning in chemistry in general. Abungu et al. (2014) mentioned among other skills from practicals identified five process skills that commonly practised in teaching chemistry in general. These are observing, measuring, recording, interpreting and manipulation. All these science process skills are acquired through the practical application of experiments side by side when the subjects' theory is taught. Furthermore, each science process skill separately studied under the following topics as subheadings here below.

2.6.3a Observation

The characteristics of objects and events that might happen during the experimentation process could be identified using ones' sense known as an observation. It required the learner's friendly approach more in close concentration to some features. It is also being observed during practical activities in the laboratory session. It is one of the science process skills, which demands hands on practices to provide details of information that may happen in the laboratory. For instance, during titration experiments, the substances' color change was observed at the conical flask during chemical reaction, and at the end, the learner must measure the volume and record the titre's observed value to effect the change (Colen, 2013). In this respect, observation as a process-skill took part as an agent in acquiring other science process-skills, such as recording, reading of the measured values and acquiring hands-on skills. The chemistry syllabus in secondary school emphasizes the practice of observation skill simply for their immediate demand, and speculates of excitement that learners bring to the classroom setting and developing other science process skills (Feyzioğlu, 2009). It is one of the skills, and appropriate to practice the sciences in general and helpful to learners in day-to-day activities of their life situations. Practical activities in chemistry, especially in volumetric analysis's lessons could be used to function through effective instructions to improve learners' willingness to observation by using all the senses to make either intentional or careful observations (Nbina et al., 2010). An argument concerning observation, which is an essential tool that would be required by the learners, is used to achieve scientific and other important skills in chemistry. In the end, it continued to exist as a scientific role-play model. Furthermore, it assists learners as a foundation in scientific literacy in the livelihood of their future career.

2.6.3b Measuring

In primary schools, most learners get informed of basic measurement skills and volumes of substances were considered as basic skills that learners get as skills from science through teaching science subject matter and mathematics lessons. Some basic measurement skills were acquired through teachings practices of measuring parameters such as weights, length, temperatures and time at lower grades (Aguisiobo, 1998). However; when learners join secondary schools, measuring the objects built on using precision measuring tools (Bentley, Ebert & Ebert, 2007). At this stage, learners are exposed to measuring instruments in the lessons' practical activities during their leaning. In chemistry lessons at the secondary school level, the learners' ability to measure objects extended to further complicated skills by applying several practical activities in the laboratory. The tasks set, such as weighing a sample of a substance, using a balance and/or measuring the volume of a substance in a burette require learners to read and use instruments and apparatus in the laboratory room that entails the use of observation skill (Feyzioğlu, 2009). Therefore, the main objectives of practical lessons in secondary school chemistry syllabus enable learners to develop science process skills through measuring materials. Finally, it prepares learners for chemistry examination either in matriculation or class tests to achieve a good score, specifically in volumetric analysis and other related topics in chemistry (Colen, 2013). Volumetric analysis and other related topics that are found in chemistry subject alert for skill generation after learners conduct experiments.

2.6.3c Recording

Most practical activities in chemistry subject matter, in general, provides the basic and higher-order process skills that involve recording the data, observations, manipulative skills like handling, measurements, drawing and representation of set-ups for experiments to be done, and tabulating the data from readings of titration and rate of reaction experiments (Abungu et al., 2014). The recording is as one of the science process-skills that describe an outlook of the presentation of experimental results, which can be expressed in a tabular form and supported with graphs and drawing in their analysis (Johnstone et al., 2001). The learners' ability to exchange ideas about the results of practical work is of great importance. An average value of the quantity measured can be obtained from two or more readings made through the blueprint of the given experimental activities can be presented in a tabular form. Tabulation of the data recorded could make experimental activities easier for the learners to be acquainted with a pattern and understand its appearance in the research reports (George, Stuart & William, 2005). The records made by the learners reveal the accuracy and precession of the results observed from the given practical works. Therefore, learners have to be well developed with skills that entail recordings to secure accuracy and precession of the result through observation. A recording is one of the science process skills, which must be experienced from the subsequent use of equipment and chemicals in the laboratory as well.

2.6.3d Interpretation

Interpretation is one of the strategies used by researchers in the analysis stage. It is a cognitive skill, which allows learners to analyse crude data obtained from practical activities to make it easier for the reader. There are generally numerous types of interpretations ready from data obtained through practical work to make data sense, by differentiating others' interpretations, which may be acceptable while others could be not acceptable. However, interpretations are statements that generalize practical activities' work and the data gathered from field observations by relating some aspects of theoretical paradigms (Gultepe, 2016). The two important practices such as experience and information gathered by the learners used to account for the interpretation of data during practical work in chemistry subject in particular and other science teachings in general as well. In the end, it enables learners to explain what is being observed about practicals during the experimentation process.

2.6.3e Manipulative skills

Even though the learners acquire manual skills by manipulating the apparatus available in the laboratory room, the key idea imagines in solving the problem is that they have to be familiar with how to handle, manage and deduce the data from any machine. However, which can be affordable only if the concerned body trained by the subject specialist of these materials well in the laboratory to get the intended skills, after all this; manipulative skills cannot be achieved precisely without having suitable laboratory facilities. Manipulative skills in sciences are also encountered often the schools established the laboratory facilities well in the laboratory rooms. It is also likely supported that laboratories are indeed the only place to learn and practice the hands-on skills, but many skills depend upon the particular piece of equipment available (Johnstone et al., 2001). The literature consistence about the laboratory facilities in providing manipulative skills can seriously help learners get other desirable skills to include problem solving and research skills that benefited the scientific communities (Ifenkwe, 2013). Learners with little or no manipulative skills struggle to manage equipment in conducting experiments and may fail to cope with the desired skills like important observations because they gather unnecessary poor data (Johnstone et al., 2001). From this explanation, one noted that learners initially informed with appropriate laboratory equipment and then they get manipulative skills through hands-on experience. After all things at hand, it is easy to get other additional science process skills too, associated with next to hands-on activities with laboratory equipment. Particularly, it is also essential to establish the manipulative skills from the observation and accurate recording of the data during the investigation of volumetric analysis.

2.6.4 Precaution during Practical Works in Chemistry

Teaching chemistry and some other experiment-oriented subjects through conducting practical activities in the laboratory can be stimulating learners only if they are doing activities largely in a favourable environment in setting the conditions conducive for desirable learning purpose. However, learners who are not in favour of laboratory activities less experienced with practicals, out of curiosity, refuse to do practical lessons in risky behaviour in the laboratory (National academy of science(NAS), 2011). Moreover, learners do not get involved in doing practical activities in the laboratory means that there is no hands-on experience, which may cause serious injury or, even proven death. For example, learners may not be eager to touch hot objects and they may be in a state of fearing to handle apparatus and some other objects, mix reagents with inappropriate chemicals in reaction vessels and even taste specimens (Bank & Musar, 1993). As a result, science teachers must take precautions in the laboratory. As it described in Achimugu (2012), teachers have to care learners well with basic and advanced laboratory safety orders to prevent accidents that happen in the laboratory. Learners had well informed with safety before the practical lessons started in the laboratory (National academy of science(NAS), 2011). Thus, the necessary skills have been acquired as a result of learners ought to be engaged in doing practical activities in chemistry by using appropriate laboratory equipment and chemicals for the desirable experiments without fear of touching the equipment. In contrast to these, learners became out of performance concerning practical work practices due to incapability to get experiences in the laboratory because of the absence of facilities. In the lack of facilities to practice practical of the theory discussed, improvisation must be recommended from resources in the environment to replace genuine teaching materials. Learners managed the improvised genuine teaching materials to get one step extended skills including designing and constructing new materials from existing ones (Otor, Ogbeba Ityo, 2015; Hunter et al., 2000). Based on these, teachers can secure the outcome of the learning objectives.

2.6.5 Common Errors leading to poor achievement in Practical Chemistry

The data was obtained from experimental manipulations that have been associated with doubts, and it limits the summary of results when one concludes at the end of his work refers errors (George et al., 2005). For example, as one needs to find the value of some parameter, which varies linearly as a second parameter is varied, either increases or decreases. One can decide that the difference is a linear relationship from a particular set of data or how certain one, regards of each of the two parameters. The violation of this linear relationship further also denoted as the error observed during the experimentation process. Uncertainty is a part of the experimental course, which is in action, no matter how hard is, one tries to reduce it. Thus, it is important to articulate uncertainty clearly when giving experimental data. In many cases, this quality of an experiment is called "error", but it is not "error" in the common sense of the word, so someone prefers the word "uncertainty" for this quantity (Achimugu, 2012; George et al., 2005). Thus, on further action, it considered being used as a factor to negatively affect learners' achievement as if its' measure did not take at the start point of the experiment. According to Achimugu (2012), common errors identified from the paper of committed candidates during practical chemistry, which further normally lead to loss of marks are,

- Using the result with no unit or wrong unit
- Inaccurate burette reading due to observation fallacy e.g. 24.55cm3
- Lack of knowledge for reading significant figures.
- The volume of the pipette not stated or determined.
- Which indicator used in the experiment not stated.
- Averaging non-concordant titre values
- Poor mathematical/manipulation skills
- Frequent mutilation of titre values to agree with those of the supervisor.
- Poor knowledge in relating the mole concept with other functions.
- Putting alkali in the burette instead of acid.

All the above-listed factors have often been seen as errors while learners are working in the laboratory, especially it is observed in recording the data of experiments. These errors increase learners' loss of marks and negatively affect their achievements in chemistry subject in particular.

2.6.6 Graphs of titration experiments in the volumetric analysis (From literature)

There are graphic representations obtained through the blueprint of the results of titration experiments. Each graph differs from one another based on the strength and type of acids and bases employed for titrations (Skoog et al., 2004). The details regarding titration experiments' graph discussed below under each topic and at the end, it showed the effectiveness of both phenolphthalein and methyl red at some pH range (source: http://www.bcpl.net/kdrews/titration/indicators.html).

2.6.6a Strong acid Versus Strong base

At the equivalence point of the titration experiment of a strong acid with that of a strong base, the two indicators as shown in the graph below do not change colour. Here the effectiveness of the indicator depends on the pH of the solution. Upon addition of, whichever indicator, we choose no difference in the volume of acid. Ultimately, it is possible to titrate with each indicator at its' PH value i.e. with phenolphthalein; one would titrate until it just becomes colourless (at pH 8.3) because that is near the equivalence point. On the other hand, using methyl orange, one titrates until there is the first trace of orange in the solution. The red solution indicates getting further from the equivalence point.

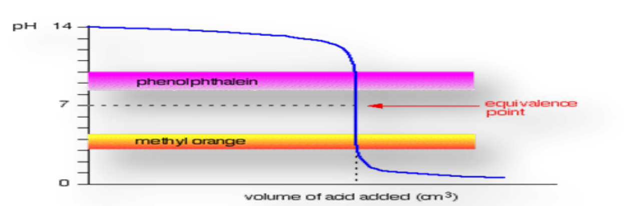


Figure 2.11 the pH ranges for phenolphthalein and methyl orange superimpose for strong acid Versus strong base titration.

2. 6.6b Strong acid Vs. Weak base

When a weak base is titrated with a strong acid, the colour change of solution with phenolphthalein indicator was seen before the equivalence point and methyl orange was seen close to the equivalence point.

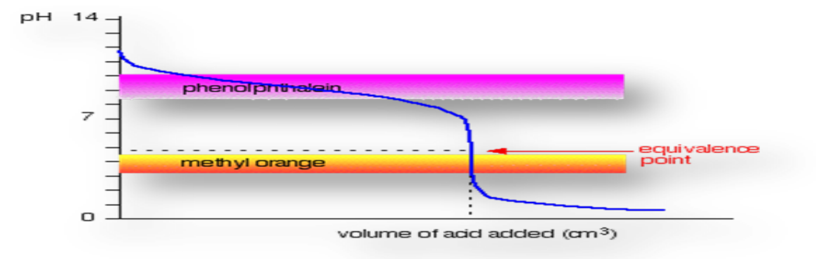


Figure2.12 strong acid Versus weak base graph

2. 6.6c Weak acid Versus Strong base

When a strong base titrated with a weak acid, the colour change of solution with phenolphthalein indicator was exactly at the equivalence point. However, with methyl orange indicator, it is not promising to give a positive response.

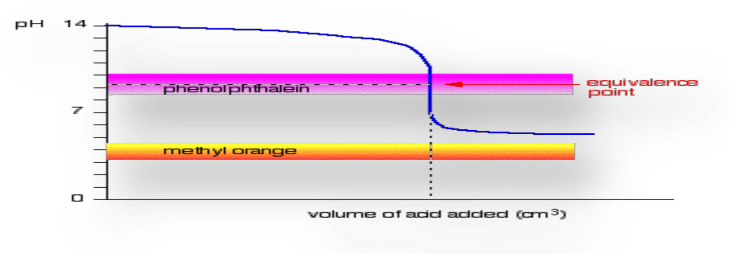


Figure 2.13 graph of titration of weak acid versus strong base

2.6.6d Weak acid Versus Weak base

The two indicators such as phenolphthalein and methyl orange are not used for titrating weak base with weak acid. The change of phenolphthalein observed before the equivalent point and methyl orange goes down the graph altogether. However, it is possible to titre a weak acid with a weak base, finding an indicator that changes or finishes at the equivalence point. In this situation, the pH of the solution has become different from case to case, it is impossible to generalize the titration history of the weak acid with a weak base. In short, in only the indictors' presence, both a weak acid and base never titrated unless we used a specific pH range.

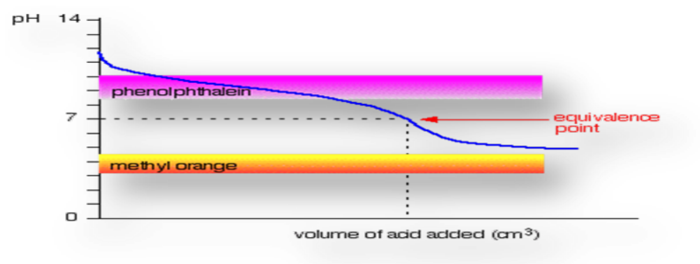


Figure2.14 graph of weak acid Versus weak base titrated at some PH-value

2.6.6e Dilute hydrochloric acid and Sodium carbonates solution

The titration result of sodium carbonate with hydrochloric acid with methyl orange indicator is exactly twice that of phenolphthalein indicator.

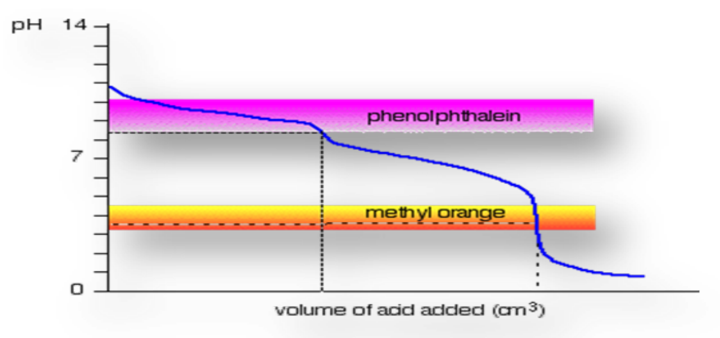


Figure2.15 The titration graph of sodium carbonate with dilute hydrochloric acid solutions

The phenolphthalein has finished its colour change at exactly the pH of the equivalence point of the first half of the reaction in which sodium hydrogen carbonate is produced in the solution.

$$NaCO3(aq) + HCl(aq) \longrightarrow NaCl(aq) + NaHCO3(aq)$$

The methyl orange changes colour at exactly the pH of the equivalence point of the second stage of the reaction.

$$NaCO_3(aq) + HCl(aq) \longrightarrow NaCl(aq) + CO_2(g) + H_2O(l)$$

2.7 Learners Misconceptions in Teaching Science subjects

Some factors made learners be misconceived before coming to school or after giving formal instruction. These factors include learners preexisting conceptions, teachers styles that they employed while teaching environmental factors. All these factors are the major concern that one considers while teaching the learners in their study. The particular knowledge constructed by the individuals will also be affected by their prior knowledge, experience, and the social context to which learning takes place (Rodr, Gonz, Viviana & Nino, 2017). Misconceptions that learners let as information influence the knowledge of latest innovative idea that play a fundamental role in successive learning, and become an obstacle in acquiring the appropriate body of knowledge that held during formal instruction in transmitting the intended knowledge of the subject matter (Özmen, 2004). It is possible to manage factors hindering learners acquiring with regard to some constructed concepts, alternative ideas employed to diminish the notions that actually obstacle the existing right concepts. Alternative concepts that learners acquire may arise from diversified contacts to which learners make sense with the physical and social world or from personal experience, interaction with teachers and other people, or through the media application in the society (Rodr et al., 2017). Alternative concepts may happen before any teaching activities of a topic intended to be learned and are often to be taught by the teacher. It also found after teaching activities have been taken place in the class.

Science is regularly changing due to successive investigations of different products to improve humankind living standards. New innovative ideas developed in day-to-day activities, and replaced old ideas that learners acquired before in their livelihood situation. Thus, some misconceptions may happen due to old ideas that learners acquired in the past (Tabor, 2009; Centigul et al., 2011). Moreover, learning chemistry is a cumulative process in which information developed and assembled from the idea of each innovative piece of work. It benefited learners with the information; they have already had at hand concerning the topic taught by the respective subject specialist. Research has shown that children bring to lessons many preexisting alternative ideas about the scientific phenomenon that interferes with their learning styles of scientific principles or concepts (Barke, Hazari & Yitbarek, 2009; Tabor, 2009). This implies ideas are remixed each other and biases the learners.

According to the constructionist views of learning, knowledge is unique and constructed through hands on materials that learners actively participated in the laboratory tasks to construct knowledge to make sense of the world, interpreting new information in terms of existing cognitive structures (Tanvir, 2014). Learners preexisting perceptions also influence the adaptation of new scientific knowledge and it participates in an indispensable role in successive learning. Difficulties in the science field's learning, particularly in chemistry occur because of learners' perception that they may have before teaching. Furthermore, some previous perceptions hinder smooth communication between teachers and learners in the teaching and learning process. These ideas as misconceptions are recognized as logical, sensible and valuable to the learners from their views, which are strongly held but may be significantly different from accepted scientific viewpoints and may not agree with scientific explanation (Ikena, 2014).Furthermore, it allowed learners to rigidity.

It was also found that perceptions are broadly held by learners in various grade levels and are quite stable and challenging to be changed by conventional teaching strategies, are often employed to complete formed science instruction (Guzzetti, 2000). Preconceptions in chemistry are extremely persistent that may stay for a long period after learners' misconception with some ideas. A study on the evolution of preconceptions describe rapid progress in fundamental ideas about chemistry subject and its' importance at lower grades. However, slow change can happen in the learner's mind after exhaustive instruction that held in chemistry subject in particular (Özmen, 2008). The persistence of elementary alternative conception at the high school level was also documented (Tabor, 2009). It showed that learners build at the time of initial exposure to the elementary chemistry principles are central because of the misconceptions, which learners are built, found in challenging the process of effective instruction (Alpaydin, 2017). The preconceptions that learners have already developed and sought as a mental framework through a scaffolding approach build all subsequent knowledge in their mind and understanding.

Learners for the information and models presented in their school environment may also generate several alternative conceptions movements due to the absence of the ability to identify conception. For instance, before the teaching of atomic theory, learners have completely exposed to explore the nature of matter at a macroscopic level that will make them not to rely on atomic theory in the explanation of physical phenomena (Park, Light, Swarat & Denise, 2009). The difficulty of learners perceived that they do not believe in something, which they cannot see. The subject to be taught largely occurs on the most abstract level so that the symbolic level contributes to misconceptions observed in chemistry.

2.7.1 Common sources of Misconceptions in Chemistry

Misconceptions can be observed among learners, teachers and even scientists due to the wrong assumption but things, which are not wrong (Tabor, 2009). It also stemmed from the interaction between learners and environments that may happen due to day-to-day activities shared in common. Features of misconceptions are personal, incoherent, and stable, and are embedded in learners' alternative perception system (Barke, Hazari & Yitbarek, 2009). According to Getachew, Sutuma & Yitbarek (2013), there are different possible sources of learners' misconceptions,

- Prior knowledge and experiences of the learners, which are not compatible with scientific concepts learners acquired.
- The use of everyday languages and metaphors having different meaning from chemistry terminologies used
- Learners not properly taught different basic concepts at the micro-level.
- Teachers’ not properly understand the teaching concepts and lack of knowledge of learners misunderstanding.
- Learners lacked the visualization of models of concepts.
- The nature and proper sequencing of the concepts learned.

2. 7.1a Learners’ concepts before they exposed to scientific norms

Learners developed their concepts from the environment through observation and day-to-day follow up activities within the societal relations (Canada, Airedo, Davila, & Gonzalez, 2017). Furthermore, they internalize the concepts and come up with their new thoughts of the world. These ideas were developed in the early stage of learning since learners did not face to any hardships in their living standards that mean, it is acquired without facing learners for any academic environment (Barke et al., 2009). Learners pick up ideas from their environments and society that they live all together. In this regard, self developed concepts may not often match up with scientific concepts they acquired after intervening with academic environments (Ikena, 2014). These previous thoughts are not necessarily wrong but are described as alternative original ideas or concepts existed before the learners exposed to other situations, either academics or other interventions throughout their lives. Concepts obtained through such notions in the past considered in the school environments as pre- scientific ideas that learners bring to school (Alpaydin, 2017). Teachers should know these preconceptions of learners to make interdisciplinary relationships between the newly attained knowledge and the well-established pre-concepts during instruction.

2. 7.1b School made Misconceptions

Misconceptions are attributed to learners' characteristics and are also caused by improper teaching approaches and materials utilized in the schools (Canada et al., 2017). Teachers' methods of instruction can also lead learners into misconception if they are usually using traditional approaches (Uce & Ceyhan, 2019). In line with this assumption, it is likely described that when learners intervened in a subject matter that is more difficult despite competent and qualified teachers participated in teaching; they can develop school made misconceptions (Awan, 2013). While teaching learners to avoid misconceptions, the concerned bodies in the school environment like teachers and the others concerned bodies must orient learners as they land to school with the appropriate necessary information, which further helps them to decrease their original misconceptions. Furthermore, reducing the misconceptions using these strategies increases the learners' achievements in the field of laboratory-related subjects, particularly in chemistry.

2.7.2 Methods that Overcome Misconceptions Developed while Teaching Chemistry

As described in section 2.7.1, there are many misconceptions perceived and developed during the teaching and learning process of the subject matter chemistry in particular, as one of the science disciplines, which may arise due to different factors. The learners may be not capable to construct a mental representation, because of lack of relevant prior knowledge, excessive mental demand, not knowing what is relevant, or failing to notice element relationships within the new information, and between it and prior knowledge (Park et al., 2009). There could be a failure to manipulate a mental representation or relate it to others, because of a lack of rules governing the relationship. Teaching processes in the schools take into account by considering the learners' development stages, which make it possible to change concepts that they have made earlier to scientific concepts. Individuals are given a chance to construct their learning structures. Meaningful learning occurs when the learners actively construct their knowledge by using the existing knowledge to make sense of newly established experiences. The first step in constructivist learning is to make the teacher aware of the learners' current idea (Awan, 2013). Teaching approaches used in classrooms like experimental activities, which are practised by teachers' help must support the idea developed by constructivist learning theory. Teaching activities of the lessons are also planned to challenge misconceptions that may happen in their life experience. It provides learners with an opportunity for conceptual reforming in their life situations to have a positive thinking for everlasting that used to incur new scientific attitudes. Teachers play an important role in teaching chemistry concepts to eliminate misconceived ideas of learners by providing enough knowledge based on a clear understanding of the concepts that the learners have before exposed to the new one. There are specific strategies employed in teaching chemistry for different concepts that help learners to change their misconceptions (Lin & Chiu, 2007). These strategies were,

- Teaching methods employed for specific instruction

- Using analogical implications and the others

Each method can be explained well in the following subheading,

2.7. 2aTeaching methods to overcome Misconceptions of Acids and Bases

Chemists can use many different methods to overcome misconceptions that are happening in teaching acids, bases and their reactions altogether. Some of these are the use of simple experiments that can be demonstrated or done by the learners, use of mental models, actual models and use of analogical relation that exist between what the learners know and the unknown concepts (Centigul et al., 2011). The implications of analogical relations can be used as an example in reducing misconceptions regarding teaching acid-base reactions concept. Misconception in chemistry practical lessons can be minimized using appropriate teaching mechanisms that reduce the misconceived idea during teaching and learning process (Özmen, 2008). Another analogy employed by testing electrical conductivity of a solution of acid, base and pure water to express the properties of substances. It can be explained by the presence of H^+ (aq) particles and OH^-(aq) particles respectively as opposed to the non-conductivity of water, which does not produce these ions. This can be further explained by the mental model, which shows the ions present in the solution (Centigul et al., 2011). Acids and bases are categorized as either strong or weak can be shown by measuring the pH of the same concentration of strong acid or base and weak acid or base. The way we measure the strength of the bulbs that we use at our homes as if a bulb gives a lot of light, it is a strong bulb (analogous to strong acid) and if a bulb gives a little light it is a weak bulb (analogous to weak acid). Teaching learners about chemistry using lots of examples minimizes their perceptions in acids and bases working on volumetric analysis experiments. Furthermore, this reduces unwanted misconception that learners may assume at the end of the lesson.

2.8 Summary of the chapter

Chapter two in this study is a review of the literature regarding science education, chemistry education and laboratory teaching activities in science education and in chemistry, and the role of the laboratory improvising resources from local environment and discussing how they relate to the problem of research conducted. The review of literature in this study relates and find out what has been studied on comparative effectiveness of actual practical and alternative practical chemistry teaching models on students' achievement in volumetric analysis in particular and chemistry in general. The issues of local material from resources in the environment, which employed after improvisation and construction of low cost materials from the environment, were extensively described. Exploring related issues for current teaching styles present good reason for anticipated project work on how it is dissimilar to which, it has already been published in scientific endeavors. The literature reviewed further presents underlying principle in doing the planned learning activities, and used to figure out a theoretical framework that will notify the blueprint of the intended objectives and methodology of the proposed study. At the end, the peer reviewed literature of different writings on the same topic or other related literature will spot on gaps, in the relevant acquainted knowledge exist today in the world (Creswell, 2004).Thus, it is considered as the reviewed materials from different resources to guarantee the suitability of current research work.

CHAPTER THREE

3. Research Methodology

3.1 Introduction

This chapter describes the overall research methodology employed in this study, starting from identifying of the problem up to its completion. The major issues discussed were research methodology, research approach, worldviews on some research issues and the tools used to analyse the respective data obtained from research instruments including some discussions on quasi-experimental non-equivalent research design, and its' extraneous as well as internal variables that affect the result of research method. As it is indicated in chapter one, the main purpose of this study was to compare the effectiveness of volumetric analysis practical lessons taught with improvised locally available materials, as an alternative approach against those taught with conventional laboratory materials on the achievement of Grade-12 learners in preparatory schools in Sidama zone, Snnprs, Ethiopia.

3.2 Research design

A qusai- experimental nonequivalent research design was employed in the study through which quantitative data was generated. Methodologically quantitative method was used. The data was generated through the blueprint of using pretest-posttest approach, and its' scores was analyzed by using appropriate statistical techniques (Creswell & Plano Clark, 2011; Creswell, 2004; Pallant, 2010). The pretests were used in order to account or control the initial differences among groups like learners' previous knowledge, and other factors that affect their achievements. Furthermore, these factors incorporated in the analysis of Co Variance (ANCOVA) to reduce the effect of confounding potential threats. This design allows the researcher in the identifications of different variables that lead the results in to the systematic errors in the study (Cramer & Howitt, 2004; Kothari, 2004, Creswell, 2004).Three independent instructional methods within a teaching methodology that used as an independent variable was manipulated during the research. From these three instructional methods those involved in the treatment condition of the ongoing research, the two instructional methods that were compared through the results of an achievement test scores were actual practical and practicals that were taught through improvised materials as an alternative approach, and the third method was the traditional method used as a control group. One natural advantage of this design is that in its characteristic, individuals in the study easily grouped than real experimental designs (Creswell, 2004) but non-randomized assignments employed for subjects during intervention periods (Geoffrey, David & David, 2005; Creswell, 2004). Quasi-experimental design in this study tolerated by using the existing class in the real study room of each school since it was not required to bring together learners and random selection for any treatment at the time of school hours in order not to create false class conditions (Field, 2009).Thus, it decreases the attirtion rate of learners in current research.

Since quantitative data is considered the strongest form of quantification while analyzing the research data (Okpala, Onocha & Oyedeji, 1993) as a result of that the scales used were interval and ratio scales. A ratio scale was used for an achievement test. The interval scale was used for the questionnaires administered to collect data concerning the laboratory facilities' opinions (Nancy, Karen & George, 2005) in the study.

Four individual experiments were designed from the topic, volumetric analysis and related topics, including the theoretical aspect of the experiments. Each group was taught about four experiments including the lessons' theoretical aspect using the respective mode of instructional variables. The three instructional modes of action different from each other through the area of presentation. An achievement test questions as a pretest in this research was given to all learners in all groups on the first day of the intervention period. Teaching activities that involved practical lessons in volumetric analysis and some other related topics in chemistry addressed all the practical work stipulated with actual practical and practical lessons that were taught by improvised materials as an alternative approach.

Actual practical activities are practical activities that were taught using conventional materials based on experiments designed from the text of contents of volumetric analysis and the related topics (Appendix-1),and which was conducted by experimental groupI learners .Practical activities on the same topic and the same text of contents were taught using improvised materials as an alternative approach was conducted by experimental group II learners. Controlled group learners were taught through the same text of contents using the traditional method but using only theoretical aspect of the lesson. During the period of treatment, all the trained teachers applied what they learned from the training session in their various group except the control group.

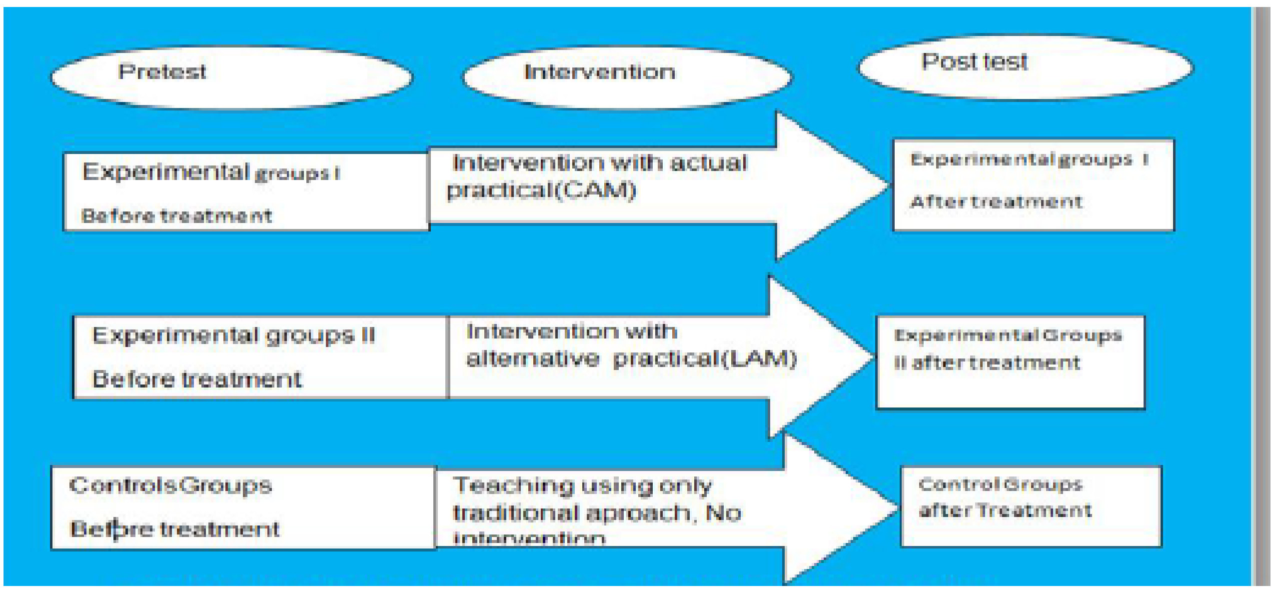


Figure 3.1 pretest-posttest quasi-experimental non-equivalent design

3.3 The symbolical representation of the design

Symbolically, the design of the study represented as shown below.

Q_1 X Q_2 = Experimental group 1(E1)

Q_1 YQ_2 = Experimental group 2(E2)

Q_1 Z Q_2 = Control group (C)

Where Q1 = Pretest

Q2 = Post test

X = Teaching with commercial material and chemicals

Y = Teaching with local material (LAM)

Z = Traditional teaching approach

Table 3:1 Research Design Format

Groups	pretest	treatment	posttest
Experimental group I	Q_1	X	Q_2
Experimental group-II	Q_1	Y	Q_2
Control group	Q_1	Z	Q_2

A1, B1 and C1 were pretest scores of experimental group I, II and control groups respectively.

A2, B2 and C2 were posttest scores of experimental group I, II and control group respectively.

X1, X2 and X3 were the three modes of instructions as an intervention

3.4 Control of Extraneous Variables

The history of one country considered as an underlying factor in the study of educational research in its existence, so the external validity of the research work was not guaranteed to be studied effectively under this condition (Geoffrey, David & David, 2005). Thus, before the commencement of the experiments to be done, the researcher has to evaluate different issues concerning the study. It must be guaranteed for the absence of the initial difference. The external validity of ongoing research was managed by confirming learners' pre-knowledge that existed in both experimental groups and control group schools with pre-evaluation, in the first day, within the same period before treatment started the process. Similarly, the posttest instruments were also administered to all groups on the same day, which was on the final day of the treatment conditions within the same period.

Numerous measures could also be employed by the researcher to decrease the external validity that leads the result into systematic error (Field, 2009; Shadish, Cook & Campbell, 2002; Creswell, 2004). Accordingly, a) Schools selected for this research were from the same cultures, socioeconomic status and from a small town. b) The teachers recruited to teach experimental groups and control group were degree holders with the same experience (8-years service). c) Practical lessons in volumetric analysis, and some other related contents in chemistry were taught for the first time with three modes of instruction independently by the assistant teachers. Only the experimental group's teachers (actual practical model and teachers in alternative practical chemistry teaching model schools trained separately at different time intervals. The one with a control group was not trained and they taught traditionally using normal teaching approach d) to minimize wastage of time during treatment due to illness of trained teachers or other factors may have happened, two teachers from each school for experimental groups were employed in training and ready for the treatment process.

Learners in each control and experimental groups of the study were in normally existing teaching classroom conditions, which were viewed as intact groups. However, before interventions were determined through discussion with school principals that were used to limit the total number of learners in each school were fifty that could be allocated without considering the ability of the learner, sex, age and other related factors used to be part of measure. Moreover, using quasi-experimental design decreases "threats to external validity" (Geoffrey et al., 2005; Creswell, 2004; Field, 2009). However, quasi-experimental non-equivalent group methods may be fragile in managing the underlying historical conditions to control internal validity (Nancy et al., 2005). External validity depicts the appropriate means of distributing the results evenly in the given research, which can be centred to the samples, which were selected from the study population (Creswell, 2004; Geoffrey, et al., 2005).Thus, confounding variables securely handled by decreasing its' negative effect in the research process.

Internal validity explains some clues to how the study proceeds and its' smooth condition enabling to manage the variables that generate promising result, but give false justifications and explanations of results. Many factors affect internal validity, which consists of effects of selection, effects of setting, effects of history, and effects of testing (Creswell, 2004; Kothari, 2004; Fatade, 2012). From the features that affect internal validity, the selection strategies in the research were managed using uniform participants based on the criteria discussed above. Samples in experimental groups and control group were homogeneous in terms of culture, from the same society and with the same language speakers. Moreover, learners in all groups had the same experience to the national curriculum in the chemistry subject at the time of the study.

The investigator conducted the present research in six governmental preparatory schools (grade-12) from Sidama Zone, Snnprs, Ethiopia. The intention was made to conduct the study in one site managed the effects of confounding variables that might have reduced the accuracy and the precision of achievement results.

Threats to internal validity such as maturation of the participants, design contamination, testing, selection, experimental mortality, instrumentation and statistical regression (Creswell, 2004; Geoffrey et al., 2005), were governed using the following conditions as rules. First, the researcher ensured that the curriculum of chemistry was not reviewed and the same throughout the schools in at the national level. Besides, there was nationwide security of people that could have brought about any change of dependent variables with its absence, which are learners' achievement test scores in chemistry and their perception concerning the chemistry subjects' laboratory issues based on the data of SQCL-questionnaire scores. Consequently, the experimental groups and control group participants experienced the constant environments in the education sector while the samples of the population were selected, which govern the effects of historical deterioration that influences sample selection during the intervention period. Second, there was no observable leave or schooling class for learners outside normal school timetables such as the two weekend days that could have led to attaining any academic knowledge to benefit learners in three groups. Third, learners in three groups were from economically the same societies or families with the same income in their livelihood, thus governing the effects of statistical regression. Fourth, learners had no chance to opt either experimental groups or control group to participate as a sampled participant from a given population that they belong, which further could have influenced the dependent variables, an achievement test score in volumetric analysis and learners' perception on items designed based on chemistry practical lessons. The schools that were selected for the study allowed their learners as a chance to take part in the study because learners can work in detail for every single question that appeared in achievement test in ongoing research. The learners under the consideration of the fact that they were found in the state of uniform features in terms of exposure to nationwide curriculum, class, and criteria for assigning learners in experimental groups as well as the same tongue used for communication develop confidence.

Fifth, learners did not dropout with their schooling opportunity in three groups during the treatment effect. The results were recorded since the intervention period was at the beginning of the schooling period as soon as the learners registered. In most Ethiopian schools, the dropout of learners are minimum, this was almost zero at the beginning and maximum at the end of schooling period in general. In this regard, current study researcher was lucky because of the absence of drop out in all schools. Since learners fear about the marks to be recorded by the teachers, the score out of 20%, no absent reported from the assistant teachers in all groups. All the examination papers and a questionnaire administered to learners before and after treatment were returned to assistant teachers in each school.

Sixth, the intervention period was nine weeks (about two month's interval), those were in between pretest and posttest, which were satisfactory in determining the effects of interventions in the current study. Seventh, the test-items were the same in pretest and posttest i.e. the measurement methods regarding achievement test and learners' perception of items concerning laboratory facilities, which were administered for learners (SQCL) were the same the study. In conclusion, both experimental groups (actual and alternative practical chemistry teaching models) have the same information regarding instruments employed in research work before and after the intervention. This issue further managed the threat of instrumentation in the study (Creswell, 2004). Finally, experimental groups and the control group were at a considerable distance, which is at least 40km away from each other, which was preventing get in touch with or/and to hinder communication between learners from group to group or school to school. The teachers at all treatment conditions had no pre-information regarding the schools to which they belonged in teaching purpose. Since the groups were intact, the reasons of delivering the study became salient and were not explained to any concerned bodies so that the learners intended to achieve something from the instruction after they attend the class and/ or pass thereby govern the possible blueprint contamination effects (Creswell, 2004) in the study.

3.5 Sources of data

In this study, the researcher employed only the primary source to gather the data. Primary sources are the direct collection of data from the samples for the first time. Secondary sources gave information about the data of some research works that had been collected, analyzed and reported before desciminating to the scientific community by someone else. Common means employed to collect data for the first time from the samples in this research were an achievement test, SQCL-questionnaire and TQ-questionnaire.The achievement test questions(ATQ) was administered to learners in three groups. SQCL-questionnaire was administered to the learners who participated in actual practical chemistry-teaching model schools and practicals that were taught through improvised materials as an alternative approach. It needed to assess learners' perceptions in both experimental groups. TQ-questionnaire was administered to all group teachers to assess their perceptions concerning practical lessons of volumetric analysis who taught practicals in actual and alternative practical chemistry teaching model schools, and control group schools by generating quantitative result for the first time, and then their perceptions were compared accordingly. Since all the teachers at all grades in the same group schools faced similar problems in the context of laboratory facilities in chemistry in general. As a result of that whether or not the teachers participated in responding the TQ-questionnaire does not affect the result at the end; because laboratory facilities inadequacy is the challenge of all chemistry teachers within the group during instructional process. Thus, all the teachers may have at most similar perceptions within each group.

3. 6 Population, Sampling and Sampling Techniques

3.6.1 Population

The population of the study was learners and chemistry teachers from Sidama Zone preparatory schools. The criteria employed for selecting the schools were based on the judgments of the investigator (Geoffrey, David and David, 2005).Thus, based on the researchers' judgment the following criteria were used for selecting sampled schools in the study. The technique employed was Purposive sampling. The criterias included (1) The presence or absence of laboratory facilities. (2) The presence of degree holders with eight-year teaching experience in chemistry subject partook in the teaching of all schools' learners (experimental groups and control) during the research was conducted. (3) In addition to this assumptions, as considered by Fatade (2012) common factors considered in schools were as (i) Willingness of school directors and chemistry teachers to cooperate in the study and (ii) presence of governmental preparatory schools in the prescribed area of the education sector of the whole population. Accordingly, six schools were selected from eight government schools located in Sidama Zone, and categorized into all groups based on the criteria listed under topic 3.6.2 in this section.

3.6.2 Sample and Sampling Techniques

Predetermined measures were taken before the research started, in allocating learners in each class in the early stage of registration period for this particular classes considering only the number of learners but not performance, age, sex and other parameters that differentiate learners. However, this was not informed to individuals who registered and allocated the learners in each schools but informed to allocate until the total number become only 50 learners in randomly selected one class before learners started to register for particular year(appendices-15,17-21).This implied that learners were mixed ability groups in intact classes of schools in each groups. The intact classes were selected using randomization. It is possible to randomize classes but impossible to allocate participants randomly in each classes from already existing learners. Sometimes researchers in education need mixed ability groups. Accordingly, the sample consisted of fifty learners in each intact class in six-government preparatory schools from Sidama zones, those allocated to three experimental groups. The schools were selected include Yirgalem preparatory school, Laku preparatory school, Arbegona preparatory school, Dara preparatory schools, Wondogenet preparatory school and Kewena Gata or Bansa preparatory school (appendices15, 17-21). Schools were assigned to the experimental groups based on purposive sampling technique using the criteria whether the schools had laboratory equipment, materials and chemicals or not. One hundred learners enrolled in each group. Two schools were allocated in one group. The total numbers of sampled learners were three hundred that were taught through the research design of quasi-experimental non-equivalent groups. Two hundred respondents or learners who participated during the intervention in both experimental groups (actual practical and alternative practical chemistry teaching models) responded for SQCL-questionnaire by tick mark to determine their perceptions regarding practical activities involved before and after treatment conditions. Sixty-five teachers enrolled in responding the TQ-questionnaire by a tick mark. The number of teachers who participated in responding to the TQ-questionnaire in all groups such as practical lessons that were taught by improvised materials as an alternative method, traditional teaching and practicals that were taught by conventional laboratory facilities was 21, 21 and 23 respectively. The age range of the learners involved in all groups was between 17 years old and 20 years old.

3.7 Data Collection Procedure

Data for this research work was collected from the participants such as learners and teachers before intervention with targeted independent instructional variables, and after the treatment period with the same variables. Treatments with independent instructional variables were started on the date of 01/10 /2015. It accomplished, after two month's duration of schooling on date 30/11/2015. All activities, those the researcher employed before, during and after treatment conditions tabulated and presented in table 3.5 below.

3. 7.1 Five stages of the research work

As it was shown in figure 3.1below, the study was carried out in five stages namely, piloting the instruments, training the teachers, pretesting, the stage of treatment and post-testing.

Figure 3.2 five stages of the research work

3.7.1a Pilot testing

All instruments were pilot tested before the main research was started in school, which was not part of groups participated for experimentation process for the current research. Achievement test questions were validated by the researcher for the current research work using different statistical techniques after pilot testing such as Cronbach's alpha, discrimination power and difficulty index. Both types of questionnaires such as SQCL-questionnaire and TQ--questionnaires were also validated after administering to the learners and teachers in pilot testing school. In the end, the result of each instrument sufficiently allowed for further steps of the ongoing study. The details of pilot testing presented under the topic instrumentation, validity and reliability

3.71b Assistant Teachers' Training for research purposes

Training involves a one-week training program for grade-twelve chemistry teachers. It was held at a separate time for each experimental group and they were well trained with the lesson plan preparation (appendix-7), how improvised chemicals and laboratory equipment from local materials (appendix 27 - 34). Eight teachers in experimental groups' schools trained separately. Each school contributed two teachers. Four teachers in control group schools enrolled, and each school contributes two teachers for the intended objective of ongoing research work. However, the researcher did not train teachers in the control group with any teaching styles used in the research work as the experimental schoolteachers. Finally, the test questions were given to the teachers, participating in this research work (appendix-6). Accordingly, all the participant teachers expressed their opinion for five questions, which were prepared and administered after frequent follow-up evaluation for eight teachers, selected from only experimental schools and enrolled in training to check their willingness to participate in current research. Based on this, for question number 1, 2 and 4 all teachers responded yes. It implied that they were interested in assisting the research work in doing teaching activities by improvising materials from the local environment and ready with any skills before the actual class handled, and doing of titration experiments in the absence of conventional materials with local materials respectively. For Likert scale type question number three (3), all the teachers enrolled in doing the research work answered very great that implied all were confident while experimenting to ensure the confidentiality of the research work. Regarding to question number five they suggestted that they would be interested and highly curious in giving information for other teachers, and orient themselves on the road map of improvisations and transferring the knowledge that they gained from training and through the entire teaching time while the research was conducted.

3.7.1c Administration of pretest

Achievements test questions were administered to all groups learners before intervention. The SQCL-questionnaire was also administered to all the learners who were taught practical lessons in volumetric analysis using conventional materials and practical lessons in volumetric analysis using improvised materials to sort out information with regard to their perception in laboratory activities. The core ideas of the pretest were to determine pre-existing awareness of the participants with regard to the concepts to be taught before treatment in both experimental groups (Creswell, 2004; Geoffrey et al., 2005). Further, all achievement test questions (ATQ) and SQCL-questionnaires were returned to the researcher.

3.7.1d Treatment method

The attention at the first glance was given for chemistry teachers in a control group and sought them after the permission of management bodies to conduct the study in their school. The information had not been made clear about the process of intervention by the researcher to the learner. However, discussions about the research were made with the school administrative bodies before the treatment started. The whole works were also given for the schools alone by avoiding the interference of other bodies in the research process in all groups. This was to stop any form of wrong assumptions and effect of other bodies on teachers' action or the part of teachers' course of action in their instruction.

Assistant teachers, those enrolled in assisting the research work were not trained by the researcher in control group schools like their corresponding colleagues who were taught practical lessons of volumetric analysis by using conventional and improvised materials separately, those trained with regard to the entire teaching methods and the respective work altogether. The researcher visited all groups during the intervention and set preconditions to make the environment conducive for teaching and learning process. However, the researcher has not tried to help or discuss vis-à-vis classroom condition or no learner's interaction that may be happened between the assistant teacher and learners in the existing classroom situation. Assistant teachers assigned in control group schools taught learners with normal teaching method, following the usual approach by using the teaching plan prepared for this research based on the contents selected in volumetric analysis. The assistant teachers in all groups taught all the contents in the texts of volumetric analysis and related topics, those including items of practical lessons such as relevant apparatus, indicators, titration, experimental procedures and calculations based on the concentration, number of moles of a substance, the mole to the mole ratio relationship of substances, solubility, safety rules and so on. The lesson plan used during instruction in control group schools differs from that of the experimental groups' schools only by the approach how to handle presentation and laboratory facilities as well as some other instructional materials employed for the research. Presentation of instructional objectives in control group schools followed regular traditional activities against flowcharts in a problem-solving process performed in experimental group's schools. Lecturing and questioning methods were involved to teach concepts related to lessons with regard to volumetric analysis in a traditional teaching method. Learners studied books and other related learning materials that were prepared by the subject specialists before the class hour started on their own interest to gain additional knowledge; indeed, it was same for groups those were taught practical lessons using conventional and improvised materials..

The teacher prepared lesson plan and made ready himself to teach an intact class based on the objective of the lessons stipulated, wrote important information on the chalkboard regarding definitions of some concepts related to volumetric analysis, and worked examples on the chalkboard about experiments prepared from the topic of volumetric analysis and some other related topics. All the teachers enrolled in both the control group and experimental groups accomplished teaching process at the same time interval.

3.7.1e Administration of posttest

The posttest with regard to achievement test questions were administered to the learners after the intervention completed in all groups. The SQCL-questionnaire was also administered to the learners those who were taught practical lessons of volumetric analysis using conventional and improvised materials separately. Thus, it was administered for samples in both actual practical and practicals that were taught through improvised materials as an alternative method in chemistry teaching models schools after the intervention achieved .All the achievement test questions and SQCL-questionnaire were returned to the researcher.

Finally, TQ-questionnaire was administered for teachers who taught learners in all groups. It was administered at the end of the intervention. No pretest was given for the teachers in all groups The aim of TQ-questionnaire was to find the information (clues) regarding laboratory facilities. TQ-questionnaire was also used in evaluating teachers' perception after treatments were accomplished. All chemistry teachers participated in replying the questionnaire in all schools that enrolled in this research since the items set considering laboratory facilities and their managing styles were the challenge of all teachers during experiment sessions.

Table 3:2 Fieldwork activities

Week	Activities that were done during the project work
BTW	A pilot study held regarding achievement test questions, Questionnaire(SQCL) and Questionnaire(TQ), setting preconditions for research purposes
1	Selection and categorization of schools into both experimental groups and a control group based on the criteria using purposive sampling
2 and 3	Selection and training of the teachers' to participate in the research
4	Administrating pretests for all groups. Questionnaires(SQCL) was administered before treatment for experimental groups but not control groups

5,6,7,8	Implementation of the lesson with regard to laboratory activities on the contents selected from the volumetric analysis for the study.
9	The administration of achievement test questions as a posttest for experimental groups and a control group as well as the administration of questionnaire (SQCL) for groups that participate in doing laboratory activities but not for the control group. Administering TQ-questionnaire to all group teachers

3.8 Instrumentation, Validity and Reliability

3.8.1 Instrumentation

The research instruments that were employed in gathering the data in this study include the achievement test questions (ATQ), a questionnaire administered to learners before and after treatment conditions (SQCL), and questionnaires (TQ) administered to the chemistry teachers.

3. 8.1a Achievement Test

3.8.1a1 Development of the Achievement Test

The Achievement Test Questions (ATQ) for this research work was prepared from chemistry practical lessons, specifically from volumetric analysis and other related topics in chemistry. The specific topics selected for items preparation from chemistry practicals were from appropriate apparatus, types of indicators, titration, experimental procedures and stoichiometric calculations that rendering concentration, the number of moles of substance, solutions, solubility, and safety rules. It was also covered from all experiments. The researcher developed the achievement test questions (appendix-2). These test questions (ATQ) administered to learners after the intervention was similar to the academic achievement test questions (ATQ) in the pretest. Teaching methods are considered as independent variables such as actual practical chemistry teaching model, practicals that were taught through improvised materials in chemistry as an alternative approach, and traditional teaching effectively handled within two months interval. Furthermore, the item analysis was done to evaluate discrimination power and item difficulty of each question. Both item difficulty and discrimination power help the researcher to determine the items either used in safely or rejected from test items ((Musa, Shaheen & Elmardi, 2018). In the end, the items with high quality after pilot testing organized, validated and ready for the research purposes (see preview of 3.8.2a, 3.8.3a and 3.8.3b, procedures how to evaluate item difficulty and discrimination power, and reliability).

3.8.1a2 The table of the Specification

The table of specification (TOS) is defined as a table that test developers employed while developing questions for the standard test or in research purposes during the study. It contains six levels in the cognitive domain, which is within Blooms' taxonomy of classification such as remembering, understanding, applying, analyzing, evaluating and creating (Orey, 2010). It is the scientific term specified the plan for writing test items (Ahmed & Zarif, 2013). It also describes what has been taught during the instructional process. In fact, it is a reflection of means of two dimensions in the instructional process like content and intellectual procedure. It is also central tools to smooth the learners' progress in understanding concepts and chemical languages in chemistry subject in particular. Furthermore, it mediates learner's knowledge construction (Kayima, 2016). The academic achievement test questions prepared for both pretest and post-test conditions of the current research purpose that was from the topics of written texts containing four experiments, which designed from volumetric analysis, and other related issues with regards to practicals according to the following table of specification(appendix-2).

Table 3:3Table of Specification

Experiment/Topic	Remember	Comprehend	Apply	Analyze	Synthesis	Evaluation
Experiment-1	1	1	1	1	1	1
Experiment-2	1	1	2	2	1	1
Experiment-3	1	1	1	2	1	1
Experiment-4	1	1	3	2	2	3

Total Questions based on BT	4	4	7	7	5	7
Total	33 questions					

3.8.1b Questionnaire on learners perception towards chemistry practicals (SQCL)

The researchers designed some of the questionnaire items (SQCL) and the others adopted from other source (Colen, 2013p154) and combined, and classified in to their category based on similarity that involve the study's objectives. Furthermore, its' suitability was ensured before starting intervention to determine learners' perceptions regarding practical lessons in grade-twelve chemistry curriculum in ongoing research. The questionnaire (SQCL) contains twenty-six items, designed using a five-point Likert scale of strongly disagree, disagree, neutral, agree and strongly agree to which learners were asked to give their opinion by tick (Appendix-4). This questionnaire was employed to assess secondary school learners' perception of chemistry instruction and its' practicals before and after all the experimental activities were done. Learners' achievement score further employed to gather the information that made the two groups differ or not. Based on ongoing study goals, the items in the SQCL-questionnaire were classified into five meaningful categorical assumptions by the researcher. They were listed as follows:- (1) learner's perception towards laboratory facilities and /or agents in getting science process skills from laboratory experiments; (2) learners perceptions based on the support of teachers and management bodies on the laboratory issues;(3) learners perceptions based on laboratory facilities in chemistry teaching; (4) learners perception on the improvisation of laboratory equipment and chemicals or the absence of genuine materials to do the intended experimental activities in chemistry education, and (5) finally, learners basic knowledge in chemistry subject that acquired from the lower grade and/or pre-knowledge of the learners before schooling.

The questionnaires (SQCL) further categorized into five perspective perceptions areas as follows.

1. Learner's perception and/or agents that made to get process skills from laboratory experiments

- ✓ Lack of observation skills from the practical result in poor achievement in volumetric analysis

- ✓ The reading skill in chemistry experiments especially measuring in the volumetric analysis is one of the causes of poor achievement.
- ✓ I can develop a recording skill from laboratory activities of volumetric analysis so that I achieve a good result
- ✓ I can develop the interpretation skill from the laboratory practice of volumetric analysis
- ✓ During laboratory sessions, other students collect different data than I do for the same problem.
- ✓ We follow the rules and procedures during practical work.
- ✓ I do chemistry practical to learn how to handle the apparatus.

2. Learner's attitude on the support of teachers and the management body about the laboratory issues

- ✓ Our teacher has no interest to teach laboratory activities in a chemistry textbook.
- ✓ School administrators do not pay attention to laboratory work in chemistry subject to be taught to increase the learners' achievement.
- ✓ I, myself, unwillingly participate in a practical activity in chemistry .Thus, I achieve a poor grade.

3. Learners' previous knowledge

- ✓ I apply my theoretical knowledge of Science in my practical work.
- ✓ Inability to determine mole ratio from stoichiometric equations contribute to poor achievement.
- ✓ Spelling errors in the balanced equation in chemistry attributed to low achievement.

4. Learner's perceptions or attitude on laboratory facility in chemistry

- ✓ Students get on well in the laboratory.
- ✓ The experiments we do in the laboratory room are related to topics in the syllabi.
- ✓ The chemicals and equipment that I need for my experiments are readily available.

- ✓ Everyone participates in doing practical work.
- ✓ We have a practical experiment for every topic that we do in Chemistry class.
- ✓ We do not have a chemistry practicals class at all.
- ✓ I always give attention to safety during practical work.
- ✓ In the laboratory, everybody is doing experiments on his/her own.
- ✓ We clean and pack the equipment and chemicals after each session
- ✓ Our laboratory has crowed when we are doing experiments.

5. Learners' perceptions on improvisation of laboratory equipment

- ✓ Teaching experiments with low cost/local materials the equity problem of quality education in urban and rural areas.
- ✓ Teachers and learners have to design an alternative practical method to alleviate practical activities' problems in due to the absence of regular materials.
- ✓ In the laboratory, I am required to design my experiments to solve given problems.

The above Items organized into five categories as follows.

Table 3.4 Categories of the questionnaire (SQCL) that was administered to the learners within experimental groups before and after treatment

			Items
Category-1	Students' perception and /or agents that made to get process skills from laboratory experiments	1	Lack of observation skills from the practical result in poor achievement in volumetric analysis
		2	The reading skill in chemistry experiments especially measuring in the volumetric analysis is one of the causes of poor achievement
		3	I can develop recording skill from laboratory activities of volumetric analysis so that I achieve a good result
		4	I can develop interpretation skill from the laboratory practice of volumetric analysis

		5	During experimental work sessions, other learners collect different data than I do for the same problem.
		6	We follow the rules and procedures during practical work
		7	I do chemistry practical to learn how to handle the apparatus
			Items
Category-2	Students' attitude on the support of teachers and the management body on laboratory issues	8	Our teacher has no interest to teach laboratory activities in a chemistry textbook
		9	School administrators do not give attention to laboratory work in chemistry subject to be taught to increase the students' achievement
		10	I, myself, unwillingly participate in a practical activity in chemistry.
Category-3	Students ' previous knowledge	11	I apply my theoretical knowledge of Science in my practical work
		12	Inability to determine the mole ratio from stoichiometric equations contribute to a poor achievement
		13	Spelling errors in the balanced equation in chemistry attributed to the low achievement
			Items
Category-4	Student' s attitude on laboratory facility of chemistry	14	Students get on well in the laboratory
		15	The experiments we do in the laboratory room are related to topics in the syllabus
		16	The chemicals and equipment that I need for my experiments are readily available
		17	Everyone takes part in doing practical work
		18	We have a practical experiment for every topic that we do in Chemistry class
		19	We don't have a chemistry laboratory session at all

		20	I am always protected (safety) during practical work.
		21	In the laboratory, everyone is doing experiments on his/her own
		22	We clean and pack the equipment and chemicals after each session
		23	Our laboratory has crowed when we are doing experiments
Items			
Category-5	Students 'opinion on improvisation of laboratory equipment	24	Teaching experiments with low cost/local materials the equity problem of quality education in urban and rural areas
		25	Teachers and students have to design the alternative practical method to alleviate the problems in practical activities due to the absence of regular materials
		26	In the laboratory, I am required to design my experiments to solve the given problems

The Questionnaires (SQCL) were administered to all the learners as pretest and post-test for only experimental groups' schools, who participated as sampled learners in actual practical and practicals were taught using improvised materials as an alternative approach models schools. However, the control group schools did not participate in filing the questionnaire since the nature of the entire items relied on the lessons' practical aspects; those needed the physical activity during the experiments. As a result, it is difficult to compare the control group schools with experimental groups' schools after intervention. The items were positively and negatively stated statements.The negatively stated statements were item 8, item 9, item 12 and item 19. At the end, they were reversed before the analysis processed (Pallant, 2010).Thus, it sustains learners wrong assumptions resulted due to inappropriate wordings of items in the ballon of the questionnaire.

The SQCL-questionnaire was appropriate and enabled the researcher to examine the learners' perception of laboratory activities by comparing both actual practical and practicals were taught using improvised materials as an alternative model in teaching volumetric analysis. One benefit of the SQCL-questionnaire for the researcher was providing a summary of learners' perceptions in chemistry laboratory facilities, practical activities in chemistry curricula, its' management and applications stipulated in teaching and learning process. As if the process of study was done with the achievement test, the SQCL-questionnaire was also administered before treatment and after treatment to both experimental groups, which were actual practical chemistry teaching model (teaching with conventional materials) and practicals that were taught with improvised materials model as alternative teaching methods. From the result of the piloting test with the purpose earlier identified, in the end, all instruments in the ongoing study were accepted reasonably on their efficacy to employ them on further considerations.

3.8.1c Teachers' perception towards TQ- Questionnaire on practicals

The researcher also designed the questionnaire (TQ) items of the current research to determine teachers' notions about practicals in chemistry curriculum. It contains thirteen items those designed with a five-point Likert scale based on scales rating like strongly disagree, disagree, neutral, agree and strongly agree. For each item in the TQ-questionnaire, teachers were asked to reply appropriate decision using the tick sign (Appendix-5).This questionnaire was employed to assess secondary school teachers' perception on practicals in chemistry subject matter. Sixty-five teachers participated in responding to the TQ- questionnaire. The number of teachers who participated in groups such as actual practical chemistry teaching model school, and practicals taught through improvised materials as an alternative approach and traditional teaching was 23, 21 and 21. Scores obtained after assessment further employed to gather the information that made the three groups differ or not. Items in TQ-questionnaire were classified into their category based on the assumptions like (1) process skills obtained from chemistry laboratory teaching, (2) teachers' perception based on improvisation, (3) advantages of teaching chemistry practicals and (4) issues used to compare practicals that are taught through conventional materials in chemistry teaching as a model and practicals that are taught through improvised materials as an alternative approach as a model. There are similar items that are listed in each category.

Table 3.5 categories of the questionnaire (TQ) administered for teachers to compare their perceptions after treatment condition in three groups

Items			
Category one	process skills obtained from chemistry laboratory teaching	1	The use of chemistry practical is to learn how to handle the apparatus
		2	Poor achievement in volumetric analysis in chemistry is due to the lack of observational skills in experimental works
		3	Chemistry practicals can develop students' reading skills and observational skills
		4	Students can develop recording skill from laboratory practice
		5	The laboratory practices develop students interpretation skill
Category two	teachers'perception based on improvisation	6	It is possible to practice chemistry experiments using locally avail. Materials
		7	Students can easily understand the practicals in chemistry when they do experiments with local materials in the absence of regular materials
		8	you encourage students to improvise
		9	Teaching with low-cost local materials solve the equity problem for quality education for both urban and rural schools
Category three	Advantages of teaching chemistry practicals	10	Chemistry practical prove a theory aspect of the lesson
		11	Chemistry practicals benefit students because they give for the student's ideas related to chemistry
		12	Students easily learn how to conduct experiments when they exposed to practical activities

Category four	Comparing actual practical model and alternative practical model	13	Students can learn practical knowledge with the conventional method as equally as an alternatively designed method.

3.8.2 Validity and Reliability of Research Instruments

3.8.2a The Validity of the research instruments

Validity is defined as the degree to which research tools measure what is supposed to be measured, and it needs that a research tool is consistent, but it can be consistent without being valid (Ravid, 2011). Validity also described connections with regard to changes and differences either observed or unobserved issues in the research. Reliability describes the regularity of the data in any situations, the relationships between changes observed that do not change, or there has been little or no change in the findings (Ravid, 2011; Pallant, 2010). Therefore, it is the consistency of the results at a different time with similar observation. It is important to decide the reliability measures of research instruments. It agrees to generalize the results attained by the measure since, in the absence of reliability; the validity of instruments cannot be ascertained (Cohen, Manion & Morrison, 2007). Validity allows the proper improvement of outcome to be measured (Ravid, 2011). Different forms of validity are employed depending on the tests' objective of used (Cohen et al., 2007). In this research work, content validity was considered as it was found to be most suitable in fitting with an achievement test in contrast construct validity was found to be appropriate for questionnaires administered to learners and teachers (Creswell, 2004). The relationship between how well the test to be successful in covering the subjects' content (Cohen et al., 2007) also considered as a measure. Construct validity is a decision that can be taken rooted in the accretion of evidence from numerous studies using a particular measuring instrument (Field, 2009). Content validity regarding the achievement test and construct validity concerning learners' questionnaire (SQCL) was made clear in the subsequent topics under this discussion.

3.8.2a1 The Content validity of an achievement test, students' Questionnaire (SQCL) and Teachers' questionnaire (TQ)

The content validity of research instruments were evaluated by three chemistry lecturers and statistician and then administered to learners and teachers to be replied. The evaluators of the instruments were from the host University of the researcher, those teaching chemistry and statistics subjects, those equipped with experience in teaching and evaluating different research proposals. They evaluated research instruments in terms of (i) language employed to readers of this materials, (ii) value added to the study's' aim, and (iii) Based on topics covered for this study. Consequently, initially prepared thirty-eight achievement test questions, and twenty-nine items in the learners' questionnaire (SQCL) were reduced to thirty-three and twenty-six items respectively. The other items in both instruments were eliminated after subsequent evaluation. All thirteen items (TQ) prepared and administered for teachers were also approved and accepted by the supervisor with no amendment required. The researcher and research assistants handled the study together. The role of the researcher was controlling all the activities, which were done in each groups' schools. Eight teachers were trained separately from the schools both practical lessons were taught using conventional materials and improvised materials. Two teachers enrolled in current research from each school. Four teachers in control group schools enrolled, and each school contributes two teachers for the intended objective of ongoing research work. However, the researcher did not train teachers in the control group with teaching styles used in the research work as the experimental schoolteachers. The strategy furthermore considered the result of achievement test scores by default in predicting factors that hamper the learners learning activities. However, the study adopted a crosschecking method in learners' achievement in chemistry subject and its practical lessons, specifically in volumetric analysis. It also used to sort out learners and teachers perception of chemistry subject matter and in the end; it suggested the role of the practical lessons in volumetric analysis in particular. Furthermore, their perceptions towards practical lessons in chemistry compared the experimental groups to develop the study's final objective. Fundamentally, research questions I, II, III, IV and V were raised and took at hand to assess the impact of teaching methods on dependant variable, which is an academic achievement in volumetric analysis. Data sources were triangulated with particular attention that was given to time, which maximized the study's reliability by fostering avoidance that ignores unawareness in teaching the subject matter.

3.8.2a2 Construct Validity of Learners' (SQCL) and Teachers' questionnaire (TQ)

In this study, the questionnaire(SQCL) containing twenty-six items, some of them were developed by the researcher and the others were adopted(Colen, 2013p154) based on the assumptions that pertain to learners' perception of practical lessons in chemistry subject and further, which were administered to the learners to be filled out. Questionnaire (TQ), containing thirteen items was also developed by the researcher based on assumptions about teachers' perceptions in practical lessons stipulated in chemistry subject content areas. It was given for all the teachers to be filled out by a tick mark. Statistician educator from researchers' host university assessed the construct validity. He ensured the competency, correctness, and fitness of the items (Creswell, 2004) based on Ethiopian samples' context. The researcher evaluated and guessed learners' perceptions effectively on items with regard to the nature of laboratory teaching styles in chemistry and the theoretical concepts of the curriculum to ascertain the intended outcomes in education. The statistician educator also evaluated the items again so that minor amendments were effected to come across the intended objective of the study. Then after, both types of questionnaires (SQCL and TQ) to be administered and filled out by the learners and teachers respectively were given to the supervisor for comments who found the items adequate for this research. Finally, the supervisor accepted to proceed the further researches'' activities. Both the questionnaires after pilot tests had been distributed to the learners and teachers. However, the SQCL -questionnaire was distributed to only both the experimental group's learners but not the control group learners.

3.8.2a3 The face validity of instruments

Three lecturers who teach chemistry and one statiscian teaches statistics in the researcher's host university evaluated the face validity of achievement test questions, SQCL-questionnaire and TQ-questionnaire. They evaluated instruments in terms of appearance, the types of questions or items included language style, format used and other related issues. Finally, the three instruments were considered as valid instruments in their appropriateness and approved for current research.

3.8.3 Reliability and Normality of Achievement test Questions, Reliability of SQCL and TQ-questionnaires from the pilot study

3.8.3a Reliability of Achievement test

Reliability describes the degree to which in administering similar instrument (well similar research tools) independently that constantly produces the same (or similar) results under similar circumstance (Cramer & Howitt, 2005). The reliability of an achievement test of ongoing study has been determined by pilot testing in school different from schools, those were employed for this research but whose samples have similar features including grade level, age, culture and exposure to a similar curriculum and other factors concerned learners. The total number of learners enrolled in pilot testing in the achievement test was fifty. Learners in pilot testing school took the achievement test after they completed the contents to be taught about volumetric analysis and related topics in grade twelve (Grade-12). To evaluate the reliability, all thirty-three achievement test items arranged in Microsoft excel by giving zero (0) for learners who answered wrong and one(1) was given for the learners answered correct answer in each item. The Cronbach's alpha was calculated (using SPSS 20 software) to decide the achievement tests' inter-rater consistency. Accordingly, a Cronbach's alpha value was 0.759. Thus, the entire achievement test questions were supposed to be consistent and a moderate level in their difficulty. Each item of the achievement test questions contains a score of (3.03) three points zero three marks. This gave a total value hundred marks in both pretest and post-test since similar items used before and after treatment. In the end, a maximum score calculated became a hundred marks.

The scores of achievement test questions (ATQ) after assessment in pilot testing were used in item analysis. The quality of the items was determined by calculating the discrimination index and item difficulties then after, accordingly, improving items that fail to cope up the standard was done to be member of the test questions (Boopathiraj & Chellamani, 2013). From the subsequent evaluation, as a rule with regard to discrimination index, having the value 0.40 and above considered as high-quality items; the value from 0.30 to 0.39 inclusive are convincingly good but may be needed to upgrading; the value between 0.20 and 0.29 inclusive are unimportant items, those are found in border line and need some revision, below 0.19 are judged as poor items and required major amendment or must be removed from the test items (Baharti, Ajita & Bahavisha, 2013; Fatade et al., 2013). The higher result of scores of difficulty index indicates the items are easier and learners can replay the answers without getting difficulty. The lower result of scores of the difficulty index indicates the more difficult the item it implied. The item difficulty is calculated using the ratio of the item correct to all items, which is generally stood for as p (Baharti et al., 2013).The inference of a p-value, which implies the difficulty of the item, is a feature of both the items responded correctly and the condition of how the test was taken. Item difficulty and discrimination index obtained by using item analysis of the test supported the researcher in deciding what was mistaken with preparing individual items (appendix-3). Item and test analysis supplied sensible data about how individual items and the whole tests carried out in actual test conditions. The discrimination index of items in achievement test is more than 0.40 and that of item difficulty is in between 46% – 90%. This supports the outlook noted regarding the fitness of values item difficulty and discrimination indexes of the tests (Ebel, 1979). In the end, all the items of the achievement test questions (ATQ) were accepted for the current research purpose. As it was shown in Appendix-3, with regard to the difficulty and discrimination index of each item for the achievement test questions for current research purpose, the mean of item difficulty (0.54), which was within the agreement ranges of item difficulty ranges from 46% to 90% and the discrimination index also ranges from 0.34 to 0.7 (Kheyami, Jaradat, Al-Shibani & Ali, 2018). Based on these criteria, all items as a whole fulfilled to make available a complete final version of achievement test items. As indicated in Table 3.3, the items were prepared mostly by considering the lower-order cognitive domain; so far, it was assured by random selection of items in the balloon of the test questions.

3.8.3b Normality of Achievement test Questions (ATQ) in Pilot study

As shown in table-3.6 below Kolmogorov-Smirnov[a] and the Shapiro-Wilk, the value was 0.200 and 0.225 respectively. This value, which is greater than 0.05 is non-significant it means that the achievement test in the pilot study was normally distributed. It is also confirmed from the histogram graph below by inspection and the sample used > 30 from the assumption of the central limit theorem (Kothari, 2004).

Table 3.6 Mean and Standard Deviation of learners in the pilot study

Descriptives

			Statistic	Std. Error
students' score in achievement test in a pilot study	Mean		21.92	.735
	95% Confidence Interval for Mean	Lower Bound	20.44	
		Upper Bound	23.40	
	5% Trimmed Mean		22.01	
	Median		22.50	
	Variance		26.97	
	Std. Deviation		5.19	
	Minimum		11.00	
	Maximum		31.00	
	Range		20.00	
	Inter quartile Range		7.25	
	Skewness		-.295	.337
	Kurtosis		-.647	.662

Table 3.7 Tests of Normality of achievement test in a pilot study

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
students' score in achievement test in a pilot study	.082	50	.200*	.970	50	.225

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

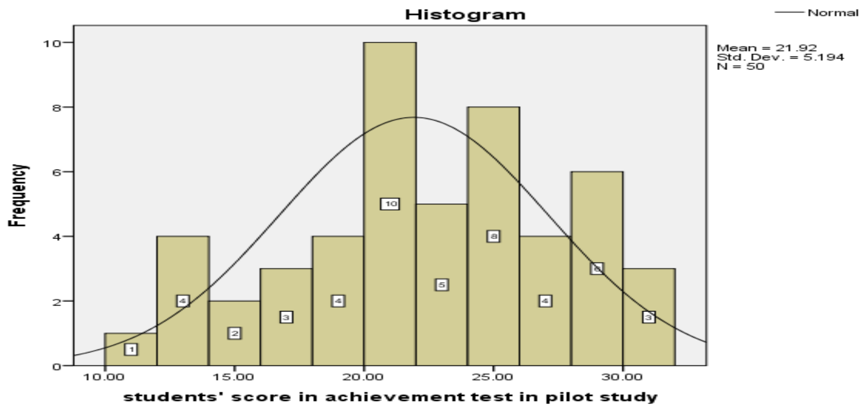


Figure 3.3Normality histogram graph for achievement test score in pilot study

3.8.3c Reliability of Learners' SQCL-Questionnaire in the Pilot study

Some of the items in questionnaire (SQCL) were designed by the researcher, and the others were adopted (Colen p154) categorized with their similarity into five-category areas in ongoing study. This questionnaire (SQCL) was employed for the current research purpose after designing based on some areas of perceptions that learners may perceive about laboratory activities in chemistry in general and volumetric analysis in particular. The inter-item reliability of items were evaluated, after administering for 200 learners in school, which was not part of the experimental schools used in a pilot study (Hayole project school). The data was collected, filled in SPSS 20, and Cronbach's alpha value was obtained. Cronbach's alpha computed for category 1, category 2, category 3, category 4 and category 5 showed an inter-rater reliability coefficient of 0.891, 0.722, 0.719, 0.748 and 0.745 respectively. The inter rater Cronbach's alpha values in all categories is greater than 0.7. All the items were accepted to apply in the future career of the current research with index of reliability value 0.698.

3.8.3d Inter-rater reliability of TQ-questionnaire administered for teachers in

Pilot study

The items in TQ-questionnaire (appendix-5) were prepared based on some perceptions that teachers may have in laboratory activities in chemistry education in general and volumetric analysis in particular by the researcher. The inter-item reliability of items was determined using the questionnaire type (TQ), which was designed for teachers to be replied by tick mark. It was evaluated after administering for 18 teachers in the pilot study that was not part of the experimental schools. The data was collected, filled in SPSS-20 software, and Cronbach's' alpha value obtained. Accordingly, Cronbach's alpha computed for category 1, category 2, and category 3 respectively showed the inter-item reliability coefficient of 0.814, 0.761, 0.727 respectively but the inter-rater reliability value for category four could not be evaluated since there was only one item within category four. It alone used to evaluate the differences occur in teachers perception concerning practical issues in all groups' schools, and furthermore, its' result was interpreted and presented in chapter four.

3.9 General statistical tools and some assumptions considered in this research

The quantitative data of the research was collected using the achievement test questions (ATQ) administered to all groups, SQCL- questionnaire was administered to learners who were taught practical lessons using conventional and improvised materials, and TQ-questionnaire were administered to the teachers in all three groups respectively. The scores of all instruments after cleaning the data were analyzed using descriptive statistics like mean and standard deviations values, which are the fundamental precursor to carry out inferential statistical analysis (Pallant, 2005 & 2010). The researcher has tested both similarities and dissimilarities of learners' achievement test score for an experimental group I (the actual practical chemistry teaching model) and experimental group II (practical lessons that were taught through improvised materials) as well as learners' response in posttest questionnaires that measures their perceptions toward scientific concepts, and the use of experimental activities in chemistry. These issues measure the recognition of scientific approach as one of thought to be understood by the end-users. The focus is on the duties of how learners experienced the science process skills and some other necessary practical skills that may be required at most times in practical investigations. Questionnaire (SQCL) administered to learners were used to evaluate learners' perception in practical lessons in volumetric analysis before and after treatment conditions in both the experimental groups (actual practical chemistry teaching model and practical lessons in volumetric analysis that were taught through improvised materials as an alternative method model) but not the control group. No attempt was made in the study to test correlations and time-dependent change that happened due to treatment conditions in all groups. Thus, this excluded the implementation of statistical tool regarding correlations that exist in two-time intervals in ongoing research work for each group. The statistical tools that employed in the study were both descriptive and inferential statistics. Three groups were involved in the research and more importantly, it is stronger in comparing the differences of the mean values of more than two mean values to account the type of errors raised due to confounding factors such as type I, type II and type III errors. These errors were observed when the data analyzed using independent sample t-test, analysis of variance(ANCOVA) and analysis of Co-variance(ANCOVA) respectively. Analysis of variance and covariance were in the right way that used to analyze the data in this study to test the null hypotheses predicted (Ho_1 to H_{O3}) based on the research questions raised to test the academic achievements among groups. Furthermore, it generalized the t-test values more precisely due to small type II and III errors respectively, thereby reducing the effect of confounding variables that affect the achievement results (Field, 2009). A one-way analysis of variance (ANOVA) was adopted to compare academic achievement test results among groups and to confirm the relationship, which exists between F-test and t-test to be which $F= t^2$. Independent sample t-test was also employed to compare the learners' scores of SQCL-questionnaire administered to learners in actual practical and alternative practical chemistry teaching model schools (the two experimental groups), which were set in comparison. Finally, to evaluate the result of teacher's perception from the questionnaire (TQ) administered to all groups, analysis of variance (ANOVA) were used to analyze scores of the three intervened groups. For all statistical tests of the data, an alpha level of $p= 0.05$ was used in the entire research. Assumptions considered for any two samples to be compared while using independent samples t-test were, in normal distribution criterion for two samples with normality tests like Shapiro-Wilk or Kolmogorov–Smirnov test or it can be assessed graphically using a normal quantile plot; the same variance or homogeneity of variance and independent data sampling technique(Field, 2009; Kothari, 2004).Furthermore,it ensured the suitability of method used in current research.

It can also be assured based on the definition of the central limit theorem, so, for means calculated from samples within a given population having finite variance come close to be found in a normal distribution, anchored in that it did not consider the distribution of sampling technique is normally distributed (Field, 2009). Rules of thumb applied that it stated for a t-test to be valid for the sample of smaller size only if the sample means are normally distributed as long as the sample size is at least twenty or thirty, which ensured the population distribution would have to be approximately normal in this condition (Cohen et al., 2007; Field, 2009). However, the data analysis of the study using Shapiro-Wilk test often considered more efficient than the Kolmogorov-Smirnov test (Field, 2009) revealed that the quantitative data collected with respect to an achievement test questions (ATQ) and the SQCL-questionnaire administered to the learners separately significantly deviated from a normal distribution. This is because the significant value of the Shapiro-Wilk test for each of post-test academic achievement scores and questionnaire administered to learners (SQCL) was below the significant level of 0.05 and for that of pretest achievement score the Shapiro-Wilk test for the only traditional method of teaching was below 0.05. Moreover, works of literature advocates the t-test statistics are not valid for small samples from non-normal distributions (Field, 2009). However; it is convincing for large samples, which are greater than thirty (30) from non-normal distributions (Kothari, 2004; Cohen et al., 2007). Finally, based on the greater number of the sample was selected and as a rule it was greater than thirty (30). Hence, it justified the adoption of the t-test statistics for ongoing research work.

CHAPTER FOUR

4. Data Analysis and Interpretation

4.1 Introduction

This chapter describes the main study results to investigate and answer the research questions that provide information in the ongoing study. The data obtained from the field by using both pretest and post-test in experimental groups and the control group were analyzed and summarized using statistical tools such as descriptive and inferential statistics (Field, 2009). Descriptive statistical results such as standard deviation and mean values were obtained from an achievement test questions,SQCL-questionnaire administered to learners and TQ-questionnaire administered to the teacher after linear combinations of the items. All instruments were used in the analysis of the data. The mean as a descriptive statistics was used to measure the data's central location so that its' precise meaning can be explained easily in this situation (Pallant, 2010; Fatade, Mogari & Adelaja, 2013). Furthermore, the mean in reality measures the central value of different observations, those were obtained from samples described well in the analysis of scores (Pallant, 2005 & 2010). The results obtained in this study were the scores from an achievement test questions, and a close-ended questionnaire (SQCL) administered to the learners in both experimental group to gather their perceptions about laboratory facilities and their advantages in doing experiments as well as TQ- questionnaire administered to chemistry teachers in all experimental groups schools. The standard deviation reveals the square root of the square of the distances of all the individual learners' scores from the mean value (Field, 2009; Pallant, 2010) in all instruments. The larger the standard deviation, which is far away from the average value means that the scores stretch out from the mean and vice-versa. The statistical tools used to judge touching the mean achievement score of both the experimental groups (actual practical model and alternative practical chemistry teaching model) and control group (Traditional method) with the target to come up to a decision whether or not the interference improved learners' achievement score in chemistry practical lessons. Analysis of learners' responses to the questionnaire allowed in generalizing the impact of an intervention that influenced their outlook or perceptions on practical activities in chemistry in general, and to the specific in volumetric analysis, which is one of the important topics in chemistry subject in the acquisition of science process skills during experimentation process. The learners responded to their opinion by filling the tick mark for each item. It was then organized in the SPSS software sheet to perform the analysis of the t-test or any other test of row data from the score of SQCL- questionnaire. The items in both types of questionnaires were linearly combined and the t-test was evaluated separately by using these linearly combined mean values of the items. An independent sampled t-test was employed to find out the mean values of the score attained by the two of the three groups were statistically significant or not, thus validating or nullifying the stated hypotheses of research set based on research questions from post-test achievement scores. The F-test statistic was employed in this study because of three groups were involved in investigating the research questions. Thus, notably it is a more reliable statistical analysis used to compare the differences of two or more means showed a precise result by signifying how far the errors differ for type I, type II and type III errors, more importantly with type three the errors become insignificant (Hill & Lewicki, 2007; Field, 2009; Kothari, 2004). As if there were three group means involved to compare, the t-test between two groups within three groups and the ANOVA F-test must be equivalent. An attempt was made only to confirm this relationship in the study by considering the analysis of p-values, which was obtained from the statistical tests. These variations observed in achievement test prepared from chemistry practical lessons involved volumetric analysis in all groups. The variations were also observed in learners' perception on practical lessons in chemistry between two experimental groups such as actual practical and practical lessons were taught by using improvised materials as an alternative method in chemistry teaching. The differences in teachers' perceptions were also observed through the score responded using TQ-questionnaire among the three intervention groups and between within groups. However, for current research, the researcher employed the ANOVA, F-test for both achievement test questions (ATQ) and TQ-questionnaire administered to the teachers; and independent sample t-test was used to test the null hypothesis of learners' perceptions on the scores of SQCL-questionnaire.

4.2 Achievement test questions (ATQ) and SQCL-questionnaire Results' Interpretation before the Intervention

The pretest achievement questions (ATQ) and questionnaire(SQCL) administered for learners were given as an instrument to assess the previous knowledge that learners already had and their perception regarding chemistry practical lessons before the intervention started. The advantages or fate of the pretest in this research with achievement test was to get informed with the background knowledge that learners acquired, concerning laboratory practical lessons in chemistry and science process skills from teaching volumetric analysis and related topics opted for this study in both the control and experimental groups before interventions were started. Furthermore, the pretest of the ongoing research was needed as a covariate while generating the posttest result from the raw data (Pallant, 2005). A Pretreatment questionnaire (SQCL) was administered to only experimental groups' learners, which further provided clues or a sample of learners' previously acquired perception about laboratory activities in chemistry. It also used as an advantage in providing the targeted science process skills. This section attempts to discuss the pretest score of achievement test questions and questionnaire (SQCL) scores obtained before the intervention.

4.2.1 Students' Achievement test before the Intervention

Thirty-three constructed-response items as the pre-achievement test were given to learners to be responded (Appendix-2). From these items, 28 are multiple-choice types, each with one mark and three were short answer type questions. The first two with one mark and the third question number 31 with 1.5 marks. Finally, all the 33 items contain a maximum score of 33 and, which further converted into a total score recorded out of 100%. The pretest achievement scores of the control and the two experimental groups in the current study were analyzed using descriptive and inferential statistics. Finally, the

ANCOVA result was used to see between the covariate effect before treatment and after treatment. Here, only the age of the learners used as a covariate.

4.2.1a Test of Normality of Achievement test score before Intervention

The Kolmogorov-Smirnova and Shapiro-Wilk tests are tests used to fix on the normality distribution of the pretest achievement scores in three groups. As shown in table 4.1 the Shapiro-Wilk test for local or practical lessons that were taught by improvised materials as an alternative approach and actual practical model, the p-value, $p > 0.05$ indicated that the pretest achievement score of the two teaching methods are normally distributed but the pretest achievement score of that of traditional teaching method was not normal. These values work best for samples $n < 30$. Since large samples were used in this research work, and from the inspections of normality data in graphs below in this section indicate that the data of all the experimental groups are normally distributed.

Table 4.1 Tests of Normality of pretest achievement score

teaching methodology		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
achievement of students in the pretest	Local	.100	100	.015	.985	100	.296
	Traditional	.122	100	.001	.974	100	.046
	Actual	.135	100	.000	.977	100	.072

a. Lilliefors Significance Correction

The following is the histogram graphs of achievement tests in the actual practical model, alternative model and traditional teaching methods

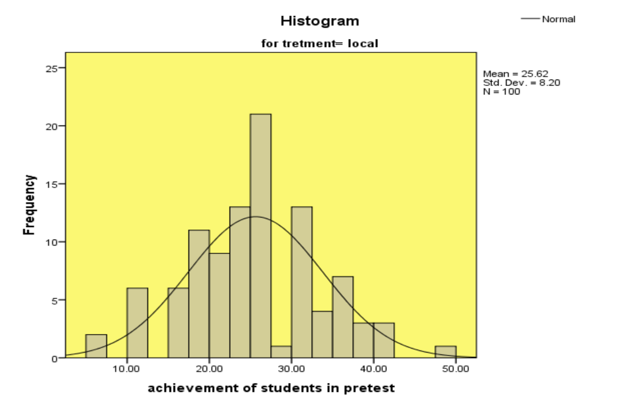


Figure 4.1 Normality histogram of achievement test score before treatment with local materials

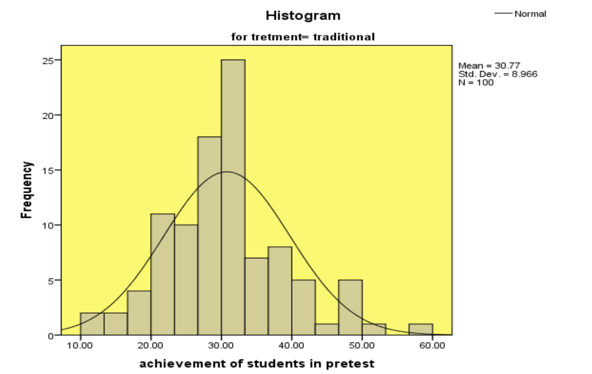


Figure 4.2 Normality histogram of achievement test scores before treatment with the traditional method

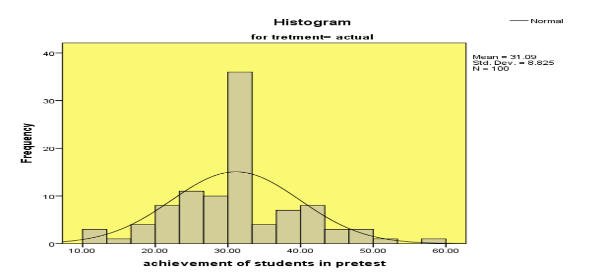


Figure 4.3 Normality histogram of achievement test scores before treatment with conventional materials

4.2.1b Comparison of the Achievement Scores of Actual practical and Traditional Method of Teaching before Intervention

The statistical analysis results of achievement test before intervention in both the experimental groups and control groups were not necessarily considered to judge the comparison of the mean values in groups since the schools enrolled were pretested without intervention to any academics in the class (having non-comparable characteristics). The pretest results did not consider factors that affect learners' result in each group; it is not possible to judge and compare the two groups with mean values. However, it gave some clue when the mean value of after intervention achievement score was analyzed to compare groups further.

As shown in Table 4.2 and Table 4.3 below, an independent samples t-test was conducted to compare the pretest achievement scores experimental group I (actual practical model schools) and control group (traditional method). There was no significant difference in achievement test scores for the both actual practical chemistry teaching model with mean and standard deviation values (M= 31.085, 8.825) and traditional method with mean and standard deviation value (M=30.769,SD = 8.966; t (198) = -251, p= .802, two-tailed. The magnitude of the dissimilarities in the mean (mean difference=-.315, 95% c I 1.258 to -2.796 was very small (Eta squared =0.0003). From this t-test statistics, the effect is too small almost both groups were equal before treatment although it is non-comparable.

Table 4.2 The Actual and traditional method Group Statistics for achievement scores before the intervention

	teaching methodology	N	Mean	Std. Deviation	Std. Error Mean
achievement of students in the pretest	Traditional	100	30.7696	8.96595	.89660
	Actual	100	31.0851	8.82493	.88249

Table 4.3 Independent Samples Test of the achievement scores of the actual and traditional method before the intervention

		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	T	Df	Sig. (2-tailed	Mean Difference	Std. Error Differen	95% Confidence Interval of the Difference

						)		ce	Lower	Upper
achievement of students in the pretest	Equal variances assumed	0.296	0.587	-0.251	198	0.802	-0.315	1.258	-2.80E+00	2.165
	Equal variances not assumed			-0.251	197.95	0.802	-0.315	1.258	-2.80E+00	2.165

4.2.1c Comparison of the Achievement test Scores of Local and traditional method of Teaching before the Intervention

As shown in Table 4.4 and Table 4.5 below, the pretest achievement scores of learners were analyzed by using independent samples t-test to compare both experimental groups (local or practical lessons that were taught by improvised materials as an alternative approach and control group schools those were taught practical lessons by traditional teaching method). There was considerable difference in pretest achievement scores for both learners were taught about volumetric analysis by locally improvised materials with mean and standard deviation values (M= 25.62, SD= 8.200) and traditional method with mean and standard deviation (M=30.769, SD= 8.966; t (198) = -4.242, p=0 .000,P<0.05, two-tailed. The differences in the mean (MD = -5.154, with 95% c I, is equal to and between -7.550 to –2.758 and (Eta squared =0.079) was greater than the value moderate effect of 0.06. From this t-test statistics, the effect is large so, both groups were not equal before treatment.

Table 4.4 independent sample t-test Achievement scores for local and traditional method

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
achievement of students in pretest	Equal variances assumed	.870	.352	-4.24	198	.000	-5.15	1.22	-7.55	-2.76
	Equal variances not assumed			-4.24	196.44	.000	-5.15	1.22	-7.55	-2.76

Table 4.5 The achievement scores' group Statistics of the local and traditional method of teaching

teaching methodology		N	Mean	Std. Deviation	Std. Error Mean
achievement of students in a pretest	Local	100	25.62	8.20	.820
	Traditional	100	30.77	8.97	.897

4.2.1d comparison of the Achievement test Scores of both Local group learners and Actual Method group schools before the Intervention

As shown in Table 4.6 and 4.7 below, for independent samples t-test conducted to compare the pretest achievement scores between learners that were taught using improvised material and who were taught by conventional materials. A significant difference was observed in both local achievement test results I with mean and standard deviation values (M= 25.616, SD=8.200 and actual (M= 31.085, SD=8.825; t(198)= -4.540, p=0.000, two-tailed. The magnitude of mean difference observed (MD =-5.470, with 95% c I between -7.550 to –3.094 was greater than the value moderate effect 0 .06 but less than the large effect 0.14 (Eta squared = 0.094). From this t-test statistics, the effect is large so, both groups were not equal before treatment. This implies that practical chemistry-teaching model schools were found in favour of laboratory equipment and chemicals involved in teaching chemistry compared to practicals that were taught through improvised materials as an alternative method model schools.

Table 4.6 The achievement test scores' group statistics for the local and actual method of teaching before intervention

Group Statistics					
teaching methodology		N	Mean	Std. Deviation	Std. Error Mean
achievement of students in the pretest	Local	100	25.6155	8.20038	.82004
	Actual	100	31.0851	8.82493	.88249

Table 4.7 The achievement test results of the learners were taught by locally improvised material and conventional materials before the treatment

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
achievement of students in pretest	Equal variances assumed	.117	.732	-4.540	198	.000	-5.469	1.205	-7.845	-3.094
	Equal variances not assumed			-4.540	196.9	.000	-5.469	1.205	-7.845	-3.094

4.2.1E Presentation of ANOVA result of an achievement test Score before the Intervention

As indicated in Table 4:8a Levene's test is used to examine the homogeneity of variance with the value P= 0.416, P > 0.05, indicates that the pretest achievement scores did not violate the assumption of the homogeneity of variance. The significant value for Levene's test P >0.05, P = 0.416. The significant value for P > 0.05, P=.660 does not violate the assumption used for homogeneity.

Table 4:8a The Variances of homogeneity test of learners' achievement results before intervention

Test of Homogeneity of Variances			
achievement of students in the pretest			
Levene Statistic	df1	df2	Sig.
.416	2	297	.660

As indicated in Table 4.8b, Table 4.9 and Table 4.10,a one-way between-groups analysis of variance (ANOVA) was performed to investigate the impact of previous exposure in teaching and learning process in chemistry in general and volumetric analysis in particular before the intervention. The schools in experimental groups and control group were arranged using the purposive sampling technique and the classes were intact groups. There were statistically, significant differences at the value p <0.05 level in pretest achievement scores in three different teaching methods as soon the groups formed even if they were not on treatment conditions, non-comparable. The mean difference in scores between the groups was significant with Eta = 0.078, which is the value between moderately large (Eta = 0.06) and the value (Eta = 0.14). Post hoc comparisons using the Tukey's HSD test also computed for these non-comparable groups. Even though they were tested before the intervention and the results computed, the mean score for a group that was with the actual practical model (M=31.085, 8.825) significantly different from group with practicals that were taught by improvised local materials (M=25.616, SD=8.200). However, it was non-significant with control groups taught by traditional teaching method (M=30.770, SD=8.966).

Table 4.8b Mean and standard deviation comparison of learners' achievement score in the pretest

achievement of students in a pretest								
					95% Confidence Interval for Mean			
Treatment methods	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Local	100	25.6155	8.20038	.82004	23.9884	27.2426	6.06	48.48
Traditional	100	30.7697	8.96595	.89660	28.9906	32.5487	12.12	57.57
Actual	100	31.0851	8.82493	.88249	29.3340	32.8362	10.61	57.57
Total	300	29.1568	8.99869	.51954	28.1343	30.1792	6.06	57.57

Table 4.9 ANOVA- results of learners in pretest achievement score

ANOVA					
achievement of students in the pretest					
	Sum of Squares	Df	Mean Square	F	Sig.

Between Groups	1886.043	2	943.022	12.545	.000
Within Groups	22325.880	297	75.171		
Total	24211.924	299			

Table 4.10 learners pretest achievement post hoc test Multiple Comparisons						
Dependent Variable: the achievement of students in a pretest Tukey HSD						
(I) teaching methodology		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Local	Traditional	-5.154	1.23	.000	-8.04	-2.27
	Actual	-5.469	1.23	.000	-8.36	-2.58
Traditional	Local	5.154	1.23	.000	2.27	8.04
	Actual	-.3155	1.23	.964	-3.20	2.57
Actual	Local	5.469	1.23	.000	2.58	8.36
	Traditional	.3155	1.23	.964	-2.57	3.20
*. The mean difference is significant at the 0.05 level.						

4.2.1F Presentation of the ANCOVA result of achievement test score before Intervention

4.2.1f a Test of homogeneity

The output obtained from SPSS-20 software shown in Table-4.11 indicates the significant value or p-value is 0.564, which is above the cutoff point so that the assumption of the homogeneity of regression slopes of this value sustains the results provided from an inspection of scatter plots in each group to winding-up and precede the ANCOVA.

Table 4:11 Levene's Test of Equality of Error Variances

Levene's Test of Equality of Error Variances			
Dependent Variable: the achievement of students in the pretest			
F	df1	df2	Sig.
0.574	2	297	0.564

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a Design: Intercept + treatment + Age + treatment * Age

Table 4:12 Homogeneity Tests of Between-Subjects Effects

Tests of Between-Subjects Effects						
Dependent Variable: the achievement of students in a pretest						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2488.226a	5	497.645	6.735	.000	.103
Intercept	1412.091	1	1412.091	19.111	.000	.061
Treatment	248.831	2	124.415	1.684	.187	.011
Age	184.074	1	184.074	2.491	.116	.008
treatment * Age	302.338	2	151.169	2.046	.131	.014
Error	21723.698	294	73.890			
Total	279246.745	300				
Corrected Total	24211.924	299				
a. R Squared = .103 (Adjusted R Squared = .088)						

4.2.1f b Test of linearity

As shown in figure 4.4 obtained running with the SPSS-20 software to check the general distribution of scores for each of the groups. The straight-line relationship indicates no curvilinear relationship observed in the pretreatment scores of the three groups.

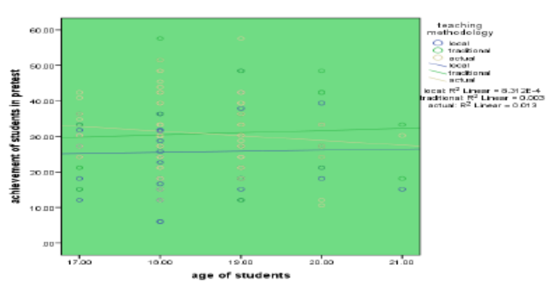


Figure 4.4 Test of linearity of pre achievement test score with age of students

4.2.1Fc Presentation of the ANCOVA results of Achievement test before the Intervention

As shown in Table 4.12, 4.13 and 4.14 below, a one-way between-groups analysis of covariance (ANCOVA) based on the three teaching methods such as actual practical chemistry teaching model, practical lessons of volumetric analysis were taught by using improvised materials as alternative approach and traditional methods were conducted using SPSS-20 version software to compare the effectiveness of teaching methods before the interventions. $F(2,296) = 12.511$, $P < 0.05$ is significant in difference. From Tukey's post hoc analysis between local and traditional MD= -5.170, STD error = 1.233, $P < 0.05$ is also significant in difference. This difference is visualized using the mean and standard deviations values between local (M=25.62, SD=8.20) and traditional (M=30.77, SD=8.97). Here schools were purposely assigned in quasi experimental non equivalent design being they were newly launched schools with no laboratory facilities as of alternative practical chemistry teaching model schools for experimentation process. However, sometimes in alternative practical chemistry teaching model schools,specifically in Arbegona preparatory schools, teachers use improvised materials to conduct experiments stipulated in chemistry subject. Teachers have their own initiatives to use improvisation. The results indicate that learners in schools assigned in traditional method of teaching style as a control group scored higher results compared with schools assigned in alternative practical model schools before intervention. Initially these two groups' learners were in equitable position regarding the facilities in their laboratories. This implied that both groups had no facilities but still they had a room for to be differing in academic achievements. Thus, there is a difference in learners' academic achievement between the traditional method of teaching school with the higher score and the learners in alternative practical schools with lower academic achievements. This significant result inferred that schools assigned in traditional might be motivated by teachers' teaching styles, some other school factors like management styles, the availability of related reading materials might be made the learners to achieve the higher achievement results. Some potential threats were not also homogenized by controlling the extraneous variables before intervention (Creswell, 2004). This result is in line with the literature (Nbina, 2012) is that it must be ascribed the teaching problems in the schools and learners were less motivated by the teacher that it decreases their performances in practical lessons. Thus, learners in alternative practical chemistry teaching model schools scored low results when compared with Traditional method of teaching. Tukey's post hoc analysis between local and actual MD=-5.47, STD error =1.228, $P < 0.05$ is also significant. This significant difference also visualized using mean and standard deviation values. Tukey's post hoc analysis for local with (M =25.62, SD=8.20) and actual (M=31.09, SD=8.83.The higher result of actual practical model schools' learners indicates actually learners were assigned purposely their schools surprisingly equipped with equipment in their laboratories , those schools allocated in actual laboratory looks like some advanced university laboratories. The greater result of actual practical model schools learners compared with the learners in alternative practical schools, being schools initially purposely allocated in alternative practical schools though they were not had standard equipment and chemicals. Thus, it implied that the learners were taught about practical lessons in actual practical model score a higher result due to practical activities they did for experiments beside theoretical explanations of the practical lessons before intervention. It implied that learners were not equally treated, one with equipped laboratory and the other with no facilities. Here, in alternative practical schools learners were not supported by the teachers' means that teachers teaching style was less informative to inculcate possible knowledge, related reading materials, management style and other factors might affect the result. This result is in line with the literature (Bailey & Garratt, 2002) is that the teachers need active learning approach means the driving force for this approach is that you learn something by doing it. Thus, the learners in actual practical chemistry teaching model schools became academically efficient and scored higher result when compared with alternative practical chemistry teaching model schools learners before intervention. Tukey's post hoc analysis between traditional and actual MD= -0.300, STD error =1.233, P = 0.808, $P > 0.05$ is non-significant. There were so many factors in the school environment that might be made the schools different. Both actual practical chemistry teaching model schools and schools allocated in traditional method treated differently one with highly equipped laboratory environment and the other with no laboratory facilities. However, both scored academically almost similar result. This is almost similar result came from the variations of potential threats and due to uncontrolled extraneous variables. These potential threats positively affected the traditional method of teaching schools' learners. Although learners were taught practical lessons of volumetric analysis with equipped facilities in the laboratories of the actual practical chemistry teaching model schools. However, the two comparison groups scored almost similar result. Thus, due to learners might be motivated by schoolteachers or the teachers' ability difference in the subject matter or other factors, learners in traditional method of teaching schools scored almost similar results before the intervention. Learners in traditional method of teaching schools positively motivated in cooperative learning style. Thus, learners positively motivated due to cooperation among learners and between learners and teachers. This result is consistent with the literature (Achor & Wude, 2014) is that cooperative learning is though special in it's use to effect a good academic achievements. Learners' achievements have also been the major focus of the educational process. Thus, learners achieved in academic achievement in almost similar fashion.

Furthermore, ANCOVA initially was required to check and reduce the interaction of various factors that affects the achievement score before intervention. Although age of the learners included as covariates its effect in significant and further the result obtained before intervention is the commutative result of all confounding variables. Therefore, it must be regulated using assumptions for those potential threats.

Table 4.13Learners' Mean and standard deviation of achievement result before treatment

Tests of Between-Subjects Effects						
Dependent Variable: the achievement of students in a pretest						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1887.648[a]	3	629.216	8.343	.000	.078
Intercept	536.994	1	536.994	7.120	.008	.023
Age	1.605	1	1.605	.021	.884	.000
Treatment	1887.140	2	943.570	12.511	.000	.078
Error	22324.276	296	75.420			
Total	279246.745	300				
Corrected Total	24211.924	299				
a. R Squared = .078 (Adjusted R Squared = .069)						

Table 4.14a pretest achievement ANCOVA result

Dependent Variable: the achievement of students in a pretest			
teaching methodology	Mean	Std. Deviation	N
Local	25.6155	8.20038	100
Traditional	30.7697	8.96595	100
Actual	31.0851	8.82493	100
Total	29.1568	8.99869	300

Table 4.15 Pair wise comparisons of learners' achievement score before intervention

Pair wise Comparisons of learners in pretest achievement score						
Dependent Variable: the achievement of students in a pretest						
(I) teaching methodology		Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference [b] Lower Bound	Upper Bound
Local	Traditional	-5.170*	1.233	.000	-7.596	-2.744
	Actual	-5.470*	1.228	.000	-7.887	-3.053
Traditional	Local	5.170*	1.233	.000	2.744	7.596
	Actual	-.300	1.233	.808	-2.726	2.126
Actual	Local	5.470*	1.228	.000	3.053	7.887
	Traditional	.300	1.233	.808	-2.126	2.726
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).						

4.2.2 Results and Normality of Students' Questionnaire before Treatment

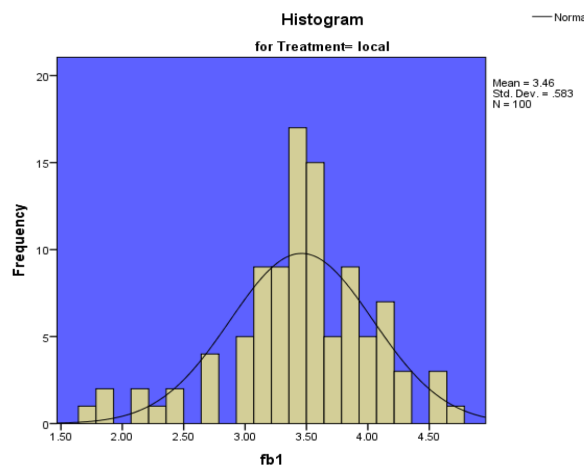
4.2.2a Test of Normality and its analysis

From Table 4:16, after a linear combination of all the items together from a test of normality of Shapiro-Wilk test and from the evidence of large population as well as inspecting the normality histogram for all items in each category (A to L), it is shown that the scores were normality distributed.

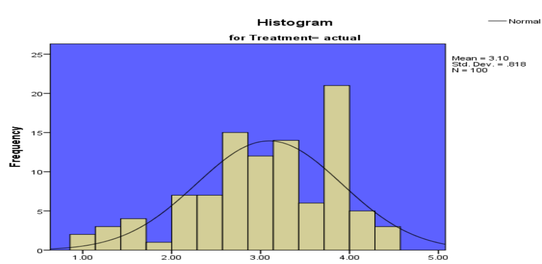
Table 4.16 Test of Normality of learners' SQCL-questionnaire score before treatment

Tests of Normality		
teaching	Kolmogorov-Smirnov[a]	Shapiro-Wilk

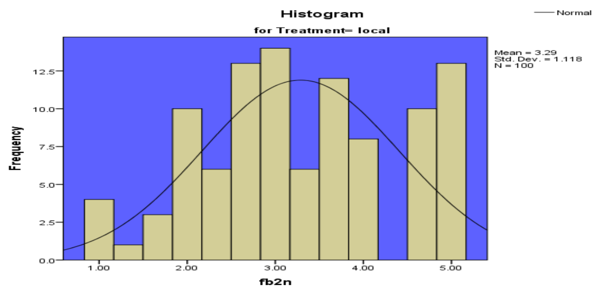
methodologies		Statistic	Df	Sig.	Statistic	Df	Sig.
fb1	Local	.128	100	.000	.951	100	.001
	Actual	.098	100	.019	.961	100	.005
fb2n	Local	.121	100	.001	.949	100	.001
	Actual	.140	100	.000	.967	100	.012
fb3n	Local	.199	100	.000	.950	100	.001
	Actual	.136	100	.000	.958	100	.003
fb4n	Local	.098	100	.020	.975	100	.052
	Actual	.081	100	.098	.990	100	.696
fb5	Local	.229	100	.000	.887	100	.000
	Actual	.209	100	.000	.881	100	.000
Fbtn	Local	.092	100	.035	.979	100	.117
	Actual	.054	100	.200*	.985	100	.294
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							



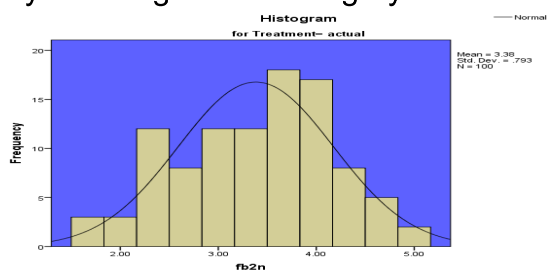
A. Figure 4.5 Normality histogram for category fb1-alternative practical model



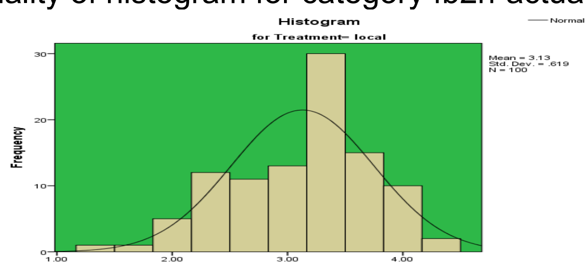
B. Figure 4.6 Normality histogram for category fb1 actual practical model



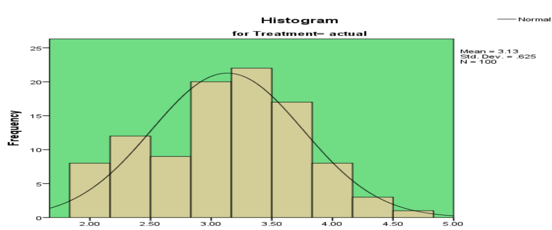
C. Figure 4.7 Normality of histogram for category fb2n-alternative practical model



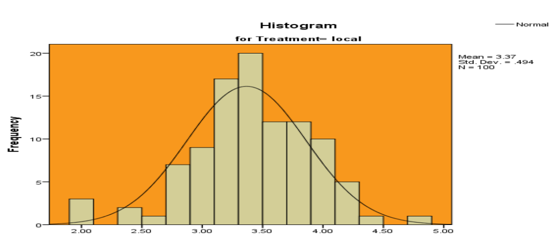
D. Figure 4.8 Normality of histogram for category fb2n-actual practical model



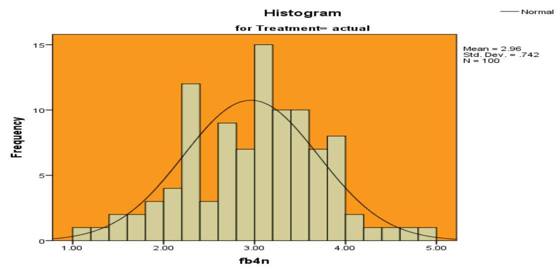
E. Figure 4.9 Normality of histogram for category fb3n-alternative practical model



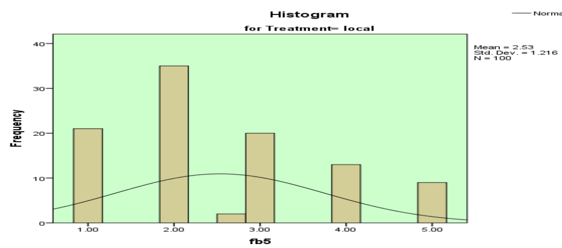
F. Figure 4.10 Normality of histogram for fb3n-actual practical model



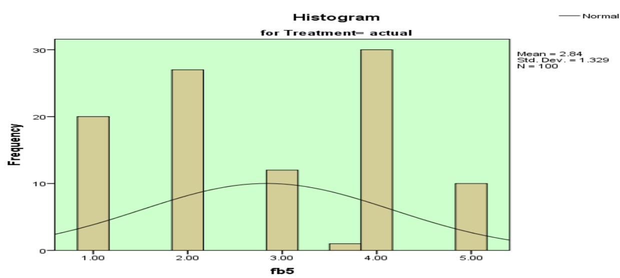
G. Figure 4.11 Normality of histogram graph for fb4n-alternative practical model



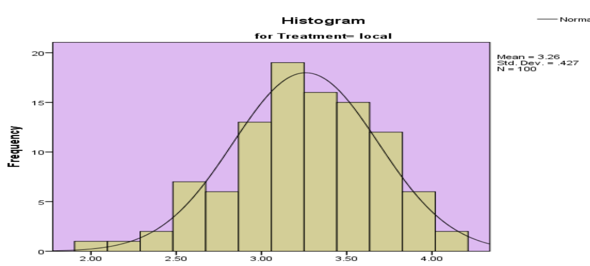
H. Figure 4.12 Normality of histogram for category fb4n-actual practical model



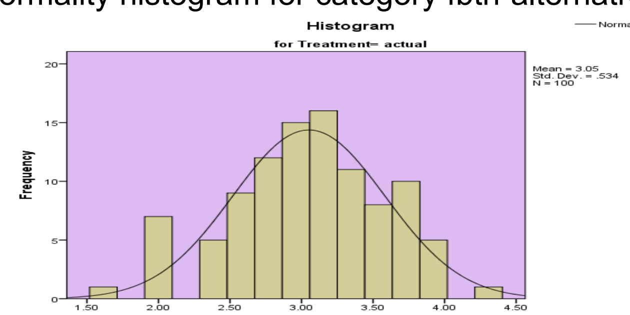
I. Figure 4.13 Normality of histogram for fb5-alternative practical model



J. Figure 4.14 Normality of histogram for fb5-actual practical model



K. Figure 4.15 Normality histogram for category fbtn-alternative practical model



L. Figure 4.16 Normality of histogram for category fbtn-actual practical model

4.2.2b Interpretations of Results of Questionnaire (SQCL) before Treatment

Some of the pretreatment items in the questionnaire (SQCL) was designed. The others were adopted (Colen, 2013, p154) to gather the data about their perceptions regarding laboratory activities that the schools own to teach and learn effectively. The twenty-six (26) items of the SQCL-questionnaire were further categorized into five perceptions areas in their similarities by the researcher to be filled out by the learners. The items were organized by using a five-point Likert scale mode that was rated via strongly agree, agree, neutral, disagree, and strongly disagree. Learners were asked to fill out with a tick mark in each item in SQCL-questionnaire (appendix-4). The following assumptions were considered while the items were prepared before employing the questionnaire (SQCL) for ongoing research. First, analyses on the score of the questionnaire (SQCL) were averaged across items because of that the items were with five alternatives, it was not considered as an issue that affects the result when one takes the average value of the scores. Secondly, responses on the SQCL-questionnaire are important by themselves when one requests to match up to the scores to somewhat meaningful. Thirdly, using the broad-spectrum, the effects of unfeasible uses tend to compensate the much smaller effects for the questions that are poorly written such as scale points, labels, scale directions, neutral responses(Fatade, 2012).

For SQCL- questionnaire with no or zero value and the value five was the greatest score accessible in Likert scale while the least score obtained by the learners in any one item was valued one. For the questionnaire (SQCL) scores of both actual practical chemistry teaching model and practical lessons that were taught by improvised materials as an alternative approach in chemistry teaching model groups, the items were linearly combined and computed for each category, and all total items at first, which were analyzed, summarized and interpreted using descriptive statistics. Table 4.17 below indicates the statistical analysis results (SQCL) of the pretreatment scores for both experimental groups. According to the researchers' view, the items of the questionnaire (SQCL) categorized into five areas in perception. Furthermore, responses of the learners in each category used to compare the groups.

In category one, as it was described regarding the perceptions of learners pertain the laboratory facilities and practical lessons in chemistry, those were taught by improvised materials, based on the result obtained after linear combination of items in category one as shown in Table 4:18, for category-1(fa1), $t(178.89)=3.63$, $p=0$, $p<0.05$ is significant. MD=0, 364, STD error =0.100. the learners perception indicate that there was a significant different between actual practical chemistry teaching model schools and alternative practical chemistry teaching model schools before intervention held. The difference after post hoc test was visualized using the mean and standard deviation values, For an alternative method group schools learners obtained (M=3.46, SD=0.582) and actual practical model schools with value (M= 3.09, S.D= 0.818). This result regarding learners' perception inferred that teaching learners practical lessons in volumetric analysis using improvised materials were a good alternative approach that learners need to practice experimental activities in the absence of conventional materials. This implied that learners could be equipped with science process skills when they conduct practicals on chemistry as that of experiments conducted using conventional materials. The literature in line with this inference agreed (Saxner & Robertson, 2010) is that the use of innovative scientific teaching methods should be used to teach sciences as against the lecture method so as to make the science subject interesting to the learners.

Similarly, as it was shown as in category two (fb2n), $t(178.2)= -0.705$, $P = 0$, $P < 0.05$ is significant in difference. From Tukey's post hoc analysis, the difference is visualized using the mean and standard deviation values of learners' perceptions. Accordingly, the score concerning the attitude of learners on the support of teachers that learners in local or practical lessons were taught through improvised materials as an alternative approach in chemistry teaching model group schools obtained (M=3.28, SD=1.11) and Mean score of actual practical model group schools (M=3.38, SD= 0.793). This result inferred that learners perceived teachers help in practical lessons in volumetric analysis teaching is mandatory. This result is in line with the literature agreed (Jenkins and Shoopman, 2013) is that having a more knowledge teachers is associated with a larger knowledge means that the score of learners are dependent on teachers knowledge. Thus, teachers have a great potential to make learners result high as much as possible. Since learners were not exposed to any hands on activities before interventions held and the schools were purposely grouped due to absence of facilities in their schools, they strongly need the help of teachers and administrative bodies to exercise practical activities using facilities, those were either improvised or standard facilities in the laboratory. However, as the results indicate learners were not helped with facilities while conducting experiments in the laboratory. Thus, they perceived low score in perception. It needs some conceren to come up with efficient result as that of experiments were done using conventional materials.

In category-3(fb3n), as shown in table 4:18, $t(198) = 0.038$, $P = 0.97$, $P > 0.05$ is non-significant in learners perception. The mean score of local or practical lessons that were taught using improvised materials as an alternative approach model schools (M=3.13, SD=0.619) is the same as the mean score of actual practical model group schools (M=3.13, SD=0.62). This inferred that perceptions of learners were the same regarding previous knowledge that they acquire before they exposed to experimental conditions. Learners were desired using improvised materials instead of conventional materials for experiments in volumetric analysis. However, I hope their previous knowledge is dependent on their teachers motivation to help them in acquiring skills and cognitive knowledge.According to the result obtained,it seems and learners perceived that the presence of facilities only cannot help them in acquiring skills. It is dependent on teachers' ability to transfer knowledge and using cooperative learning strategy to be efficient in achievements. This result is in line with the literature(Chatila & Husseiny,2016) is that cooperative learning has a positive effect on learners cognitive, emotional and social skills such as promoting higher achievement, greater use of higher level critical reasoning competencies and strategies, and greater collaborative skills and attitudes necessary for working effectively with others. However, literature includes some studies reporting no significant effect on learning.

As shown in the Table 4:18, in category-4(fb4n), $t\ (172.39) = 4.563$, $P=0$, $P < 0.05$ is significant in difference of learners perception. This difference in learners' perceptions before intervention visualized using after the Tukey's post hoc analysis. Accordingly, the mean score of practical lessons that were taught by improvised materials as an alternative method (M=3.36) is higher than the mean score of teaching learners with actual practical chemistry teaching model (M=2.96). Practicals that were taught with improvised local materials as an alternative approach with the standard deviation value (SD=0.49) was lower than that of practical lessons were taught with actual materials (SD=0.74).This result inferred that learners perceived learning chemistry practicals is possible with improvising materials from the resources in the environment in the absence of conventional materials. Since the schools purposely allocated because of absence of conventional materials in the laboratory but they were in doing practicals using improvised materials that they feel a good perceptions compared with the learners in schools who were taught using convectional materials. There were also many potential threats that were not controlled since learners were taken a test before intervention without homogenization of the treatment condition.

As shown in category-5(fb5) after linear combination of items with in the category $t(198) = 1.684$, $P=0.094$, $P > 0.05$ is non-significant with learners perception before the treatment. This result inferred that learners in both groups had the same perception on improvisation of laboratory equipment. Learners in actual practical chemistry teaching model school had positive perception regarding to improvisation. Because of the fact that learners in actual practical chemistry teaching model schools who were taught practical lessons in chemistry using conventional materials also need to improvise materials related to the experiments in the absence of standard materials, in case there exist financial constraints and due to the spontaneity nature of improvised materials to get them easily. Furthermore, it is low in cost to use it any time when needed. This result is consistent with the literature (Temechegn, 2012; Gupta, 2016; Emendu, 2010) is that teachers can use improvisation instead of conventional materials since it used low cost or no cost material that nature allowed. It also used to guarantee the continuity of experiments with spontaneous nature of resources in the environment.

As it shown in Table 4:18, for Fbtn, after linear combination of all items in general, $t(188.1) = 3.045$, $P=0.0003$, $P < 0.05$ is significant in learners' perception before intervention between learners who were taught practical lessons in chemistry using improvised materials and who were taught practical lessons using conventional materials. The difference is visualized with a mean and standard deviation values of learners perceptions with improvised (M=3.26, SD = 0.43) and actual practical (M=3.05, SD=0.53). From this analysis, one easily deduce that learners' perception were high in alternative practical chemistry teaching model schools based on all cumulative result obtained after linear combinations of individual items compared with learners who were taught the same practicals using conventional materials. It implies that learners in schools who were taught practicals using improvisation perceived in the absence of conventional materials is that improvisation is mandatory and experiments can be done hands on activities to cope up the appropriate skills and avoiding the problems resulted from the ineffective instructional process. Thus, learners in all groups had strong need for practicals to be done using facilities in the laboratory. However, learners in alternative practical chemistry teaching model schools, initially they were set in comparison with actual practical chemistry teaching model schools' learners. High score in learners' perception in alternative practical schools indicate that the possibility of manipulation of equipment in doing practicals in the scarce of facilities in the laboratory though both groups was compared before interventions.

Table4:17 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
fb1	Equal variances assumed	13.91	0	3.63	198	0	0.364	0.100	0.16623	0.5623
	Equal variances not assumed			3.63	178.89	0	0.364	0.100	0.1661	0.5625
fb2n	Equal variances assumed	13.43	0	-0.71	198	0.482	-0.097	0.137	-0.367	0.1737
	Equal variances not assumed			-0.71	178.52	0.482	-0.097	0.137	-0.3672	0.1739
fb3n	Equal variances assumed	0.012	0.91	-0.04	198	0.97	-0.003	0.088	-0.1769	0.170
	Equal variances not assumed			-0.04	197.98	0.97	-0.003	0.088	-0.1769	0.170
fb4n	Equal variances assumed	15.75	0	4.56	198	0	0.407	0.089	0.2311	0.583
	Equal variances not assumed			4.56	172.39	0	0.407	0.089	0.2309	0.583
fb5	Equal variances assumed	3.68	0.06	-1.68	198	0.094	-0.303	0.180	-0.6586	0.052
	Equal variances not assumed			-1.684	196.47	0.094	-0.303	0.180	-0.6586	0.052
Fbtn	Equal variances assumed	4.052	0.05	3.05	198	0.003	0.208	0.068	0.0733	0.343
	Equal variances not assumed			3.05	188.81	0.003	0.208	0.068	0.0733	0.341

Table 4: 18 Mean and Standard deviation of the questionnaire (SQCL) before treatment

Group Statistics						
teaching methodologies			N	Mean	Std. Deviation	Std. Error Mean
fb1	Category-1	Local	100	3.46	0.58	0.058
		Actual	100	3.0957	0.82	0.08
fb2n	Category-2	Local	100	3.2867	1.12	0.11
		Actual	100	3.3833	0.79	0.08
fb3n	Category-3	Local	100	3.13	0.62	0.06
		Actual	100	3.1333	0.63	0.06
fb4n	Category-4	Local	100	3.367	0.49	0.05
		Actual	100	2.96	0.74	0.07
fb5	Category-5	Local	100	2.5333	1.22	0.12
		Actual	100	2.8367	1.33	0.13
Fbtn	Overall	Local	100	3.2592	0.43	0.04
		Actual	100	3.0512	0.53	0.05

4.3 Results from Students' Achievement Test Questions (ATQ) and Questionnaire Administered (SQCL) after theTreatment

The post-test instruments were the same as the pretest instruments, which were employed to determine roughly the change of perception that participants may bear after the treatment. It was manipulated by both an achievement test Score (ATQ), which administered for all groups, and a questionnaire score (SQCL) administered to only actual practical and alternative practical model groups schools. Their results were compared to come up with the final agreement. The post achievement test was also considered as a useful instrument in the current study. it serves to measure learners' performance or/and achievements in both control group schools and experimental groups schools in selected topics of chemistry subject in general and volumetric analysis in particular after treatment. However, post-treatment questionnaire (SQCL) which was the same as pretreatment SQCL-questionnaire (appendix-4), which provide an overview of learners that get some idea about laboratory activities in chemistry subject in general after treatment or all activities handled on. In particular, administering the questionnaire (SQCL) after the treatments preview or provide some feedback of the assessment whether the learners' perception in both the actual practical chemistry teaching model group schools and practicals that were taught through improvised materials in chemistry teaching model group schools changed after the action of the treatment were taken in the ongoing study. In this part, an argument was made to discuss the posttest achievement score and learners questionnaire score results after the treatment.

4.3.1 Results from Learners' Achievement Test after the Intervention

The post-test achievement questions were the same as pretest achievement questions, which consisted of thirty-one (31) items. The researcher constructed achievement test questions (TQ) items to be responded by the learners (Appendix-2). Twenty-eight (28) were multiple-choice type from these items each with one mark and three were short answer type. The first two with one mark and the third question number 31 with 1.5 marks. Finally, thirty-three, 33 items contains a maximum score of 33%. In the end, a total score recorded was evaluated per hundred percent (100%). After the intervention, participants' achievement test results in control group schools and experimental groups' schools were analyzed, summarized, and interpreted using both Descriptive (mean and standard deviation) and inferential statistics(ANOVA and its' post hoc analysis, and ANCOVA).

4.3.1a Assumptions

4.3.1a .1 Test of Normality of Achievement test after the Intervention

The p-p plot by inspection, it is the cumulative probability of the variable against a particular distributions' cumulative probability (Field, 2009). In this case, if the data are normally distributed then the actual z-score will be almost the same as the expected z-score or the values are almost fall the diagonal of the plot and the sample size is large =100, which is greater than 30. As this happens, then the variable is normally distributed. Furthermore from K-S, $D(100) = .111$ and $.118$, $p > 0.001$.

Table 4:19 test of normality of achievement test after treatment

Tests of Normality							
	teaching methodology	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
achievement of students in post-test	Local	0.111	100	0.004	0.945	100	0
	Traditional	0.118	100	0.002	0.965	100	0.009
	Actual	0.127	100	0	0.962	100	0.006
a. Lilliefors Significance Correction							

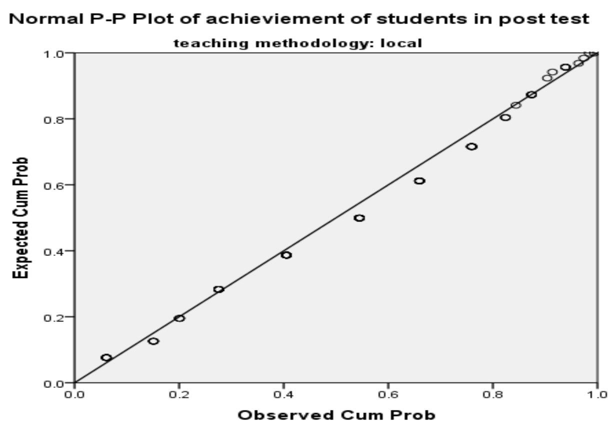


Figure 4.17 Normality test of the p-p plot of posttest achievements of students in an alternative practical model

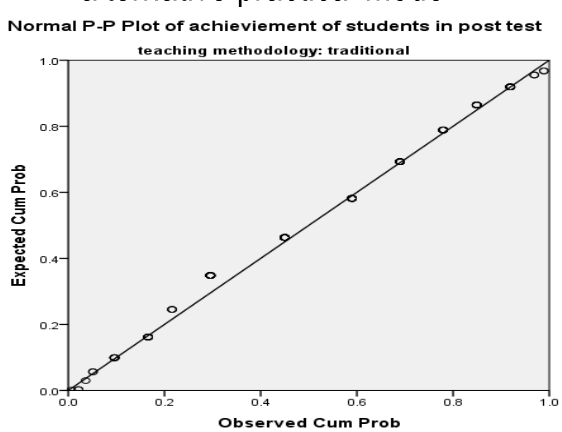


Figure 4.18 Normality test of the p-p plot of posttest achievements for traditional method

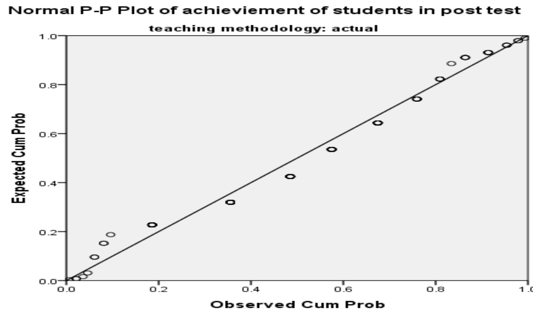


Figure 4.19 Normality test of the p-p plot of posttest achievements for actual practical

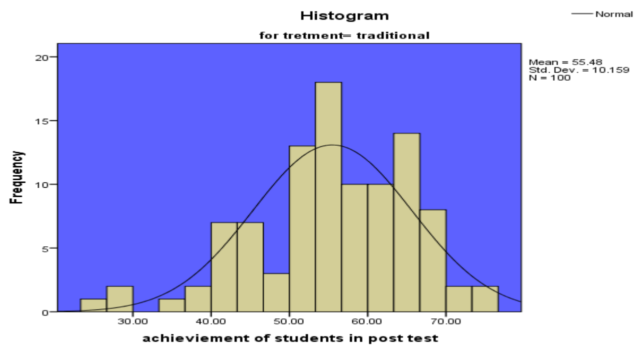


Figure 4.20 Normality histogram of posttest achievements for traditional method

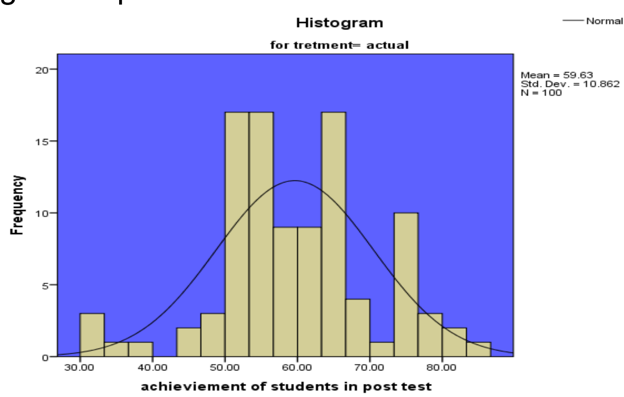


Figure 4.21 Normality histogram graph in posttest achievement students' score of the actual practical chemistry teaching model

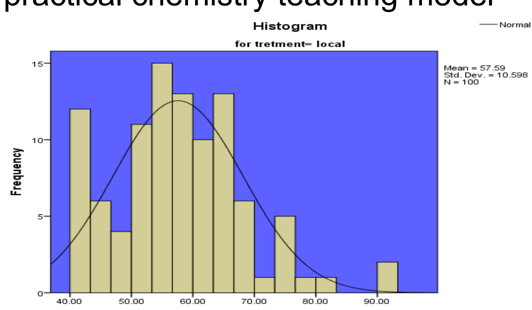


Figure 4-22Test of normality of posttest achievements for alternative practical

4.3.1A2Test of Homogeneity of Regression Slopes of Posttest Score with age of Students

The output that was obtained from SPSS-20 software in Table-4.20 have shown that the significant value or p-value is 0.957 which is above the cutoff point so that the assumption of the homogeneity of regression slopes was achieved, this further supports the conclusion gained from an inspection of scatter plots for each group.

Table 4.20Test of homogeneity of regression slopes of posttest score with the age of students

Tests of Between-Subjects Effects					
Dependent Variable: the achievement of students in post-test					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1235.781[a]	5	247.156	2.226	.052
Intercept	3884.924	1	3884.924	34.989	.000
Treatment	13.941	2	6.971	.063	.939
Age	369.305	1	369.305	3.326	.069
treatment * Age	9.856	2	4.928	.044	.957
Error	32644.027	294	111.034		
Total	1027996.849	300			
Corrected Total	33879.809	299			
a. R Squared = .036 (Adjusted R Squared = .020)					

4.3.1a3 Test of linearity of posttest achievement score with the age of students

From the graph below, one does not want to see the curvilinear relationship of a dependent variable and the covariate used (age of learners) is linear. The assumption regarding linear relationship does not violate.

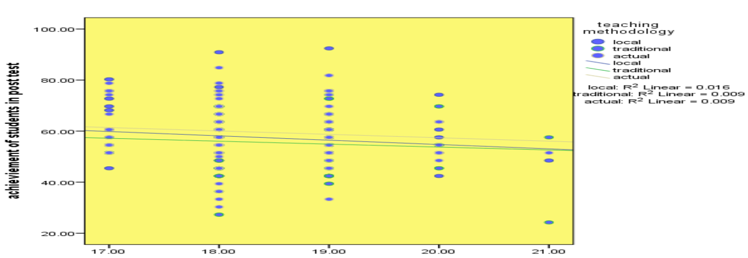


Figure 4.23 Test of linearity of posttest achievement score with the age of students

4.3.1a4The linearity of a posttest achievements with pretest achievements

From the graph below, one does not want to see the curvilinear relationship of the dependant variable and the covariates used in pretest are linear. The researcher has not violated the assumption of a linear relationship.

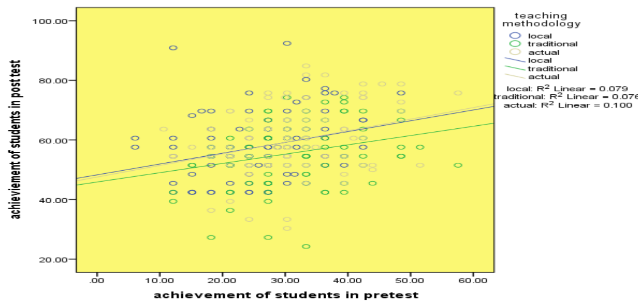


Figure 4.24 Test of linearity of posttest achievements with pretest achievements

4.3.1a.5 Test of Homogeneity of Regression slope of Posttest with pretest

The output obtained from SPSS-20 in Table-4:21 shown the significant value or p-value is 0.890, which is above the cut off homogeneity test value. The assumption of the homogeneity of regression slopes further supports the conclusion gained from the inspection of scatter plots for each group.

Table 4.21Tests of Between-Subjects Effects of homogeneity of regression slopes posttest score with pretest

Dependent Variable: achievement result of students in post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3674.011[a]	5	734.802	7.152	.000
Intercept	53881.246	1	53881.246	524.439	.000
Treatment	25.000	2	12.500	.122	.885
Pretest	2785.469	1	2785.469	27.112	.000
treatment * Pretest	23.851	2	11.926	.116	.890
Error	30205.798	294	102.741		
Total	1027996.849	300			
Corrected Total	33879.809	299			

a. R Squared = .108 (Adjusted R Squared = .093)

4.3.2 Comparison of the Achievement scores of Local and Traditional Method of Teaching after the Intervention

As shown in Table 4.22 and 4.23 below, an independent-samples t-test was conducted to compare learners' post achievement test scores between experimental group (local) and control group (traditional teaching method). A non-significant difference between learners' achievements who were taught practical lessons, using improvised materials (M= 57.585, SD=10.598 and who were taught the same contents by traditional (M=55.479, SD=10.159; t(198)=1.43, p=0.153, two-tailed. The magnitude of the differences in the means (mean difference = 2.106, 95% C I -.789 to 5.001 was very small (Eta squared =0.01). From this t-test statistics, the effect size was too small; almost both groups were equal after the intervention.

Table 4.22 Mean and standard deviation of achievement score of practicals in chemistry that were taught by improvised materials and traditional teaching model

Group Statistics					
teaching methodology		N	Mean	Std. Deviation	Std. Error Mean
achievement of students in post-test	Local	100	57.5852	10.59843	1.05984
	Traditional	100	55.4793	10.15900	1.01590

Table 4.23 after intervention achievement result of independent sample t-test between improvised materials and traditional teaching methods

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
achievement of students in post-test	Equal variances assumed	.087	.769	1.43	198	.153	2.106	1.468	-.789	5.00
	Equal variances not assumed			1.43	197.6	.153	2.106	1.468	-.789	5.00

4.3.3 Comparison of Posttest Achievement scores of practicals that were taught through improvised and Actual method of Teaching after the Intervention

As shown in Table 4.24 and Table 4.25 below, an independent-samples t-test was performed to compare the post-test achievement results of learners that existed between experimental groups such as alternative practical and actual practical groups. There was a non-significant difference in achievement results in both groups learners who were taught practical lessons in volumetric analysis using improvised materials(local)(M= 57.5852, SD=10.59843 and who were taught the same contents by conventional materials (M=59.630, SD=10.862; t(198)= 1.348, P = .179, p > 0.05 two-tailed. The means difference (MD = -2.045, 95% with a confidence interval, C I -5.038 to 0.948 was very small (Eta squared =0.009). From this t-test statistics, the effect size was too small almost both groups were equal after the intervention.

Table 4.24 Independent Samples Test alternative practical and actual practical models of teaching after the intervention

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
achievement of students in post-test	Equal variances assumed	.276	.600	-1.348	198	.179	-2.045	1.52	-5.04	.95
	Equal variances not assumed			-1.348	197.88	.179	-2.045	1.52	-5.04	.95

Table 4.25 Mean and standard deviation of achievement score of the alternative practical and actual practical model after treatment

Group Statistics					
teaching methodology		N	Mean	Std. Deviation	Std. Error Mean
achievement of students in post test	Local	100	57.59	10.60	1.059
	Actual	100	59.63	10.86	1.086

4.3.4 Comparison of the Posttest Achievement scores of Actual and Traditional Method of Teaching after Intervention

As shown in Table 4.26 and Table 4.27 below, an independent-samples t-test was carried out to compare the participants' achievement test results after the intervention that existed between actual practical chemistry teaching model groups' schools and traditional method. Based on the achievement results, a significant difference was observed between traditional method (M= 55.479, SD = 10.159) and actual practical model (M=59.630, SD= 10.862; t(198)= -2.791,.P = 0.006, $p < 0.05$ two-tailed. The magnitude of mean difference, MD = -4.151, and which is in a 95% confidence interval, CI -7.084 to -1.218 was small (Eta squared =0.039). From this t-test statistics, the effect size was small; almost both groups were equal after the intervention.

Table 4.26 Independent Samples Test of teaching methodologies actual and traditional

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
achievement of students in post-test	Equal variances assumed	.705	.402	-2.79	198	.006	-4.15	1.49	-7.084	-1.22
	Equal variances not assumed			-2.79	197.12	.006	-4.15	1.49	-7.084	-1.22

Table 4-27 Group Statistics –mean and standard deviation					
teaching methodology		N	Mean	Std. Deviation	Std. Error Mean
achievement of students in post-test	Traditional	100	55.479	10.15900	1.016
	Actual	100	59.630	10.86208	1.086

4.3.5 Presentation of Achievement test results of one-way between-group analysis (ANOVA) after the Intervention

As shown in Table 4.28, Table 4.29 and Table 4.30, a one-way between-groups analysis of variance (ANOVA) was carried out to assess the three teaching methodologies' effectiveness and compare their effectiveness by dependant variable as an achievement test. The schools were grouped into experimental groups based on purposive sampling, and the actual existing classes after pre- used parameters as a measure such as sex, ability, age and some other factors to allocate learners in real classes for the current study. Significant difference was observed statistically at the $p < 0.05$ level due to the achievement test results of the three groups (2,297) =3.875, P=0.022. Despite reaching a statistical difference result, the actual difference in mean scores between the groups was quite small. The effect size calculated using eta squared = sum of squares between groups divided to the total sum of squares was 0.0254 and So that the effect is small. Post-hoc comparisons using the Tukey's HSD test indicate that the mean score for actual with mean and standard deviation values (M=59.630, SD=10.86) was significantly different from teaching learners with local materials having the mean and standard deviation value (M=57.585, SD=10.598) and traditional method with the mean and standard deviation values (M=55.479, SD=10.159). It was also confirmed that learners' results in traditional teaching methods are quite different from those were taught by using local materials as an alternative method by transitivity. Almost similar standard deviation with small difference shows that teaching learners with improvised material instead of conventional materials are mandatory for newly launched schools and schools in rural areas that do not have laboratory facilities.

Table 4.28 Achievement test score Mean and Standard deviation after the intervention

Descriptives								
achievement of students in post-test								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Local	100	57.58	10.598	1.0598	55.482	59.69	42.42	92.42
Traditional	100	55.50	10.159	1.0156	53.464	57.49	24.24	74.24
Actual	100	59.63	10.862	1.086	57.475	61.79	30.30	84.84
Total	300	57.57	10.645	.615	56.356	58.77	24.24	92.42

Table 4.29 ANOVA result of achievement score after intervention

ANOVA					
achievement of students in post-test					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	861.643	2	430.821	3.875	.022
Within Groups	33018.166	297	111.172		
Total	33879.809	299			

Table 4.30 Post Hoc Test of multiple comparisons after the intervention

Multiple Comparisons							
Dependent Variable: the achievement of students in post-test							
						95% Confidence Interval	
(I) teaching methodology			Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tukey HSD	Local	Traditional	2.11	1.49	.336	-1.41	5.62
		Actual	-2.05	1.49	.357	-5.56	1.47
	Traditional	Local	-2.11	1.49	.336	-5.6	1.41
		Actual	-4.15	1.49	.016	-7.7	-.64
	Actual	Local	2.05	1.49	.357	-1.5	5.56
		Traditional	4.15	1.49	.016	.64	7.67
		Traditional	4.15	1.49	.016	.64	7.66
*. The mean difference is significant at the 0.05 level.							

4.3.6 Presentation of the ANCOVA result of achievement test after the Intervention

As shown in Tables 4.31, Table 4.32 and Table 4.33, an analysis of covariance (ANCOVA) with one-way between groups was conducted to compare the effectiveness of three different instructional styles used as interventions independently. It is needed to conclude, which method is positively used in providing information to reduce the low post academic achievement test scores of learners in volumetric analysis in particular and laboratory activities in chemistry subject in general. Teaching methods was used as an independent variable that entailed the three types of treatments such as actual practical, alternative practical and traditional method of teaching, and the dependent variable consisted of post-academic achievement scores. Posttest achievement questions administered to the learners after the treatments were completed. The age of learners and pretest was used as the covariates in this analysis. Groundwork confirmation of the result was carried out to guarantee that there was no violation of assumptions (normality, linearity, homogeneity of variances, and homogeneity of regression slopes) used to confirm the reliability of the covariates (preview cf.4.3.1a). After regulating the queries in pre- intervention scores concerning assumptions, a significant difference was observed between the three treatment groups on achievement test result after intervention $F(2, 295) = 4.52.$; $p=0.012$, partial eta squared=.030.There is a strong relationship between before-treatment, and after-treatment on achievement test results as indicated by $F(1,295) = 27.362$, with partial eta, squared =.085. Nevertheless, no relation observed with the age of learners with partial eta values 0.12. It means that pretreatment learners' achievements directly affect achievements after intervention but the learners’ age does not affect achievements either before interventions or after the intervention. The effects were the same in the case of age since it is used as a covariate parameter. From the Table 4.28- of pair wise comparison teaching with alternative practical model/using local materials is almost the same as or as effective as teaching with actual practical model/teaching with conventional materials both having p-value=.912 in Levene’s test, almost having the same marginal means value 58.785 and 58.875 respectively. However, $F(1, 295) = 3.430$ with the p values, $p = 0.065$ in Table 4. 32 indicate learners’ age is non-significant covariate. $F(1,295) = 27.362$ with p values=0 indicate learners’ pretest result is a significant covariate. Finally $F(2,295) = 4.532$, with $p = 0.012$ with partial eta value=0.30 indicates that teaching with the three teaching strategies has shown a difference. If one can effectively utilize each strategy as much as possible, learners can easily understand the subject matter taught.

Table 4.31 Tests of between-subjects effects result in posttest learners' achievement score

Tests of Between-Subjects Effects						
Dependent Variable: the achievement of learners in post-test						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3997.578[a]	4	999.394	9.866	0	0.118
Intercept	2863.949	1	2863.949	28.273	0	0.087
Pretest	2771.652	1	2771.652	27.362	0	0.085
Age	347.418	1	347.418	3.43	0.065	0.011
Treatment	916.281	2	458.141	4.523	0.012	0.03
Error	29882.231	295	101.296			
Total	1027996.849	300				
Corrected Total	33879.809	299				
a. R Squared = .118 (Adjusted R Squared = .106)						

Table4.32 Mean and Standard Deviation values of Learners' posttest achievement scores

Estimates of mean and std error				
Dependent Variable: the achievement of students in post-test				
			95% Confidence Interval	
teaching methodology	Mean	Std. Error	Lower Bound	Upper Bound
Local	58.757[a]	1.035	56.719	60.794
Traditional	55.064[a]	1.016	53.065	57.063
Actual	58.875[a]	1.016	56.876	60.873
a. Covariates appearing in the model are evaluated at the following values: the achievement of students in pretest = 29.1567, age of students = 18.3867.				

Table 4.33 Univariate tests of achievement test score after the intervention

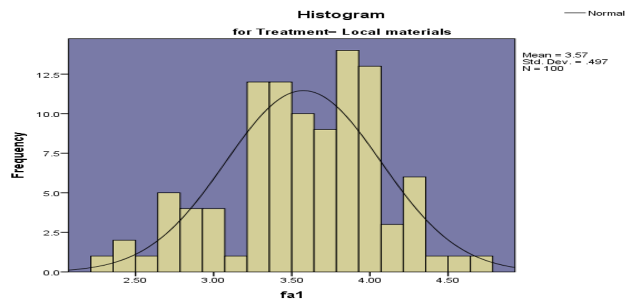
Univariate Tests						
Dependent Variable: the achievement of students in post-test						
	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	916.281	2	458.141	4.523	.012	.030
Error	29882.231	295	101.296			
The F tests the effect of teaching methodology. This test is based on the linearly independent pair wise comparisons among the estimated marginal means.						

4.3.7 Interpretation of Normality and Results of Students' Questionnaire after the Intervention

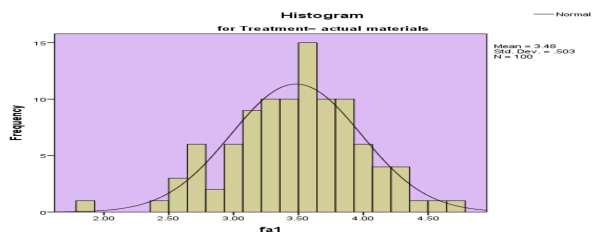
4.3.7a Test of Normality of SQCL- questionnaire after treatment

From the Table 4.34, after a linear combination of all the items, from a test of normality of Shapiro-Wilk test and from the evidence of large population (n >30) as well as from the inspection of the histogram for all items in each category (A to L), the scores are normality distributed.

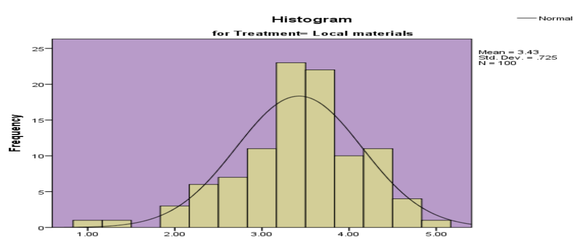
Table 4:34 Tests of Normality of questionnaire(SQCL) after the intervention							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
teaching methodologies		Statistic	Df	Sig.	Statistic	Df	Sig.
fa1	Local materials	.105	100	.008	.973	100	.038
	actual materials	.091	100	.040	.986	100	.394
fa2n	Local materials	.159	100	.000	.958	100	.003
	actual materials	.114	100	.003	.967	100	.014
fa3n	Local materials	.128	100	.000	.969	100	.017
	actual materials	.200	100	.000	.955	100	.002
fa4n	Local materials	.083	100	.088	.986	100	.369
	actual materials	.078	100	.137	.982	100	.189
fa5	Local materials	.215	100	.000	.928	100	.000
	actual materials	.133	100	.000	.964	100	.008
faTn	Local materials	.101	100	.013	.978	100	.085
	actual materials	.074	100	.200*	.983	100	.208
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							



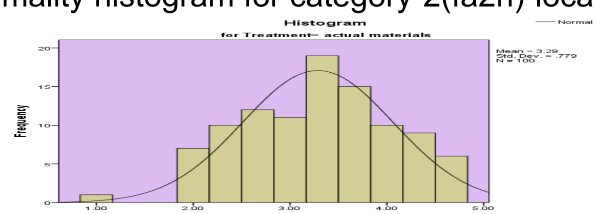
A. Figure 4.25 Normality histogram for the category- 1-local materials



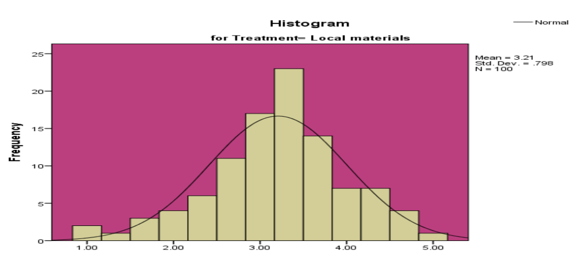
B. Figure 4.26 Normality histogram for the category-1 fa1-actual materials



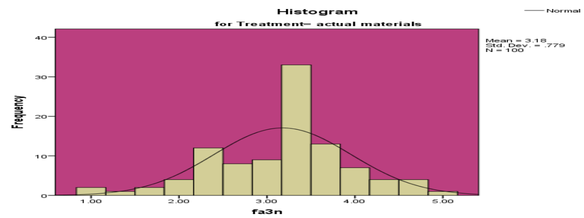
C. Figure 4.27 Normality histogram for category-2(fa2n)-local materials



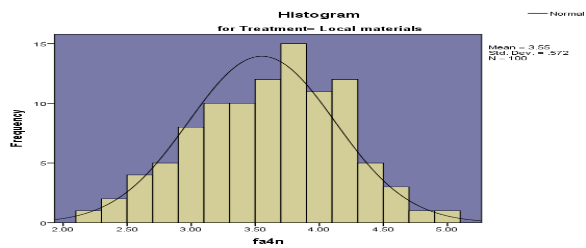
D. Figure 4.28 Normality histogram for category-2(fa2n)-actual materials



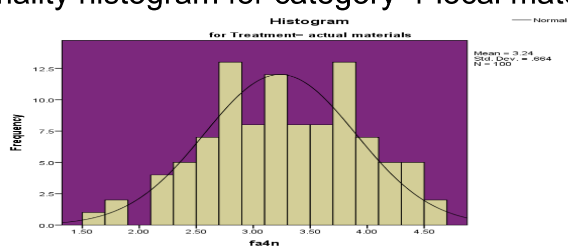
E. Figure 4.29 Normality histogram graph of category-3(fa3n)-local materials



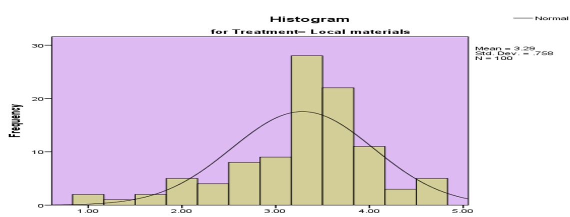
F. Figure 4.30 Normality histogram for category-3(fa3n)-actual materials after treatment



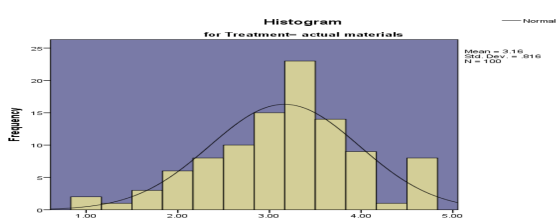
G. Figure 4.31 Normality histogram for category-4-local materials after treatment



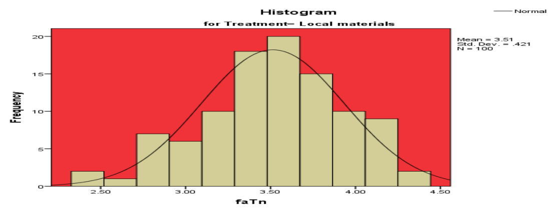
H. Figure 4.32 Normality histogram for category-4-actual materials after treatment



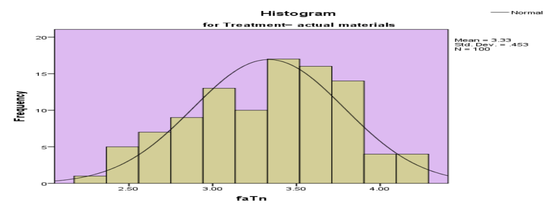
I. Figure 4.33 Normality histogram for category-5-local materials after treatment



L.Figure 4.34 Normality histogram for category-5-actual materials after treatment



L.Figure 4.35Normality histogram for scores after a linear combination of all items-Total-local materials



L.Figure 4.36 Normality histogram for scores after a linear combination of all items-Total-Actual materials

4.3.7b Results of Questionnaire (SQCL) administered to learners after the Intervention

The post-treatment SQCL-questionnaire was administered to learners in both experimental groups was the same as the pre- intervention questionnaire (SQCL). The total number of items were twenty-six (26) after amendment by statistician and subject specialists in the field, which was rated based on a five-point Likert scale that involved strongly disagree, disagree, neutral, agree and strongly agree to which learners responded based on their perceptions by tick mark(appendix-4).The post-treatment SQCL-questionnaire scores of only experimental groups such as Actual practical chemistry teaching model and practical lessons in the volumetric analysis that was taught through improvised materials as a model included in the comparison. Finally, post-treatment questionnaire scores were analyzed using the independent sample t-test and descriptive statistics such as means, standard deviations concerning the scores of the test. As shown in the Table 4:35 the results of statistical analysis of post-treatment score from the questionnaire (SQCL) administered to learners that were found in experimental groups such as actual practical chemistry teaching model and practical lessons of volumetric analysis that were taught through improvisation as an alternative approach were presented. The items in SQCL-questionnaire were categorized into five perspective areas in their similarity to gather information about learners' perceptions in experiment related works in the laboratory. Items in each category analyzed alone after linear combination mean values using independent sample t-test, standard deviations and mean values of the.samples.

Accordingly, as shown in category-1(fa1), t(197.978) =1.313, p=0.191, P > 0.05 is statistically non-significant difference in learners perceptions after intervention. However, from mean and standard deviation values practicals that were taught by improvised materials as an alternative approach model schools learners score were slightly higher mean value (M=3.57) and lower standard deviation (SD=0.497) compared to actual practical chemistry teaching model schools learners score with the mean value recorded (M=3.48) and standard deviation (SD=0.502). This result implied that learners in both groups might acquire science process skills in equitable manner. It indicates the potential of improvised material in acquiring science process skills in the absence of conventional materials.This result is in line with the literature(Temechegn,2012;Yitbarek,2012) is that indicates both conventional and improvised materials almost equally important in chemistry laboratory.

As shown in Table 4:35 in category 2(fa2n) t(198)=0.234, P = 0.190, P > 0.05 is non significant difference in learners perception. The trend in category-2 is visible and similar in perception as it was seen in category-1. The mean score of learners' who were taught practicals in volumetric analysis with improvised local materials as an alternative approach scored the mean value (M=3.43) higher than the learners who were taught the same content with actual practical chemistry teaching model strategy scored with the mean value (M=3.3). Similarly, practicals that were taught volumetric analysis by improvised materials as an alternative approach with the standard deviation value (SD=.725) is lower than that of the standard deviation of actual practicals (SD=0.779). However, this mean and standard deviation values were also non-significant indifference.

As shown in Table 4.35 and in category-3(fa3n), t(198)=0.269, P=0.788, P > 0.05 is non-significant in learners' perceptions. Concerning the learners' mean score for those who were taught practical lessons with improvised materials as an alternative approach in category-3 with (M=3.2,SD=0.758) which was higher in perception when compared with the mean score of learners who were taught practical lessons using conventional materials(M=3.17, SD=0.779). Even though there are a little difference with mean and standard deviations value, it is still non-significant in difference after intervention.

As shown in table 4:35 in category-4(fa4n),t(198)=3.605, P=0.000, P < 0.05 is significant in difference after intervention acomplished. The difference in perception are visualized using the mean and standard deviations for learners in group who were taught practical lessons using conventional materials (M=3.24, SD=-66) and learners' perception who were taught practical lessons in volumetric analysis (M=3.55, SD=0.57).

As shown in table 4.35 in category-5(fa5), t(198)=1.107,P=0.269, P > 0.05 is non-significant in learners perceptions after the treatment held. This result inferred that learners in both group strongly need improvisation to use in practical lessons. It can be replaced in a place of conventional materials. In its presence, practicals can be done in appropriate time continually due to spontaneity nature of resources from the environment and accessing it easily. Thus, both groups have similar perceptions regarding improvisations in providing science process skills.

After linear combination of all items, FaTn as it shown in Table 4.35, t(198)=2.891,P=0.004, P < 0.05 is significant in difference in learners' perceptions. The overall learners' perceptions were compared in both actual practical chemistry teaching model schools and practical lessons in a volumetric analysis that were taught by improvised materials as an alternative approach model schools. The difference in learners perceptions were visualized using mean and standard deviation values. Accordingly, the mean score of learners who were taught practical lessons in volumetric analysis with an alternative approach (teaching with improvised materials) in chemistry as a model (M=3.5) was higher than the mean score of the learners' perceptions (M=3.3) taught by the actual practical chemistry teaching model. Similarly, the standard deviation recorded by learners those were taught about practical lessons using an alternative practical chemistry teaching model (SD=0.421) was lower than that of actual practical chemistry teaching model (SD=0.453). From this, one can easily deduce that teaching with improvised local material is a good alternative approach in the absence of conventional laboratory facilities.

Furthermore, as a conclusion, as shown in Table 4.35, the t-values of the independent sample t-test in all categories except category 4 and linearly combined all items mean values(FaTn) were non-significant with all p-values, p>0.05 is significant in difference. Specifically, as shown in Table 4.35, t(198)= 2.891, P=.004, P < 0.05 for all linearly combined items the mean values of learners' score (FaTn) indicate that there was a significant difference between learners' perceptions in two comparisons group.

Table 4:35 Independent Samples Test of the questionnaire (SQCL) after treatment

		Levene's Test for Equality of Variances		t-test for Equality of Means						
Category		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
fa1	Equal variances assumed	.000	.985	1.313	198	.191	.093	.0707	-.047	.232
	Equal variances not assumed			1.313	197.978	.191	.093	.0707	-.047	.232
fa2n	Equal variances assumed	1.426	.234	1.316	198	.190	.140	.106	-.069	.350
	Equal variances not assumed			1.316	196.999	.190	.140	.106	-.069	.350
fa3n	Equal variances assumed	.040	.842	.269	198	.788	.030	.111	-.190	.250
	Equal variances not assumed			.269	197.886	.788	.030	.112	-.190	.250
fa4n	Equal variances assumed	3.273	.072	3.605	198	.000	.316	.088	.143	.489
	Equal variances not assumed			3.605	193.757	.000	.316	.088	.143	.489
fa5	Equal variances assumed	1.292	.257	1.107	198	.269	.123	.111	-.096	.343
	Equal variances not assumed			1.107	196.943	.269	.123	.111	-.097	.343
FaTn	Equal variances assumed	1.357	.246	2.891	198	.004	.179	.062	.057	.301
	Equal variances not assumed			2.891	196.947	.004	.179	.062	.057	.301

Table 4:36 Mean and standard deviation output table comparison of actual practical model and alternative practical model

Group Statistics						
	teaching methodologies		N	Mean	Std. Deviation	Std. Error Mean
fa1	Category-1	Local materials	100	3.5743	.49736	.04974
		actual materials	100	3.4814	.50258	.05026
fa2n	Category-2	Local materials	100	3.4267	.72487	.07249
		actual materials	100	3.2867	.77853	.07785
fa3n	Category-3	Local materials	100	3.2067	.79812	.07981
		actual materials	100	3.1767	.77915	.07792
fa4n	Category-4	Local materials	100	3.5510	.57216	.05722
		actual materials	100	3.2350	.66414	.06641
fa5	Category-5	Local materials	100	3.2867	.75808	.07581
		actual materials	100	3.1633	.81580	.08158
faTn	Overall	Local materials	100	3.5131	.42119	.04212
		actual materials	100	3.3342	.45320	.04532

4.4 Teachers' Perception of Laboratory Activities Chemistry teaching

A questionnaire (TQ)(appendix-5) containing thirteen items (13 items) was designed by the researcher to be replied by the teachers in all groups including the control group to identify their perceptions of chemistry teaching styles and its' practicals conducted and further effects that will be observed on learners during teaching and learning process in chemistry in general. This questionnaire was administered to 18 chemistry teachers in the pilot study who taught chemistry subject in all grade level. The Cronbach's alpha that measures inter rater consistency of each item within the categories was obtained for TQ1, TQ2 and TQ3 were 0.814, 0.761, 0.727respectively. However, question number thirteen (TQ4) in category four was a single item, which used to compare actual practical chemistry teaching model with practical lessons that were taught through improvised materials as an alternative approach in chemistry teaching as a model in general. Its' inter rater reliability had not been computed. However, only raw data may be used (if the test is descriptive statistics) to evaluate the differences in teachers' perceptions in this regard. However, for inferential statistics, the software includes it for analysis.

The TQ-questionnaire was administered to the teachers in all groups after a pilot study was accomplished. Accordingly, as shown in Table 4:37 and Table 4:38 below, the items were linearly combined within each category. The items in category one (TQ1) and category three (TQ3) with ANOVA Value (F=2, 1.700: P=0.191): (F=2, 0.305; P=0.738): and from post hoc test analysis that entailed teachers' perceptions on practicals and laboratory activities in chemistry teaching respectively were non-significant. However, after a linear combination of all items in categories such as category-2 (TQ2) and category-4(TQ4) with ANOVA value (F=2, 24.781; p = 0.000, P < 0.05): (F=2, 6.360; p=0.003, P < 0.05) and from post hoc test analysis, teachers' perception on laboratory activities in chemistry teaching and its' practicals with three different teaching methods respectively was significantly different.

The perceptions of teachers were also compared with linearly combined mean values of all items with ANOVA value (F=2, 10.653; P=000) and using Turkeys' post hoc test analysis, the teachers' perception on laboratory activities in chemistry teaching was significantly different. Specifically, based on Tukey's post hoc analysis, teaching with local materials, practicals that were taught by improvised materials as an alternative approach in chemistry teaching as a model was the same as teaching with traditional methods used as a control group having the MD =-222, STD error= 0.152, P=.310 which was greater than that of P=0.05 significant level. Teachers' perceptions on teaching with the actual practical model (teaching with conventional materials) was significantly different from teaching practicals that were taught by improvised materials as an alternative method having MD=, 0.445, STD error=0.148, p=0.011 which was less than that of p=0.05 significant level. Teachers' perceptions in teaching learners with the actual practical model (industrially processed materials) were significantly different from teaching learners with traditional methods having MD=0.669, STD error=0.148, p=0.000 which was less than that of p <0.05 significant level.

Table 4.37 ANOVA result of TQ-questionnaire

		Sum of Squares	Df	Mean Square	F	Sig.
TQ1	Between Groups	.914	2	.457	1.700	.191
	Within Groups	16.677	62	.269		
	Total	17.591	64			
TQ2	Between Groups	26.161	2	13.081	24.781	.000
	Within Groups	32.727	62	.528		
	Total	58.888	64			
TQ3	Between Groups	.211	2	.106	.305	.738
	Within Groups	21.440	62	.346		
	Total	21.651	64			
TQ4	Between Groups	15.584	2	7.792	6.360	.003
	Within Groups	75.954	62	1.225		
	Total	91.538	64			
TQT	Between Groups	5.138	2	2.569	10.653	.000
	Within Groups	14.951	62	.241		
	Total	20.089	64			

Table 4: 38 post hoc test multiple comparisons of Questionnaire (TQ)

Multiple Comparisons								
Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
TQ1	Tukey HSD	Local	Traditional	-.095	.160	.823	-.479	.289
			Actual	.187	.157	.460	-.189	.563
		Traditional	Local	.095	.160	.823	-.289	.480
			Actual	.282	.157	.177	-.094	.658
		Actual	Local	-.187	.157	.460	-.563	.189
			Traditional	-.282	.157	.177	-.658	.094
			Traditional	-.282	.154	.206	-.668	.104
TQ2	Tukey HSD	Local	Traditional	-.285	.224	.415	-.824	.253
			Actual	1.162	.219	.000	.635	1.669
		Traditional	Local	.286	.224	.415	-.253	.824
			Actual	1.448*	.219	.000	.921	1.974
		Actual	Local	-1.162*	.219	.000	-1.689	-.635
			Traditional	-1.448*	.219	.000	-1.974	-.921
TQ3	Tukey HSD	Local	Traditional	-.095	.181	.860	-.531	.341
			Actual	.041	.177	.971	-.386	.467
		Traditional	Local	.095	.181	.860	-.341	.531
			Actual	.136	.177	.725	-.290	.562
		Actual	Local	-.041	.177	.971	-.467	.386
			Traditional	-.136	.177	.725	-.562	.290
TQ4	Tukey HSD	Local	Traditional	-1.000	.342	.013	-1.820	-.180
			Actual	.081	.334	.965	-.717	.887
		Traditional	Local	1.000	.342	.013	.180	1.820
			Actual	1.085	.334	.005	.283	1.887
		Actual	Local	-.085	.334	.965	-.887	.717
			Traditional	-1.085	.334	.005	-1.887	-.282
TQT	Tukey HSD	Local	Traditional	-.223	.152	.310	-.587	.141
			Actual	.445	.148	.011	.089	.801
		Traditional	Local	.223	.152	.310	-.141	.587
			Actual	.669	.148	.000	.313	1.025
		Actual	Local	-.445	.148	.011	-.801	-.090
			Traditional	-.669	.148	.000	-1.025	-.313
*. The mean difference is significant at the 0.05 level.								

Table 4.39 Mean and Standard Deviation comparison of TQ-questionnaire

Teaching methodologies		TQ1	TQ2	TQ3	TQ4	TQT
Local	Mean	4.35	3.988	4.302	3.476	4.161
	N		21	21	21	21
	Std. Deviation	0.55	0.764	0.729	1.250	0.541
Traditional	Mean	4.45	4.274	4.397	4.476	4.385
	N	21	21	21	21	21
	Std. Deviation	0.599	0.675	0.403	0.679	0.497
Actual	Mean	4.17	2.826	4.261	3.391	3.716
	N	23	23	23	23	23
	Std. Deviation	0.389	0.736	0.586	1.269	0.435
Total	Mean	4.315	3.669	4.318	3.769	4.076
	N	65	65	65	65	65
	Std. Deviation	0.524	0.959	0.582	1.196	0.560

Table 4.40 before and after treatment learners' perception comparisons in SQCL-questionnaire score

Independent sample t-test						
SN	Before treatment			After treatment		
	Code for categories	significant	Non significant	Code for categories	significant	Non-significant
1	fb1	X		fa1		X
2	fb2n	X		fa2n		X
3	fb3n		X	fa3n		X
4	fb4n	X		fa4n	X	
5	fb5	X		fa5		X
6	Fbtn	X		FaTn	X	

There were three views,

1) Categories with their results significant before treatment and become non-significant after treatment

2) Category with the result non-significant before and after treatment

3) Categories including all items after linear combination is significant before and after treatment

As it was shown in table 4.40 above in all three categories, fb1 Versus fa1 , fb2n Versus. Fa2n and fb5 Versus fa5 the results were significant before intervention. However, after intervention the result became non-significant. Actually, the variables indicate learners' perception regarding science process skills that they acquire from experimental activities, teachers and management bodies in the support of learners in doing laboratory facilities and learners opinion on improvisation of laboratory equipment could be secured after the intervention with facilities either standard or improvised. In all the three categories learners perceptions were changed after the intervention completed. Thus, they were positively understand and almost perceived equitably the importance and existence of facilities in the laboratory. It is sure that learners can be equipped with important skills when they manipulate materials in the laboratory. Thus, the results indicate learners acquire science process skills in equitable fashion. Furthermore, teachers also tried to help learners in providing with facilities at the time of intervention. Learners' perceptions about improvisation also have equitably important in providing the necessary skills. Initially, before intervention significant result obtained and after intervention held the result become non- significant.

As it is shown in category three (fb3n and fa3n) in both case before and after treatments the score of learners' perception was similar, non-significant. This similar perception after and before treatment indicates learners were not happy in previous teaching style. The presence of facilities only does not guarantee learners to score high academic achievements. It also depends on other either factors that are controlled or uncontrolled variables (Creswell, 2004).

As it was shown in table 4.40 above category -4 before and after treatment (fb4n Versus. fa4n) and all items after linear combination (Fbtn Versus faTn) were significant in learners' perception. The result of category 4 after and before treatment regarding learners opinions on laboratory facilities in chemistry were similar and significant. This indicates that learners have still perceived differently regarding facilities, those were standard and improvised materials, although both have similar potential in acquiring science process skills being other factors equal.

Table 4.41 Comparison of achievement test result before and After the Intervention

IV	Before treatment						After treatment					
	Independent sample test		ANOVA		ANCOVA		Independent sample t-test		ANOVA		ANCOVA	
	T-test		F-test		F-test		T-test		F-test		F-test	
	Sig	non-sig	Sig	non-sig	Sig	non-sig	Sig	non-sig	sig	non-sig	sig	non-sig
Actual Vs. Alternative	X							X				
Actual Vs. Traditional		X					X					
Alternative Vs. Traditional	X							X				
Actual Vs. Alternative Vs. Traditional			X		X				X		x	

There are two views,

1) The independent sample t-test of both actual practical Versus alternative practical chemistry teaching model schools and alternative practical Versus traditional method of teaching schools as a control were significant indifference before treatment condition held but they were non-significant after treatment

2) Actual practical Versus traditional method of teaching as a control was a non significant in difference before treatment but a significant difference was observed after intervention

3) Both the F-tests of ANOVA and ANCOVA analysis were shown a significant difference. The differences between within the groups can be determined after Tukeys' post hoc analysis, and it is similar with the significant and non-significant result obtained using independent sample t-test.

4.5 Summary of the chapter

The results of a score of each instrument were analyzed using both the descriptive statistical tools such as mean, standard deviations and inferential statistical tools like independent samples t-tests, one-way analysis of variance (ANOVA), and one-way analysis of Covariance (ANCOVA). In the end, the results of the study were presented to the end-user rationally in this research after confirming the preliminary checks by using different assumptions such as normality, regression slopes, homogeneity test, and linear relationships. All the checks for the data were undertaken before analyzing each data generated from the learners' score in the achievement test before and after the treatment. The pretest achievement scores were used for the identification of factors that affect learners result before the intervention and its impact on learner's scores after intervention. The pretest results were also included as a covariate in the analysis of covariance (ANCOVA) in posttest academic achievement results. post-treatment test scores of the SQCL-questionnaire that were administered to learners used to determine the impact of treatment condition on learner's achievement test questions scores that the learners may obtained as soon as after treatment seized. Besides, the TQ-questionnaire administered to the teachers also interpreted to ensure their perceptions toward the laboratory issues in all sampled schools. Achievement results of the pretest summarize some preview regarding learners' perceptions in chemistry practical activities in general and volumetric analysis before intervention. Five results were obtained based on the research questions. The results were listed and logically presented in chapter five.

CHAPTER FIVE

5. Discussions of the Results

5.1 Introduction

In this chapter, the answers to five research questions and the test of respective null hypotheses set in the study were discussed and the findings based on the study identified and rectified to apply its result to the end-users. It further suggests research areas in chemistry education in developing countries that involves limited and no laboratory facilities. The research questions were answered based on the results presented in chapter four and the methodology used in Chapter 3. Below are the summaries of the results and answers to the research questions with their respective hypothesis systematically discussed by supporting with the literatures.

5.2 Summary of the findings of the results

The results of data collected from the field by employing three different instruments such as achievement test questions, a questionnaire administered to learners (SQCL) and a TQ-questionnaire was administered to teachers were systematically discussed. It compared the effectiveness of an actual practical and alternative practical chemistry teaching models in reference to traditional method of teaching. Learners were taught about practical lessons of volumetric analysis using conventional materials as an actual practical and improvised materials as an alternative practical chemistry teaching. Only posttest results of academic achievement test and the learners' scores of SQCL-Questionnaire were used to compare their perceptions between the two comparison groups such as actual practical and alternative practical and further used to test the null hypothesis between the groups. The score of TQ-questionnaire used to compare teachers' perceptions among and between within three intervention groups. The results of all groups' learners were compared by using descriptive statistical tools such as mean, standard deviations, and inferential statistics like independent sample t-test, analysis of variance (ANOVA) after turkeys' post hoc HSD test analysis, and analysis of Co Variance (ANCOVA). Although all tests can be used to compare the differences exist among and between within the groups, analysis of variance (ANOVA) were employed to test the null hypothesis Ho_1 to H_{O5} . except hypothesis H_{O4},which is tested using independent t-test that render scores generated using the blue print of achievement test questions (for hypothesis 1-3), SQCL-questionnaire(for hypothesis 4)and TQ-questionnaire(for hypothesis 5) in ongoing research (appendices 2, 4 and 5)respectively. Only linearly combined mean values of the response of all items in SQCL-questionnaire and TQ - questionnaires were used to test the Null hypothesis for H_{O4} and H_{O5} .

From the analysis and Interpretations of the data in chapter four the following summary of the major findings have been stated bellow. Furthermore, for each finding the discussions have been made by comparing with other findings in related literatures of previous studies.

1. There was a non-significant difference in the post achievement test scores between learners who were taught by the actual practical chemistry-teaching model (teaching by using conventional materials) and those exposed to the alternative practical chemistry-teaching model, teaching with improvised local materials and chemicals.
2. There was a significant difference in the posttest achievement scores that existed between learners who were taught by the actual practical chemistry-teaching model, and those who were taught by traditional method of teaching as a control group.
3. There was a significant difference in the posttest achievement scores between learners exposed to the alternative practical model, teaching with local materials and those exposed to the traditional method of teaching as a control group.
4. There was a significant difference in learners' perception after post-treatment response scores recorded regarding SQCL-questionnaire between learners exposed to the actual practical chemistry-teaching model and those exposed to the alternative practical chemistry-teaching model (teaching with improvised local materials). However, the difference level was different for each category. Its explanation thoroughly described in the analysis part of chapter four.
5. There was a significant difference in teachers' perceptions among the three groups(taught by conventional material, improvised material and Traditional method)

Finally, the key results of the findings discussed thoroughly under the following topics by supporting relevant related literatures.

5.3.1a Research Question 1

Would there be any significant difference in the mean scores of the post-test for academic achievement of learners who were taught practical lessons in volumetric analysis with conventional practical chemistry materials and those who were taught using improvised materials, as an alternative practical chemistry teaching model in volumetric analysis?

5.3.1b Research Hypothesis 1

There is no significant difference in the posttest mean academic achievement scores of learners who were taught practical lessons of volumetric analysis using conventional practical chemistry materials and those who were taught using improvised materials as an alternative approach in volumetric analysis.

The finding of the result obtained from the analysis of the data collected as shown in Tables 4.28 , 4.29 and 430 respectively in chapter four, $F(2,297) = 3.875$, $P = 0.022$, partial eta squared = .0254 is significant. Thereby using Turkey's HSD post hoc multiple comparisons, MD=4.91, $P = .357$, $P > 0.05$ indicates that there was a non-significant difference in academic achievement between the learners who were taught regarding practical lessons of volumetric analysis using conventional materials and learners who were taught using improvised materials as an alternative method . Thus, Hypothesis 1 that set based on research Question 1 was accepted.

This result inferred that learners could be taught about practical lessons in chemistry using improvised laboratory facilities, which is equitably important as conventional materials to achieve a good academic achievement. It can be used in the absence of conventional materials due to financial constraints or other factors to afford conventional materials. Furthermore, teaching learners about practical lessons in volumetric analysis using improvised materials acquiring science process skills as we acquire the skills from conventional materials. Thus, it is also good for teaching experiments with improvised materials that learners acquire skills as conventional materials and smoothly help teachers to motivate their learners to easily understand and internalize the chemistry concepts. Furthermore, it continually guarantees teacher to use in the laboratory because of its spontaneity nature and obtained easily from resources in the environment. In line with this result, literatures advocate the consistency of the result that laboratory activities create conducive environment making the instructions fun and enthusiastic for learners by increasing understanding of concepts that are not possibly clear with other teaching styles. Thereby both approaches are equitably important in acquiring science process skills and assist learners to achieve good academic achievements (Achimugu, 2019; Okori & Jerry, 2017; Orhan & Sahin, 2018). It bridges the gap between practical and theoretical knowledge. In addition to the consistency of the result of the findings, literature also overemphasize improvisation over conventional materials that learners are equipped with planning and designing before instruction held by improvising appropriate materials irrespective of teaching with conventional materials (Hunter et al., 2000). Moreover, literatures also argued the advantage of improvisation in the scarce or absence of conventional materials are quit exaggerating and important in the context of developing countries to deal with the problems that may occur in practical teaching (Ngala 2019; Emendu, 2010). Because of these situations, teachers ought to find the appropriate methods that alleviate the problems hindering the quality education in chemistry in general (Orla, 2005). Along with this idea, there is also, information indicating the consistency of the result using improvised materials from environments' resources to use it in the absence or financial constraints that halt affording standard materials (Okori et al., 2017; Okafor, 2001). It further maximally hampered the deterioration of science teaching and ensures the quality of education for schools either they are located in rural or urban areas if and only if teachers critically use the technique of improvisations (Thomas & Israel, 2012; Khitab, 2012). In contrary to the findings, literature described shortcomings of improvised materials in practical teaching is that practical activities taught by improvised materials gets some "precision and accuracy" problems that may be avoided by using macro scale concentration of the chemicals (Baeza et al., 2015). It means that teachers ensure quality education by avoiding any factors that halt improvisations.

5.3.2a Research Question 2

Would there be any significant difference in the mean scores of the post-test for academic achievement of learners who were taught practical lessons in volumetric analysis with conventional practical chemistry materials and those who were taught the same contents using traditional method as a control group?

5.3.2b Research Hypothesis 2

There is a significant difference in the mean posttest academic achievement scores of learners who were taught practical lessons of volumetric analysis with conventional practical chemistry materials and those who were taught using traditional method as the control group.

According to the findings obtained based on the research question 2 and its' hypothesis 2; as shown in Table 4.28, Table 4.29 and Table 4.30 in chapter four, $F(2,297) = 3.875$, $P = 0.022$, partial eta squared = 0.0254 is significant .After Tukey's post hoc HSD, MD =1.491. $P = .016$, $P < 0.05$ is still significant. This difference is visualized after Tukey's post hoc with mean and standard deviation values for conventional materials (Mean=59.630, SD=10.86) and traditional method (Mean=55.48, SD=10.16) indicate that there was a significant difference in academic achievements between learners who were taught practical lessons in chemistry using conventional materials, and who were taught using traditional method. Based on the research question 2, the hypothesis was accepted. The result of the finding inferred that teaching learners with well-equipped facilities develop the conceptual understanding and used in acquiring science process skills due to materials manipulation in the laboratory. It used in understanding challenges experienced by learners during instructional process. It facilitates the instructions for practical lessons. In practical chemistry, teaching using conventional materials decreases the gap between practical knowledge and theoretical knowledge of chemistry in general. Thus, learners in favor of well-equipped facilities in the laboratory achieve a good academic achievement compared with traditional method. In line with this finding, the literature advocates the result of the findings that teaching learners in doing practicals using appropriate facilities result in effective learning process and enhances the development of conceptual understanding rather than teaching the chemistry concepts using only the traditional approach without material manipulations (Ngala, 2019; Uzezi & Zainab, 2017). It is also consistent with the literature (Bailey et al., 2002) is that constructivist model discard the traditional view including knowledge corresponds to or matches the reality.

Literature also in agree with the idea or basic concepts acquired can be halted by rote memorization of facts maximize cramming, and learners get concepts non-meaningfully when they were taught using only traditional method (Awan, 2013). Thus, it supported the agreement of the result obtained and in the same literature in contrary to this idea, thereby described that learners acknowledged the traditional method of teaching because of obtaining high marks (Awan, 2013). However, the finding of analysis of the result disagrees with learners' acknowledgement about traditional method.

Sometimes teachers preferred to use traditional method for teaching learners without experiencing them with hands-on activities. Thus, it halts learners to get scientific information and make instructional procedures difficult in chemistry. In line with this action , Ural (2016) described about the shortcomings of traditional method in that it forces learners to follow up a laboratory manual procedure and learners learn the scientific information from the theory faced difficulty, and they cannot notice the relationship between the experiment and scientific theory. In contrary to the result of finding, the literature also supports that the teacher can maximizes learners' achievement by increasing students-teacher interaction using cooperative learning system, scaffolding and collaborative instructional approaches(Gabriel, Osuafor, Cornelius, Obinna & Francis, 2018; Uduafemhe, 2015; Achor & Wude, 2014).Thus, it can be achieved finding appropriate instructional approach in the absence of facilities.

However, traditional teaching method experienced and continued until now in some schools that located in rural areas and newly launched schools in some areas of the country, and the others are well equipped with laboratory facilities. It is difficult to address quality education equitably for all schools with this gap, due to big variation with facilities in the laboratory. Minimizing and confirming the gap that existed in teaching the laboratory activities, which are equipped with facilities and no facilities set under the comparisons to recommend appropriate methods of teaching for the subjects with practical activities inclusive. It is possible to reduce or eliminate this gap totally or roughly by finding alternative appropriate routes of instructional processes due to absence or shortage of conventional materials in the laboratory. The literatures provokes the possibility of ideal practical teaching,which is traditional by comparing with conventional materials, thereby the result in the literature agreed with the discussion for alternative actions suggested to fill a gap (Duban, Aydoğdu &Yüksel, 2019; Souza et al., 2012). It implied when one use trational method of teaching appropriately,learners have aprobability to achieve agood result as learners are taught using conventional materials.

5.3.3a Research Question 3

Would there be any significant difference in the mean scores of the post-test for academic achievement of learners who were taught practical lessons in volumetric analysis using improvised materials as an alternative practical chemistry teaching model and those who were taught using traditional method as a control group?

5.3.3b Research Hypothesis 3

There is a significant difference in learners' post-test mean academic achievement scores that was taught practical lessons in volumetric analysis using improvised materials as an alternative approach and those who were taught using traditional method as a controlled group.

Finding of the result of analysis of data using analysis of variance(ANOVA) with further post hoc test analysis as shown in Table 4:29 in chapter four, $F(2,297) = 3.875$, $p=0.022$, $p<0.05$ partial eta squared = .0254 is significant. From Tukey's post hoc HSD result, MD =1.491, $P = .336$, $P > 0.05$ indicate, there was a non-significant difference in academic achievements between the traditional method and practical lessons that were taught by improvised materials as an alternative approach. The hypothesis based on the research question three was not statistically accepted. This result inferred that both methods have similar advantages for teaching practical lessons in volumetric analysis. This implied when learners were taught practical lessons in volumetric analysis in the absence of improvised materials, in case, it may happen, teachers must be confident and prepared well in constructing knowledge regarding the subject matter that they taught as well. They are also enthusiastic in finding some other appropriate teaching styles; it declares the possibility of teaching practicals using traditional method as teaching style in the absence of facilities in the laboratory either improvised or conventional. This implied that learners could have an opportunity to learn practicals without hands on activities. In line with this, the literature consistent (Uduafemhe, 2015) is that the need to find the most appropriate instructional approach to assist practical lessons, teachers in their academic activities, stimulate and sustain the learners' interest is very important . This is because interest is a key ingredient for recording high achievement in any academic pursuit especially in technology education, which is chemistry inclusive. Thus, learners can learn either scaffolding or collaborative instructional approaches to effectively, record high achievement in the absence of facilities in the laboratory permits to follow alternative routes. Thus, the traditional method of teaching educationally may guarantee for laboratory activities in instructional process. In line with the finding literature consistent (Adega, 2011; Ali et al., 2000) suggests it is not possible to neglect any teaching method used for sciences. Furthermore, in conclusion, it depends on the teaching style of the teacher that he employed in the instruction process together with his readiness to motivate and help learners to understand easily what he taught.

In contrary to this finding that magnify the possibility of teaching learners about practical lessons in volumetric analysis using traditional method over improvised materials, learners achieved high mark. However, there are a number of literatures thoroughly describe about a great advantage of improvisation and it can be thought as provision of an alternative best in the absence of facilities when the schools gets financial constraint over traditional method (Maeland et al., 2017; Akpegi, n.d; Okori et al., 2017). From the inferences of the works of literatures' discussion; and the support of the mean and standard deviation result as shown in Table 4.29 that learners were taught about practical lessons using improvised materials are high scorers when compared with control group learners. This inferred that improvisation is important strategy, which is needed to be as an alternative approach for teaching practical lessons in volumetric analysis. It also allows learners to be as a modernizer (Hains-Wesson et al., 2017). In contrary to the findings, literatures advocated the advantage of improvised materials in cost implications and found it be used for practical lessons in chemistry. They can also be improvised from local resources that existed in learner's respective environments are used as simple alternatives to use for science subjects instead of teaching only traditional method (Orhan &Sahin, 2018; Khitab, 2012). Since chemistry is one of the science subjects and it is, central for all sciences such as biology, physics, Geology, Biochemistry etc (Zudonu et al., 2018). It needs special treatment regarding experiments in the absence of facilities in the laboratory. Because of this, it is explanatory to develop appropriate solutions to the problems that hinder good achievements in volumetric analysis in a chemistry subject. However, the researcher still kept in unfavorable conditions or discouraged with the non-significant result because of unexpected results that disagreed with "literatures on the study of improvisation acknowledged its importance rather than traditional method" (Jonsyn-Ellis, 2002; Gupta, 2016; Temechegn, 2012; Achimugu, 2019). Thus, the appropriate use of traditional method of teaching that dependant on the activities of teachers and their interest may lead learners to achieve agood result.

5.3.4a Research Question 4

Would there be any significant difference in learners' perceptions after treatment in the responses to the SQCL-questionnaire, between those who were taught practical lessons in volumetric analysis using a conventional practical chemistry materials and those who were taught using improvised materials as an alternative practical chemistry teaching model?

5.3.4b Research Hypothesis 4

There is no significant difference in learners' perception in the post treatment scores of the SQCL-questionnaire administered to the learners who were taught practical lessons in volumetric analysis using conventional materials and who were taught using improvised materials as an alternative approach.

The post-treatment questionnaire (SQCL) classified into five categories based on similarities of their idea, which was administered to the learners, was the same as pretreatment questionnaire (SQCL) that was also administered to the same learners. The questionnaire (SQCL) contains twenty-six items with a five-point Likert scale which rated using strongly disagree, disagree, neutral, agree, and strongly agree to which learners were asked and replied their perception with " tick mark" to each item (see appendix-4). Only the post-treatment questionnaire (SQCL) scores of both experimental classes (practicals taught using conventional and practicals that were taught by using improvised materials used for further analysis. The independent sample t-test was used to determine the null hypothesis and for the results of significant value further post hoc HSD test was used to visualize the difference.The preview of Table 4.35 in chapter four has shown the results of statistical analysis of post-treatment scores of the SQCL-questionnaire. The learners in the control group schools were not included in comparison since they were taught about the only theoretical aspects of texts of contents using the traditional method. Thus, learners in the control group were not exposed to hands-on activities about practical lessons in the laboratory but the theoretical aspects of practicals and their procedures were explained to them well to understand the contents of the lessons. Since the items used in SQCL-questionnaire were described issues concerning the laboratory and its activities that further exclude the control group learners from the comparison.

Seven items within SQCL-questionnaire under the category one(fa1) having similar ideas, which signify learner's perception on agents that help them to acquire appropriate skills and science process skills from the stipulated experiments performed in the laboratory. Based on the result obtained in category-1(fa1)after linear combinations of the items, as shown in Table 4.35, $t(198)=1.313$, $P=0.191$, $P > 0.05$ is statistically a non significant in difference. Based on the findings of the statistical result of the learners' perceptions indicate the potential of improvised materials in providing appropriate science process skills and agents used to acquire the required appropriate skills. It implied that the perceptions of the learners regarding practical lessons of volumetric analysis that were taught by improvised materials in acquiring science process skills were almost similar to the learners who were taught practicals of the same content areas by conventional materials eventhough they were faced on different laboratory teaching circumstances. In line to these perceptions, the literature agreed (Achor & Taangahar, 2011) is that non-significant result inferring teaching practical lessons in volumetric analysis with improvised material is almost similar with teaching practical lessons of the same contents by conventional materials in acquiring the science preocess skills. This finding is also in contrary with the result of (Mboto, Ndem & Stephen, 2011), thereby the perceptions describing the significant difference in achievement test results that existed between learners taught with improvised and accredited materials.

This category2(fa2n) contains three items that signify similar idea regarding learners' attitude towards the support of other bodies such as teachers and administrative bodies and they themselves in the laboratory activities to increase the achievements in volumetric analysis in particular. As shown in Table 4.35, $t(198) = 1.131$, $p=0.190$, $p > 0.05$ is a non-significant. This result indicates that learners have similar perception in both groups regarding learners' interest, teachers' and school administrators' willingness helping in their study. The finding also inferred that learners that were taught practical lessons in volumetric analysis get the same support from their teachers and administrative bodies while experiments were done using improvised materials as that of the learners who were taught by conventional materials. Learners in both groups were highly interested in doing experiments since it might be given them enthusiasm and increase the idea for creativity. In line with this result, the literature agreed that for particular science subjects, teacher has to help learners with appropriate materials to conduct the experimental part of the lesson, to the least, he must borrow materials from neighbors' school to conduct the experiments or he can use whatever the opportunity he does to desire his learners (Duban et al., 2019). In the end, he can achieve the planned goal successfully through educating the learners in this approach.

For Category 3(fa3n) that contains three items, which describe similar ideas, regarding previous knowledge of learners in chemistry. According to the result of posttreatment SQCL-questionnaire scores, as shown in Table 4.35, $t(198) = 0.269$, $P=.788$, $P > 0.05$ is non significant in difference. .Although the facilities are found largely in actual practical chemistry teaching model schools comparing with alternative practical chemistry teaching schools,which are almost non in facilities. However, the finding of the result reveals that both groups have almost similar results,which signified learners' perceptions were similar about the previous knowledge of practical lessons in volumetric analysis in particular. After Tukey's post hoc analyses actual practical (M=3.18, SD=0.78) Versus alternative practical (M=3.21,SD=0.798) indicates that concerning the mean score of learners in perception who were taught volumetric analysis by improvised local materials as an alternative approach in category 3 is slightly higher than those who were taught volumetric analyses using conventional material. It implied that learners in both groups perceived the need of doing practicals with appropriate facilities are mandatory. Learners in both group can apply the theoretical knowledge for experiments stipulated in volumetric analysis. However, the inability in determining the mole ratios in stoichiometric equations and spelling errors further contributes for low achievements. The presence of instruments in critical manner avoids learners' negative perception, which can also be solved by using low cost materials nearby environment to teach learners in the absence of conventional materials in treating learners to ensure the quality education. In line to this finding, the literature in agree and consistent (Rahmawati & Koul, 2011) indicating that laboratory activities could be used for improvement and effectiveness teaching of chemistry in general. Thus, learners can actively involved in practical situation using their theoretical knoweledge and critically managed facilities in the laboratory room.

Category 4(fa4n) contains ten items having similar ideas, which described regarding learners' attitude on laboratory facilities in a chemistry subject in general. For linearly combined items in this particular category, from the posttest treatment SQCL-questionnaire, according to the finding as shown in Table 4.35, t(!98) = 3.605, P = .000, $P < 0.05$ is significant in difference. Learners in two comparison groups perceived differently about laboratory facilities in two groups. Because of that after post hoc result, the mean and standard deviation results of Improvised (M = 3.367, SD = 0.49442) and Conventional (M=2.96,SD =0,74237) indicated that learners were taught with improvised materials have a good perception towards facilities in the laboratory compared with learners that were taught volumetric analysis by conventional materials. Finding of the results confirm that learners perceived doing practicals with improvised materials feel well and all learners participate in material manipulations at least by designing materials to make laboratory environment conducive. Thus, it increases the confidence, creativity, interest and curiosity in the chemistry subject like learners conduct experiment with conventional materials. In line to this, literatures agreed that it is possible to teach learners about practicals in chemistry in general even in the absence of conventional facilities in the laboratory, through improvisation from resources in the school environment (Abdullah, Mohamed & Ismail, 2007).This alternative approach can be used only when the occurrence of financial constraints and shortage of appropriate materials in the laboratory.

Category 5(fa5) contains three items with similar ideas or opinions those described about learners' opinion on improvisation status quo of laboratory equipment. From posttest intervention, SQCL-questionnaire, as shown in Table 4.35 t (198) =1.107,P=.269, P > 0.05 is non-significant. This result indicates both comparative groups have the same assumption regarding improvisation means that even learners who were taught practical lessons in volumetric analysis using conventional materials positively perceive about improvisation and its' necessity for doing experiments stipulated in volumetric analysis due financial constraints exist. From this, it inferred that learners those who were taught about volumetric analysis using improvised material are found in a positive perception and it signified learners became confident to do practical lessons, relax their mind since it increases the degree of creativity compared with learners that were taught with conventional materials. In line with finding, the literature advocates the importance of facilities either improvised or conventional materials (Abakpa, Achor & Odoh, 2016; State, Ataha & Ogumogu, 2013) is that practice of experimentation and laboratory activities are urgently needed to stop the dichotomy between practice and theory. Thus, scientific attitude can be developed among science learners who participated in scientific discussions and by designing of interesting experiments in a noble manner.

Linearly combined mean values of all items of SQCL- questionnaire used to test the fourth hypotheses (faTn). After linear combination of all items, as shown in Table 4.35, t(198)=2.891, P=.004, P < 0.05 is significant. Further, for Turkey's post hoc analysis for actual practical chemistry teaching model schools (M=3.33, SD=0.45) Versus alternative practical chemistry teaching model schools (M=3.51, SD= 0.42). Finding reveals that there was a significant difference in perception for linearly combined all items (faTn) between learners who were taught practical lessons by using an actual practical chemistry teaching model schools and practical lessons that were taught using improvised materials as an alternative approach. Thus, the hypothesis set was rejected. This result inferred that when learners are doing experiments in the laboratory giving attention to improvised materials their intention focused on the advantage of improvised materials .Thus, the greater with mean value of learners' perception in (faTn) describes the possibility of doing experiments by improvisations due to the occurrence of financial constraints to afford conventional materials or other factors. In line to this finding there are several literatures declare the possibility of teaching experiments in the absence of conventional materials, their ideas are similar with this finding is that improvisation can be replaced in a place of conventional materials due to financial constraints to afford standard materials in the laboratory(Tesfaye, 2010;Temechegn, 2012; Okafor, 2001). Others also overemphasized the fate of improvisation with greater advantages in providing extended skills such as planning and designing (Hunter et al., 2000). In contrary to this findings, literatures disagree in its' efficacy regarding to accuracy and precession rather it can be effective when the materials improvised carefully to avoid its' inefficacy (Thomas & Israel; 2012). Thus, learners ought to think about the procedure how materials improvised, when and who improvised that they bear in mind to predict accuracy and precession of the improvised materials.

5.3.5a Research Question 5

Would there be any significant difference in teachers' perception in the laboratory facilities and its' practical activities among the three intervention groups (Actual practical chemistry teaching model, alternative practical chemistry teaching model and traditional method of teaching)?

5.3.5b Research Hypothesis 5

There is a significant difference in teachers' perception regarding laboratory facilities and its' activities in the score of TQ-questionnaire among the three intervened groups (Actual practical, alternative practical and traditional method)

The data was collected after the research protocol was completed. In the end, after a linear combination of the items in TQ1 with the results obtained shown as in Table 4.37 and Table 4.38 in chapter four, $F(2, 62) = 1.70$, $P = 0.191$, $P > 0.05$ was non- significant. The finding indicate teachers' perception about the fate of laboratory practical lessons in acquiring science process skills in chemistry teaching is non-significant different. This result inferred that all groups' teachers have almost similar perception on the advantage of laboratory activities in providing science process skills. Teachers who found in schools of control group taught using traditional method perceived learners must be taught using facilities either conventional or improvised materials to acquire science process skills in the laboratory easily understands concepts in volumetric analysis. In line with inferences, the literature agreed and consistent to the findings (Ince, 2016; Herrington & Nakhleh, 2003; Kola, 2017) is that teachers perceived learners acquire appropriate skills when learners use different resources in the laboratory. Furthermore, learners have opportunities to examine their hypothesis through group discussions.

Category two in TQ- questionnaire contains four items that entailed similar ideas, which give us information concerning the teacher's perception in improvisation. After a linear combination of all items within TQ2 in category one, as it has sown in Table 4.37, 4.38 and Table 4.39 in chapter four, $MD = 13.08$, $F(2, 62) = 24.78$, $P = 0.000$, $P < 0.05$ is significant among all groups. Further Tukey's post hoc analysis between local and traditional $MD = -0.286$, STD error $= 0.224$, $P = 0.42$, $P > 0.05$ is non- significant. The result inferred that teachers' perception indicate that improvisation is mandatory for teaching practical lessons in the absence of conventional materials due to the occurrence of financial constraints or other factors. Both used to acquire science process skills. It implied that teachers who taught practical lessons in the absence of facilities also perceived about the necessity of appropriate materials for practical lessons in the laboratory. Even though, teachers from schools that are not equipped with facilities they strongly suggested facilities for practical activities. In line with this the literature consistent (Andinet, Seid Endris, Worku, Negasi, Abu-Bakr & Solomon, 2018) is that absence of facilities in the laboratory negatively affect the effective implementation of chemistry's practicals and further it forced learners to achieve low academic achievements.

From the Post hoc analysis teachers' perception between improvised material and conventional material with MD=1.16, STD error =0.22, P=0.000, $P < 0.05$ is significant. Since teachers' perception is significant result, post hoc analysis visualized the differences with mean and standard deviations values, for conventional (M=2.82, SD=0.736) and improvised material (M=3.988, SD=0.675). This result inferred that teachers' perceptions in teaching learners about practical lessons in volumetric analysis using improvised material is important for skill development as conventional material but it is spontaneous can easily be obtained from environment resources otherwise both used in acquiring science process skills. Improvised materials can be used in a place of conventional materials in the circumstances of either shortage or absence of standard materials due to financial constraints or other factors. In line with this, the literatures advocate (Orla, 2005) is that in the absence of laboratory facilities developing and implementing resources nature allowed in the environment for teaching, and learning chemistry can serve as an alternative approach for practical chemistry teaching. In contrary to this, teachers negatively perceived about improvisation (Achimugu, 2019) are that the inability of the majority of teachers to improvise instructional materials implies the benefits of improvisation to chemistry education are not being achieved. It further concludes serious attention could be given to improvisation of instructional materials.

For actual and Traditional MD = -1.45, STD error =0.22, P=0.000, $P < 0.05$ is significant. Further from Tukey's post hoc actual (M=2.83, SD=0.736) and Traditional (M=4.274, SD=0.675). This result inferred that teachers' perceptions regarding practical lessons taught using traditional method is higher in score over conventional materials. It implied that practicals in chemistry must be done using appropriate facilities that might be either conventional or improvised. In the absence of conventional teachers' perceived they necessarily used improvisations for practical lessons in chemistry. In line with this result, literature consistent (Yildirin, 2016) is that in order to learn by doing and living in science courses, laboratory method which is proved as one of the most effective methods of science instructions should be effectively used.

TQ3 contains three items under the category of TQ-questionnaire that are having similar ideas, which signifies about the advantages of teaching chemistry practicals. After the data was collected, all items were linearly combined within TQ3 category. In the end, after subsequent evaluations, the results obtained as shown in Table 4.37, 4.38 and 4.39 in chapter four indicate that there is a non-significant difference. This result inferred that teachers positively perceived on the fate of teaching chemistry practicals is unquestionable since it supports the theoretical aspects of the lesson to be taught. Learners easily understand the chemistry concepts using laboratory-teaching methods. It is in agreement with the idea (Ural, 2016) that importance of laboratory practice is unquestionable in chemistry education. Thus, it is the reason for why the teachers in all groups perceived almost in a similar fashion for the items that described about the advantages of practical lessons in a chemistry subject.

The aim of category four(TQ4), which contains only one item was used in evaluating teachers' perceptions in practical activities and facilities in the laboratory that they acquire from both using conventional and improvised materials in a chemistry subject. The finding as shown in Tables 4.37, 4.38 and 4.39 in chapter four $F (2, 62) = 6.36$, $P = 0.003$, $P < 0.05$ is significant in teachers' perceptions among the three groups. From Tukey's post hoc analysis the result obtained regarding teachers' perception in schools where learners were taught about practical lessons in volumetric analysis using improvised materials as an alternative approach was significantly different from teachers' perception that was taught with the traditional methods having the MD = -1, std error= 0.310, $P = 0.008$, $P < 0.05$ is significant. The differences in teachers' perception visualized using mean and standard deviations for improvised materials (M=3.476, SD =1.25) and Traditional method (M=4.476, SD=0.68). Teachers' perception on teaching learners about practical lessons in volumetric analysis using actual practical model (with conventional materials) was also significantly different from teaching with traditional methods having MD=1.085 STD error=0.304, $p = 0.003$, $p < 0.05$ is significant. The differences in teachers' perception also visualized using the mean and standard values, with conventional (M=3.39, SD=1.27) and traditional (M=4.476, SD= 1.25). In both cases, teachers' perception in traditional method is higher. This implied that teachers perceived both methods are equitably important in acquiring practical Knowledge. This result inferred that teachers in traditional schools strongly support the presence of facilities in the laboratory either conventional or improvised. Furthermore, teachers perceived learners achieve a good result after they manipulate and internalize the concept based on the facilities that they manipulate and it is easy to remember what was observed in the laboratory. Thus, learners can easily acquire skills from material manipulations. In line with this result, the literature consistent (Reid et al., 2014; Uzezi et al., 2017; Andinet et al., 2018; Isaac, Idowu & Joseph, 2014) is that laboratory work must be supported by facilities in the laboratory should achieve mastery of subject matter, developing scientific reasoning, developing practical skills and enhances quality education. Furthermore, it helps in cultivating interest in chemistry.

However, teachers' perceptions on teaching practical lessons in volumetric analysis with actual practical chemistry teaching model (with conventional materials) was non-significant in difference that compared teaching the same content with alternative practical chemistry teaching model (using locally available materials) having MD=,-0.085, STD error=0.380, P = 0.973, P > 0.05 is non-significant. From this perspective, based on the result obtained from post hoc comparison (Table 4.38) statistically signified that teachers' perceptions in both groups are equitable. This implied that teachers in both groups perceived that teaching practical lessons using either conventional or improvised used in acquiring appropriate practical knowledge is the same. This inferred that teaching chemistry in general with improvised materials equitably benefited learners as teaching using conventional materials to understand concepts in chemistry practicals. Both methods are used in acquiring science process skills due to material manipulations in the laboratory.Teachers also perceived improvisation could have a potential to be replaced in the place of conventional materials to make unambiguous the teaching and learning process in practical lessons of volumetric analysis. The literature in line with the result of the study consistent that (Ngala, 2019; Duban et al., 2019; Nachmanovitch, 2006) reveal understanding of concepts can be achieved doing practical activities of lessons using facilities in the laboratory either conventional or improvised for those experiments stipulated in chemistry.

Linearly combined mean values of all items in TQ-questionnaire (TQT) used to test the fifth Hypothesis (HO_5). All items were combined linearly, and the ANOVA was run together with other categories. Based on the result in Table 4.37 with ANOVA value, $F(2,62) = 10.653$, $P = .000$, $P < 0.05$ is significant. This result implied that the teachers' perception in laboratory activities of chemistry subject teaching was significantly different among each group and between within the two groups except the non significant difference observed after Tukey's post hoc analysis between traditional and local groups. After post hoc Tukey's multiple comparisons teachers' perceptions about practical chemistry lessons taught using improvised materials and traditional method MD $= -0.22$, STD error $= 0.1603$, $P = 0.31$, $P > 0.05$ was non-significant. The non-significant result of teachers' perceptions inferred that teachers in a control group also needs to teach learners to make chemistry concepts clear as such learners who were taught practical lessons in volumetric analysis using improvised materials. Thus, teachers' perceptions are equal for both groups indicate the importance of facilities either conventional or improvised for practical lessons in chemistry. In line with this finding, the literature consistent (Tafa, 2012; Andinet et al., 2018; National academy of science(NAS), 2011) is that learners who are not in favor of laboratory activities less experienced with practicals, out of curiosity, refused to do practical lessons in risky behaviour in the laboratory. Other literatures also recommended the fate of improvisation over traditional method of teaching (Nachmanovitch, 2006; Shitaw et al., 2017; Emendu,2010) is that improvised materials can be used in a place of conventional materials when financial constraints existed and other factors occur negatively affect to use them.

The advantage of using traditional method of teaching pronounced only if the teacher is ready with either of the following conditions like interest, motivated to teach the subject matter, preparing with content knowledge well, increasing learners-teacher interaction, using diagrammatic representations during instruction and the like account as a factors to be considered in traditional method of teaching approach(Uduafemhe, 2015). Further teachers potential in reading different related materials to impart the intended knowledge for the learners (Souza & Porto, 2012). However, the traditional method lacks material manipulation to equip learners with hands on activities.

The findings after Tukey's HSD test regarding teachers' perceptions for linearly combined all items between learners who were taught about practical lessons in volumetric analysis using improvised materials versus conventional materials MD =.45, STD error .15, P =.011, $P < 0.05$ is significant. Further, the mean and standard deviation values for significant results indicates the differences in teachers' perception that existed between practicals was taught using improvised materials is that (M=4.16,SD=0.54) and conventional materials (Mean=3.72,SD=0.44). From the greater mean and standard deviation values of scores of teachers' perception of improvised materials over conventional materials indicate the variations in teachers' perception exist between the two groups. This inferred that teachers who taught using improvised materials are positively motivated being they used materials that nature allowed in their environment. Thus, it motivates teachers to use improvisations rather than other method in the absence of conventional materials. In line with the finding, literature agreed and consistent that sensitizes teachers to find the alternatives for the lack of some of conventional science teaching materials, generates interest and motivation for indigenous technology (Ahmad, 2008). In contrary to findings, the literature disagree with teachers' perception (Achimugu, 2019) is that the inability of the majority of teachers to improvise instructional materials implies that the benefits of improvisation for chemistry education is not being achieved. Thus, for successful implementation of the objective of chemistry, serious attention should be given for improvisation.

The finding after post hoc Tukey's test about teachers perceptions between they taught learners regarding practical chemistry lessons using conventional versus Traditional method within the three interventions MD =-0.67,STD error =.141, P =0, $P < 0.05$, is also significant. Further, the mean and standard deviation values for significant results indicate the differences in teachers' perception that existed between practicals that were taught using traditional method of teaching (M=4.38; SD=0.50) Versus conventional (Mean

=3.72;SD =0.44). Findings from the analyses inferred that being all variables in TQ-questionnaire focused on science process skills, fate of improvisation, practical knowledge learners acquire and the comparisons between improvised and conventional materials to be compared the teachers' perceptions of groups within the three interventions. This implied that teachers' perceptions are positive and they strongly suggested the advantage of facilities for teaching practical lesson in volumetric analysis. In line with this result, the literature agreed with the condition that there were several studies provoked about the advantages of facilities in the laboratory over traditional method of teaching practical lessons in chemistry (Reid & Shah, 2014; Reck, Sreenivas & Louis, 2019; Yildirin, 2016) is that teachers perceived learners understanding of laboratory concepts differ based on the type of equipment used during instruction. Omiko (2015) also reported and supported teachers perceptions that learners were taught only with theoretical approach lack scientific attitude, problem solving skill, scientific in query skills, acquisition of scientific skills, scientific research environment, learn chemistry poorly and perform poorly in practical chemistry internal and external examination.

CHAPTER SIX

6. Summary, Conclusions and Recommendations

6.1 Introduction

The summaries of the major findings of the study have been presented in this chapter. Based on the suggestions forwarded through summary, implications to the research findings, recommendations, and conclusions have been made and provided for this material's end-users. This chapter describes the whole research work's main idea of by giving suggestions for future research in different teaching and learning strategies of chemistry in particular and other science-related fields in general. Finally, the expected bodies in education will measure the findings by solving already identified problems.

6.2 Summary of the study

This study was used to evaluate and compare learners' achievement score, and their perceptions as well as teachers' perceptions concerning the use of laboratory facilities in chemistry lessons in general and its' practical lesson in particular. It compared the effectiveness of an actual practical chemistry-teaching model, which was taught by conventional materials with an alternative practical chemistry-teaching model. Three different interventions were held to process the research during the instructional period such as the actual practical chemistry teaching model, alternative practical chemistry teaching models as well as a traditional teaching method as a control group used as independent variables. Learners' achievement result was used as a dependant variable, which is generated through the blueprint of quasi-experimental non-equivalent groups design using experimental groups and control group. The population used in the study was preparatory schools (Grade-12) in a Sidama Zone, Snnprs, Ethiopia. From the population of the whole government preparatory schools, six schools were selected for this research based on the purposive sampling technique, which was rooted based on the absence and presence of laboratory facilities. Moreover, in the end, they categorized into each experimental groups and the control group. The intact classes were used in this study in all groups after some activities were done about research processes before the intervention was started through discussion with all principals in all schools to allocate learners without considering the differences in age, sex, abilities and some other parameters. However, the total number of learners in each school was fifty (50), which was assured by a discussion with each school administrative bodies (directors) for the current research purposes.

In this research, five research questions were proposed to be answered based on the result's analysis of fieldwork data. For each research question, the respective hypothesis was set and tested in the study by using a 0.05 significant level. Three types of research instruments were used in the study to gather the data of the research work. namely, achievement test questions; SQCL-questionnaire that was administered to the learners to gather their perceptions toward laboratory facilities in chemistry and/ or resources in the environment that nature allowed, to be used in the laboratory, and TQ-questionnaire that was administered to teachers to gather information regarding perceptions of practical lessons in chemistry. All questionnaires were used to find information concerning materials in the laboratory, their management styles, and learners' achievements, specifically practical lessons in volumetric analysis. Some skills that learners let practised from laboratory activities that were taught by the teachers. Inter rater reliability of achievement test questions was evaluated, and its Cronbach's alpha value obtained was 0.759. SQCL-questionnaire was administered to the learners in a pilot study to evaluate the inter-rater reliability in a school that was not included in the experimental group's schools. Furthermore, the same questionnaire in content and type was administered to the participants before and after treatment conditions used to compute and find out inter rater reliability. Accordingly, the Cronbach's alpha value of the SQCL-questionnaire of the pilot study in category 1, category 2, category 3, category 4 and category 5 were 0.891, 0.722, 0.719, 0.748 and 0.745 respectively. The reliability index of SQCL-questionnaire is 0.698. The TQ-questionnaire's inter-rater reliability administered to teachers in school that was not part of the experimental schools in the research was 0.814, 0.761 and 0.727 respectively in three categories. However; the fourth category's inter-rater reliability, category 4(TQ4), was not evaluated. The index of reliability was 0.769. Thus, based on the inter-rater reliability result all types of instruments were reliable for this study. The whole study took about two months and one week, a total of ten weeks. A pilot study took around two weeks and the main study was accomplished in eight weeks, including the pretest and posttest examination period of the study. Furthermore, only the posttest scores were used to compare learners' achievement result in all groups. The results of pretest were used to identify the effect of learner's previous knowledge and some other factors before intervention. SQCL-questionnaire was used to compare the discrepancies of perceptions regarding practical lessons in volumetric analysis between learners who participated in actual and alternative practical chemistry teaching models schools in the study. In the end, the TQ-questionnaire was used to evaluate teachers' perception in all groups. It was administered to all groups' chemistry teachers only once at the end of the intervention.

Finally, the data were analyzed using both descriptive and inferential statistical tools. Mean, independent samples t-test, and analysis of variance (ANOVA) including further turkeys' post hoc test were used as examples of statistical tools, those mentioned among others. Results in Table 4.24 showed that there were statistically non-significant differences in the mean post-test achievement scores on the (t (198) = -1.348, p=0.179, p>0.05). However, there was a significant difference observed after linearly combined all items mean post-treatment scores on SQCL-questionnaire (t(198) =2.891, P=0.004, p<0.05) between learners those participated in both experimental groups such as actual practical chemistry teaching model and practical lessons in volumetric analysis, those were taught using improvised materials. This result revealed that a non-significant difference result observed statistically between the two instructional treatment conditions. After linear combinations of the items of TQ-questionnaire $F(2,62)$ =10.653, P =.000, P < 0.05 is significant in difference of teachers' perception among all groups except the non-significant difference observed after Tukey's post hoc between the teachers' perceptions in control group who taught practical lessons using traditional method and teachers' perception who taught practicals in alternative practical chemistry teaching model schools.

6.3 Implication of the research findings

As it is deduced from the achievement test results, learners obtained the result in alternative practical chemistry teaching model schools is almost similar to the result that was obtained by the learners in actual practical chemistry teaching model schools. Practical lessons, those were found in the volumetric analysis were taught by improvised materials that let learner think of a positive attitude regarding interest, curiosity and feeling to facilitate learning by halting the negative belief and attitude of the potential inhibitors (Zudonu et al., 2018). This strategy allowed learners to make decisions regarding planning and designing of materials for practical purpose in their own skills. It helped learners to develop their own skills that enclosed in the high order skills such as designing, problem solving and research planning. It also increases the motivations among learner. As a result in, learners are actively participated in experimental works starting from the designing stage of materials and even in the designing of low-cost experiments. Improvisation encouraged self-learning between and among learners. It creates a room for self-initiated discussions during instruction held in the class. However, indeed the scope of practical activities is beyond the classroom teaching and learning process. It also maximizes creativity, curiosity and scientific mindset up for further research works in chemistry. The use of improvisations during instruction agitated learners and it further encouraged teamwork, discussions and interpersonal relationships between and among learners. It further increases chemistry achievements reducing misconceptions that might be developed by the learners in the early stages (Centigul et al., 2011).Thus,learners adjust themselves with new concept by avoiding the previous unwanted concepts developed in the early stage.

6.4 Research limitations

The study was limited by some constraints. The first limitation was assistant teachers; those were trained by the researcher for this research purpose only and further held instruction during the intervention period in all groups. Since there is an individual difference in the assistant teacher's knowledge and other factors too, the results of the findings might be affected at the end due to the discrepancies in the research process. The second limitation was the frequent change of advisors more than three times at a time, which discourages the researcher, indeed the third advisor overlooks all the whole work starting from the proposal stage as beginners. The third limitation was all schools are too far apart from the researcher residential areas, which need finance potential in controlling and follow up process of the whole research work. Furthermore, the others listed below also may affect the result of the findings,

- Shortage of internet accesses i.e. its absence sometimes or at all.
- No budget allocated for the current research even for editors. I used my own salary for any cost of the research.
- The distance of research area that are 40 - 80km far away from the researchers residential areas affect in controlling the research work as intended.

6.5 Conclusions

This section presents the concluding remark of the study. It has found that there are several underlying issues in touching with activities in chemistry laboratories that contribute to learners and teachers positive attitudes towards chemistry subject and its' practical activities. According to the findings of the study, learners are generally positive in perception about doing practical activities, and they need in doing practical experiments to support the theoretical aspect of the lessons even though the schools were found in lacking appropriate materials that deserves for particular experiments in chemistry in general. Because of that in the absence of supportive materials in the laboratory for practical lessons in volumetric analysis in chemistry, the dedicated teachers and other concerned bodies in education ought to find the appropriate alternatives and replaced as a substitute of conventional materials that existed due to their lack as supportive materials. Since the instructional process of practical lessons in volumetric analysis must need appropriate materials that exactly fit in acquiring science process skills for experiments stipulated to be done in particular session, improvisations are mandatory and can have the same effect in providing the appropriate skills. Using improvised materials at any time with low cost guarantee the continuity of experimental activities to go ahead during teaching and learning process. From the results of the findings, teaching practical lessons in volumetric analysis by using improvised materials is almost the same in effects on achievements with teaching the practical lessons of the same contents by using conventional materials. It is in line with the findings of the research, those were done in education about the effectiveness of improvisations for instructional process indicating that improvised materials have almost similar effect with conventional materials to be used in the laboratory except precession problems,which can be avoided by the concentration of macro-scale level (Ochonogor, 2000; Baeza et al., 2005).Thus, due to this similar effect in achievements, teachers ought to use improvised materials when the scaricity of facilities may happen in the laboratory.

Based on the findings of the study, teaching chemistry subject in general using the traditional method is also an important teaching strategy only when teachers effectively employed the method in instructional process, i.e. teachers have to be well prepared with contents before instruction started and develop interest to teach their learners in motivation. Furthermore , teachers have to use some demonstrations and other modeling activities concerning the laboratory issues even if learners do not be engaged in acquiring science process skills like hands-on activities.

In addition to all appropriate methods, it is also important to note that learners must require information about the learning materials from different sources such as internet, library etc.... Teachers can also use different mixed types of instructional methods to bring a better understanding of concepts what learners are being taught about the lessons in chemistry in general. Thus, learners easily recap information by using at least one method of the mixed types of teaching strategies.

Finally, the teachers must sensitize themselves and use improvisations techniques to motivate learners and assure hands on activities, because of lack of conventional materials when the government fails to avail equipment and chemicals that may be happen by financial constraints and/or other factors (Olufunke, 2012; Aguisiobo, 1998). Thus, to ensure the quality education in all schools, which may be deteriorated due to absence of conventional materials for experiments stipulated in chemistry and volumetric analysis in particular, teachers have to find a suitable alternative approach at least they have to improvise appropriate materials from the environment resources or construct low-cost materials from the materials that have been already utilized in other missions, but after modification can be used for chemistry teaching and learning process (Hamisis, 2011;Yitbarek, 2012; Okafor, 2001).This further ensures the potential of improvised materials to be replaced in a place of conventional materials and gauranteed in acquiring the appropriate science process skills during practical activitites in the laboratory. If this happened, the failing of learners' performance could be reduced and further it increases good score in achievements in chemistry subject in particular and other sciences in general by reducing learners' misconceptions developed before the instruction held in the classroom.

6.6 Recommendations

Based on the literature reviewed, discussions of the results obtained from the fieldwork and conclusions of the research, the following suggestions and recommendations of the final output were forwarded to these materials' end-users. It gives important information concerning how to improvise instructional materials from locally available environment resources to use as an alternative approach in secondary schools in teaching chemistry subject. It is mandatory to improvise and more or less reconstruct low-cost materials in the absence of existing conventional materials in a rural area and newly launched schools. Accordingly, the following recommendations forwarded to the end-users of this material.

1. The teachers should use diverse or mixed-type instructional materials relevant to the lesson's content to be taught by them.

2. The teachers and other concerned officials are highly creative with innovative minds who educate citizens, particularly in developing countries.

3. Teachers must be resourceful and competent in providing the teaching materials after appropriate selection and planning to undertake the process of teaching effectively. It is used to reduce the cost of production and maintenance of instructional material.

4. The concerned bodies in the field of education struggle the shortage of facilities and must enhance the need to updates of teachers' knowledge with materials for teaching chemistry subject at the whole and volumetric analysis in particular and acquaint them with innovations.

5. This could be possible when the government regularly organizes training, seminars, and workshops for chemistry teachers or learners to equip them with modernizer mind set up to halt the existing problems at hand that obstacle the chemistry teaching in particular.

6. The government must organize as the head, the production and distribution of improvised materials based on the experiments stipulated in the national curriculum and follow up all the activities in material production to control the infrastructures' usage and their maintenance appropriately.

7. All responsible persons in education field including policymakers in secondary schools should raise fund to procure materials for improvisation of laboratory materials and chemicals in the absence of local natural resources in the environment that facilitate the effective teachings in chemistry.

8. There is the need to empower the chemistry teachers through in service training on the skills and techniques of improvisations.

9. Principals of the schools should ensure the chemistry teachers are adequately monitored on the use of improvised instructional materials for chemistry instructions.

10. There is a call for to repeat an experiment to explore comparative effectiveness of actual practical chemistry teaching model with that of practicals that were taught through improvised materials as an alternative approach in chemistry teaching as a model in other developing countries in Africa and outside Africa. It will be effective by raising enough funds for the project intended to implement in schools that are newly emerged and /or school with no laboratory equipment.

11. More research will be done on the issues of learners' academic achievements and factors that affect their achievements based on different contexts

References

Aadland, H., Espeland, M., & Arnesen, T. E. (2017).Towards a typology of improvisation as a professional teaching skill: Implications for pre-service teacher education programs, Cogent Education, 4(1). https://doi.org/10.1080/2331186X.2017.1295835

Abakpa, V. O., Achor, E. E., & Odoh, C. O. (2016). Effect of Laboratory Strategy on Senior Secondary Students' Achievement in Biology, ICSHER Journal *2*(2), 68–75.

Abdullah, M., Mohamed, N., & Ismail, Z. H. Z. (2007). The effect of micro scale chemistry experimentation on students' attitude and motivation towards chemistry practical work. *Journal of Science and Mathematics Education In S.E. Asia*, *30*(2), 44–72.

Abdulwahed. D & Nagy.Z.K. (2009) Applying Kolb's experiential learning cycle for laboratory education. Journal of Engineering Education. V99(3),284-289

Abrahams, I., & Reiss, M. J. (2012). Practical work: Its effectiveness in primary and secondary schools in England. *Journal of Research in Science Teaching*, *49*(8), 1035–1055. https://doi.org/10.1002/tea.21036.

Abrahams, I. & Millar, R. (2008) Does Practical Work Really Work? A study of the effectiveness of practical work as a teaching and learning method in school science. International Journal of Science Education, V30 (14).

Abungu, H. E., Okere, M. I. O., & Wachanga, S. W. (2014). The Effect of Science Process Skills Teaching Approach on Secondary School Students' Achievement in Chemistry in Nyando District, Kenya. *Journal of Educational and Social Research*, *4*(6), 359–372. https://doi.org/10.5901/jesr.2014.v4n6p359

Achimugu, L.(2019) Teachers' attitudes toward Improvisation of Instructional materials for Teaching and Learning chemistry. Journal of Science, Technology, Mathematics and Education (JOSMED), 15(3).

Achimugu, L. (2012.). Strategies for Effective Conduct of Practical Chemistry Works in Senior Secondary Schools in Nigeria, 1–9.

Ackerman ES (2005), Volumetric analysis of Martian Rampart crater, Lunar and Planetary science.

Achor, E. E., & Duguryil, A. P. (2015). What Effects Do Cognitive Reasoning Ability and Prior Exposure to Content have on Upper Basic Two Students ' Retention in Basic Science ?, *7*(6), 466–479. https://doi.org/10.9734/JSRR/2015/18260

Achor, E. E., Kurumeh, S. M., & Orokpo, C. A. (2012). Gender Dimension in Predictors of Students ' Performance in MOCK-SSCE Practical and Theory Chemistry

Examinations in Some Secondary Schools in Nigeria, *2*(2), 16–22. https://doi.org/10.5923/j.edu.20120202.04

Achor, E. E., & Taangahar, B. A.(2011) Relative Efficacy of the Use of Improvised and Manufactured Analogue Voltmeters in the Teaching of Voltage Measurements in Secondary School Physics, African Journal of Science, Technology & Mathematics Education (AJSTME), 1(1), 87-95, ISSN: 2251 0141 *1*(1), 87–94.

Achor, E. E., & Wude, M. H. (2014). Looking for a More Facilitative Cooperative Learning Strategy for Biology : Students ' Team Achievement Division or Jigsaw ?, *4*(12), 1664–1675.

Adane, L. & Admas, A., 2011, Relevance and safety of Chemistry laboratory experiments from students' perspective: a case study at Jimma University, southwestern Ethiopia. Educational Research, 2(12), 1749-1758

Adebayo, A. M. (2018). Entrepreneurship Education in Public Universities in Ekiti State, Nigeria. *International Journal of Education and Literacy Studies*, *6*(4), 58. https://doi.org/10.7575/aiac.ijels.v.6n.4

Adega, P (2011). The neglect of Traditional education in Nigeria and National calamity.The Tiv perspective, Department of religion and Philosophy, Benue state University, Makurdi –Nigeria

Aguisiobo, B.C. (1998), Laboratory and Resources utilization, funding and management by integrated science teachers. African journal of education, 1 (1),p 68-76

Ahmed, A & Zarif, T (2013), Table of specification development and usage: an overview. Interdisciplinary journal of contemporary research in business, V4 (12).

Ahmed, A. M. (2008). Improvisation of Instructional Materials for the Teaching of Biology / an Important. *Pristine Journal*, 1–7.

Ahmed, B. T. (2014). A Cultural Historical Activity Theory framework for understanding challenges experienced by Student-teachers of science at secondary level of education in Bangladesh Constructivist teaching approach, *14*(2), 2–12.

Akpan, B. B. (2010). Innovations in Science and Technology Education through Science Teacher Associations, Journal of Science education International *21*(2), 67–79.

Akpegi, B. (n.d.). Improvisation and effective utilization of instructional materials in science education by student teachers by, 1–11.

Aksela, M. (2009.). Nature of Chemistry in the National Frame Curricula for Upper Secondary Education in Nordic studies in science educations *5*(2), 200–212.

Alam, G. M., Oke, O. K., & Orimogunje, T. (2010). Volumetric analysis and chemistry students performance: Combined influence of study habit, physiological and psychological factors. Journal of scientific research and Essay V5(11).

Aledejana, F., & Aderibigbe, E. O. (2007). Science laboratory environment and academic performance. *Journal of Science Education and Technology*, *16*(6), 500–506. https://doi.org/10.1007/s10956-007-9072-4, psychological factors. Journal of *Scientific Research and Essays*, *5*(11), 1325–1332.

Ali, A. & Ochonogor, E.C.(2000), Alternative education in science and technology; adopting alternative to practicals in WAEC'S school chemistry examinations. ISBN 978-636-4.

Alpaydin, S. (2017). Determining the Level of Understanding and Misconceptions of Science Teacher Candidates about the Concepts Related to Material and Its Properties, journal of education and practice, *8*(30), 25–31.

Amosa, I. G, Ifeoma, V.E, & Chogozie, R. A (2014), Federal University of Technology, Comparative Effects of Two Modes of Computer-Assisted Instructional Package on Solid Geometry Achievement, Contemporary educational technology,5(2),p110-120 .Nigeria.

Ankibobola, A.O & Afolabi, F (2010), Analysis of science process skills in west Africa Senior Secondary School physics practical examination in Nigeria, Bulgarian journal of science and Education policy,4(1)

Andinet, N., Said, M., Endris, Y., Worku, W., Negasi, A., Abu-Bakr, S.,& Solomon, M. (2018). Commenting on effective laboratory teaching in selected preparatory schools, North Shewa Zone, Ethiopia. *Educational Research and Reviews*, *13*(14), 543–550. https://doi.org/10.5897/err2015.2286

Asokhia, M. O. (2009). Improvisation/Teaching Aids: Aid to Effective Teaching of English Language. *International Journal of Educational Sciences*, *1*(2), 79–85. https://doi.org/10.31901/24566322.2009/01.02.02

Awan, A. S. (2013). Comparison between Traditional Text-book Method and Constructivist Approach in Teaching the Concept "Solution," journal on research and reflection in education, *7*(1), 41–51.

Aydinili, B., & Avan, Ç. (2015). Chemical Dimensions of Plastic Wastes and Their Recycling in Environmental Education. *Journal of Educational and Social Research*, *5*(1).

Azza A. Abou-Arab, Ferial, M. Abu-Salem & Esmat, A. Abou-Arab (2011), Physico chemical properties of natural pigments (anthocyanins) extracted from Roselle calyces (*Hibiscus subdariffa*), Journal of American Science,7(7).

Babayemi, J.O, Adewuye, G.O.Dauda, K.T & Kayode, A.A.A. (2011) the ancient alkali production technology and the modern improvement: a review. Asian journal of applied sciences, V 4(1).

Badeleh, A., & Sheela, G. (2020). The Effects of Information and Communication Technology Based Approach and Laboratory Training Model of Teaching on Achievement and Retention in Chemistry. Journal of *Contemporary Educational Technology*, *2*(3), 213–237. https://doi.org/10.30935/cedtech/6055

Baeza, A., & Galicia, E. (2005). Total Micro scale Analytical Chemistry: Precision Data in Volumetric Titrations. *3r d International Micro scale Chemistry Symposium*, 5–8.

Bailey, P.D & Garratt, J.(2002)Chemical education theory and practice. Journal of the royal society of chemistry. V6 (2), ISSN 1369-5614 Pages 39-89

Baker, E. McGraw, B & Peterson, P. (2007), International Encyclopedia of Education,3rd edition, curriculum design as subject matter science.

Bank, T. W., & Musar, A. (1993). Equipment for Science Education Constraints and Opportunities. *Social Policy: ESP Discussion Paper Series No. 11*, (October).

Barley, Z. A., & Brigham, N. (2008). Preparing Teachers to Teach in Rural Schools. *Issues & Answers Report, REL*, (45), 1–21. Retrieved from http://ies.ed.gov/ncee/edlabs

Barke, H.D. Hazari, A.& yitbarek. S, S (2009), Misconceptions in chemistry, Springer, Germany.

Başer, M., & Durmus, S. (2010). The effectiveness of computer supported versus real laboratory inquiry learning environments on the understanding of direct current electricity among pre-service elementary school teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, *6*(1), 47–61.

Bentley, ML. Ebert II, ES. & Ebert, C.(2007).Teaching constructivist science,K-8: Nurturing natural investigation in standards- based class room. Crown Press

Bharti, N.K. Ajita, P & Bhavisha N. V (2013) The levels of difficulty and discrimination indices and relationship between them in four-response type multiple choice questions of pharmacology summative tests of Year II M.B.B.S students, IeJSME 7(2): 41-46

Bruck, L. B., & Towns, M. H. (2009). Preparing students to benefit from inquiry-based activities in the chemistry laboratory: Guidelines and suggestions. *Journal of Chemical Education*, *86*(7), 820–822.

Canada,F.C, Airedo-Rodriguez; Antonia, M.D. A; Gonzalez-Gomez,D & Viviana M. N (2017) Change in Elementary School Students' misconceptions on Material Systems after a Theoretical-Practical Instruction. *International Electronic Journal of Elementary Education, 9(3), 499-510*

Centigul, p. I. & Gaban, Ö. (2011). Using conceptual change texts with analogies for misconceptions in acids and bases. H.U. journal of education, V41 p112-123

Chastain, Ben B(2021) Accessed from"Jean-Baptiste-André Dumas". Encyclopedia Britannica, Invalid Date, https://www.britannica.com/biography/Jean-Baptiste-Andre-Dumas.

Chaturvedi, D. & Shrivastava Suhane, R. R. N. (2016). Basketball Benefit of Citrus Limon. *International Research Journal of Pharmacy*, *7*(6), 1–4.

Chemistry, L. (2012), Micro scale and low cost chemistry; African journal of chemical education, AJCE, special issue .*2*(1).

Chemistry textbook, Grade-12, Ministry of Education, Federal republic of Ethiopia

Cohen, L. ; Manion, L. & Morrison, K. (2007) Research methods in education, six edition. Published in the Taylor & Francis Group, simultaneously published in USA and Canada by Rout ledge, ISBN 0203-02905-4Master e-book ISBN.

Cramer, D & Howitt, D (2004), a practical resource for students in the social sciences, The SAGE Dictionary of Students.

Creswell J W. (2004), planning, conducting and evaluating quantitative and qualitative research (4th edition), university of Nebraska- Lincolin.

Creswell, J.W.,& Plano Clark, V.L (2011), Designing and Conducting Mixed methods research Thaos and Oaks, CA: Sage.

Colen, T (2013), the relationship between teacher learner interaction and the laboratory-learning environment during chemistry practicals in Namibia. Submitted PHD. Thesis South Africa(UNISA).

Curtis, V. & Smith, C. (2016), Simulated vs. Hands-on Laboratory position paper. Electronic journal of science education. V 20 (9), university of Memphis, USA.

DomNwachukwu, N. S. & DomNwachukwu, C. S. (2006).The Effectiveness of Substituting Locally Available Materials in Teaching Chemistry in Nigeria: A Case for Science Education in Developing Countries. Journal of *School Science and Mathematics*, *106*(7), 296–305.

Dower, S. (2008), Gravimetric or volumetric material, VCEnet materials.

Duban, N., Aydoğdu, B., & Yüksel, A. (2019). Classroom teachers' opinions on science laboratory practices. *Universal Journal of Educational Research*, *7*(3), 772–780. https://doi.org/10.13189/ujer.2019.070317

Ebel, R.L.(1979), Educational test and measurement evaluations; design and construction, interpretation. Eaglewood chiffs, NJ: prentice-Hall,Inc. online-non downloaded

Emendu, N. B. (2010). The use of local chemicals in teaching acid -base, online *16*(2), 1–6.

Emoyi, P.E. (2006) Students performance in tests of practical and theoretical knowledge in physics as indicators of their performance in WASSCE physics in Iseyin Local Government Area of Oyo State. Unpublished ME.D Dissertation.

Emmanuel. k, Nyia N & Elton,E M. (2017), Redefining education in Africa. "the need for sustainable development through innovative and creative learning'' international journal of trend in scientific research and development (IJTSRD).V1 (6), ISSN no 2456-6470

Ezeasor, M.E.N Opara, M.F Nnjiofor, F.N & Chukwukere, C.G (2012), Assessing teachers' use of improvised instructional materials in science education, international researcher vol.1, 3.

Fatade, A. O., Mogari, D., & Arigbabu, A. A. (2013). Effect of problem -based l earning on senior secondary school students ' achievements in further mathematics, *6*(3).

Fatade, A.O.(2012),Investigating the effectiveness of problem based learning in the further mathematics class rooms, thesis submitted to the university of south Africa.

Feyzioğlu, B. (2009). An investigation of the relationship between science process skills with efficient laboratory use and science achievement in chemistry education. *Journal of Turkish Science Education*, *6*(3), 114–132.

Field, A. (2009), Discovering statistics using SPSS, 3rd edition sage Losangeles + London + New Delhi + Singapore + Washington DC

Furio-Mas, C., Calatayud, M. L., Gusasola, J., & Furió-Gómez, C. (2005). How are the concepts and theories of acid-base reactions presented? Chemistry in textbooks and as presented by teachers. *International Journal of Science Education*, *27*(11), 1337–1358.

Gabriel, I. A., Osuafor, A. M., Cornelius, N. A., Obinna, P. P., & Francis, E. (2018). Improving Students ' Achievement in Chemistry through Cooperative Learning and Individualized Instruction, *26*(2), 1–11. https://doi.org/10.9734/JESBS/2018/42873

Garratt, J. (2002), Laboratory work provides only one of many skills needed by the experimental scientist, University chemistry Education.

George E.p. Box, Hunter, William j. Hunter (2005).Statics for experimenters, Design, innovation and discovery. Second edition. Published by John Wiley and Sons, Inc., New Jersey.

Geoffrey, M, David, De, and David, F(2005), Essentials of Research designs and methodology. John Wiley & Sons, Inc.

Getachew Sutuma E (Editor),& Yitbarek, S (Module development expert)(2013), Ministry of Education Ethiopia,Addiss Ababa, Chemistry subject area method II.Techinical advisor: PRIN international consultancy and research service plc.

Gladys, U. (2014). The Effect of Individual and Collaborative Concept Mapping Learning strategies on Chemistry Students' Anxiety and Academic Achievement, *2*(3), 19–28.

Gultepe, N. (2016). Reflections on High School Students' Graphing Skills and Their Conceptual Understanding of Drawing Chemistry Graphs, 53–81. https://doi.org/10.12738/estp.2016.1.2837

Gupta, S.(2016) Use of low cost-no cost teaching material by elementary school teachers in pedagogy of science: an evaluative study. Faculty of education, lovely professional university, phagwara, Punjab (India), 2949–2961.

Guzzetti, B. J. (2000). Learning counter intuitive science concepts: What have we learned from over a decade of research? Reading, Writing, Quarterly, 16, 89–95

Hamisi, O.D (2011).Permanent secretary, Ordinary level secondary education chemistry practicals using locally available materials. Ministry of Education and vocational training, Tanzania.

Hains-Wesson, R., Pollard, V. & Campbell, A. (2017). A three-stage process of improvisation for teamwork: Action research. *Issues in Educational Research*, *27*(1), 82–98.

Herga, N. R., & Dinevski, D. (2012). Virtual Laboratory in Chemistry - Experimental Study of Understanding, Reproduction and Application of Acquired Knowledge of Subject's Chemical Content. *Organizacija*, *45*(3), 108–116. https://doi.org/10.2478/v10051-012-0011-7

Herrington, D. G., & Nakhleh, M. B. (2003). What Defines Effective Chemistry Laboratory Instruction? Teaching Assistant and Student Perspectives. *Journal of Chemical Education*, *80*(10), 1197–1205. https://doi.org/10.1021/ed080p1197

Hofstien, A. V. I., & Lunetta, V. N. (2003). The Laboratory in Science Education : Foundations for the Twenty-First Century. Journal of Science education.

Hofstien, A. V. I., & Lunetta, V. N. (2004). The Laboratory in Science Education : Foundations for the Twenty-First Century. Journal of Science education. 88: 28-54

Hofstien, A..V .I (2004). The laboratory in chemistry education : Thirty years of experience with developments, implementation, and research laboratory activities have long had a distinctive and central role in the science (1846-1927), *Chemistry education, research and practice*, *5*(3), 247–264.

Hofstien, A.,V.I & Mamlok-Naaman, R. (2007). The laboratory in science education: The state of the art. Journal of *Chemistry Education Research and Practice*, *8*(2), 105–107. https://doi.org/10.1039/B7RP90003A

Horbowicz, M., Grzesiuk, A., Debski, H., & Kosson, R. (2008). Anthocyanins of Fruits and Vegetables-Their Occurrence, Analysis and Role in Human. *Vegetable Crops Research Bulletin*, *68*, 5–22.

Harborne J.B., & Williams C.A. 2001. Anthocyanins and other flavonoid. Nat. Prod. Rep. 18(3), 10-333. doi: 10.1039/b006257j.

Hill, T.& Lewicki. (2007). Statistics Methods and Applications stat soft, Tulsa,Ok

Hunter C., Wardell S. & Wilkins H. (2000), Introducing first-year students to some skills of investigatory laboratory Work, University Chemistry Education.v4,12-15

Ifenkwe, G. E. (2013). Educational development in Nigeria : Challenges and prospects in the 21 st century, journal of education and general studies, *2*(1), 7–14.

Igaro, K., Adjivon, A & Oyelakin. O (2011). Adapting the study of chemistry in senior secondary schools in the Gambia to cost-reducing strategies. School of Education, University of the Gambia, Serekunda, The Gambia, AJCE, 1(2)

Ikenna, I. (2014). 'Remedying Students' Misconceptions in Learning of Chemical Bonding and Spontaneity through Intervention Discussion Learning Model (IDLM)'. World Academy of Science, Engineering and Technology, Open Science Index 94, International Journal of Educational and Pedagogical Sciences, 8(10), 3259 – 3262

.Ince A, E. (2016). An investigation into prospective science teacher' attitudes towards laboratory course and self-efficacy beliefs in laboratory use. *International Journal of* Environmental and Science Education, *11*(10), 3319–3331.

Isaac, A O, Idowu, D.O,& Joseph, O.E (2014)).Impact of laboratory based instructional intervention on the learning outcomes of low performing senior secondary students in physics. Creative education, V5, p 197- 206, Nigeria.

Isaca.O.(2012), Importance of teachers' improvisation ingenuity in teaching basic technology assessment in rivers state. Department of technical education, Ignatius Ajuru University of education, Omoku campus, rivers state, Nigeria.

Iwuzor, C (2000) Enriching Science Education through Improvisation. Science Teachers association of Nigeria 41st Annual Conference Proceedings. P45-48.

Jenkins, J. L., & Shoopman, B. T. (2013). Identifying Misconceptions that Limit Student Understanding of molecular orbital diagrams-American educator, Journal of science education international, *30*(3), 152–157.

Johnstone, A. H. (2006). Chemical education research in Glasgow in perspective. Journal of C*hemistry Education Research and Practice*, *7*(2), 49–63.

Johnstone, A.H & Al-Suali, A (2001).Learning in the laboratory, some thoughts from the literature. Center for science education, university of Glasgow.5(2), 42-91

Jonsyn-ellis,F (2002).Cost-Reducing Strategies and Laboratory Management Techniques for Biology and Chemistry Teachers in the Gambia and Nigeria, (223). Education research network for West and central Africa.

Kakisako, M., Nishikawa, K., Nakano, M., Harada, K. S., Tatsuoka, T., & Koga, N. (2016).Stepwise Inquiry into Hard Water in a High School Chemistry Laboratory. https://doi.org/10.1021/acs.jchemed.6b00217.

Kassahun, C. (2015), Experimental manual for practical analytical chemistry, Chem.2152 Dilla University.

Kayima, F. (2016) Question classification taxonomies as guides to formulate questions use for classrooms. European journal of science and Mathematics Education.V4 (3) p 353-364, Norway

Kelly, O. C. & Finlayson, O. E. (2007). Providing solutions through problem-based learning for the undergraduate 1st year chemistry laboratory. *Chemistry Education Research and Practice*, *8*(3), 347–361. https://doi.org/10.1039/B7RP90009K

Kheyami D, Jaradat A, Al-Shibani T & Ali FA.(2018), Item Analysis of Multiple Choice Questions at the Department of Paediatrics, Arabian Gulf University, Manama, Bahrain. Sultan Qaboos Univ Med J. doi: 10.18295/squmj.2018.18.01.011. Epub 2018 Apr 4. PMID: 29666684; PMCID: PMC5892816.

Khitab, U. (2012). The Development of Low Cost Learning Material for the Teaching if Chemistry at Secondary Level City University Research Journal V3(1)

Kira, E & Nchunga, A (2016). Improvisation in teaching physics concepts : Teachers' experiences and perceptions, International Journal of Research Studies in Educational Technology, *5* (1), 49–61.

Kola, A. J. (2017). Developing a Constructivist Model for Effective Physics Learning. International Journal of Trend in Scientific Research and Development, V1(4). https://doi.org/10.31142/ijtsrd85

Kolb, D. A. (2013). Experiential Learning : Experience As The Source Of Learning And Experiential learning : experience as the source of learning and development, (January 1984).

Kolb, D. (1984). Experiential Learning. Englewood Cliffs, New Jersey: Prentice Hall.

Kothari, C.R.(2004), Research methodology, methods and techniques. New age international private limited publisher. ISBN (13):978-81-224-2488-1

Lagowaski,J.J.(2005) a chemical laboratory in a digital world, chemical education international, Paper based on the lecture presented at 18th ICCE, Istanbul, Turkey,3-8 v6(6).

Lagowaski, J.J.(2002), The role of the laboratory in chemistry Education, Dept. of chemistry and Biology. The University of Texas Austin, 78712, USA

Lin, J. W., & Chiu, M. H. (2007). Exploring the characteristics and diverse sources of students' mental models of acids and bases. *International Journal of Science Education*, *29*(6), 771–803. https://doi.org/10.1080/09500690600855559

Lisney, T. J., Bennett, M. B., & Collin, S. P. (2007). Volumetric analysis of sensory brain areas indicates ontogenetic shift in the relative importance of sensory system in elasmo branch Shifts in the relative importance of sensory systems, (June 2014), 6–15.

Lukum, A., & Parramatta, Y. (2015). Students' Satisfaction toward the Services of the Chemical. *International Journal of Evaluation and Research in Education (IJERE)*, *4*(1), 22–29.

Lunetta V. N., Hofstien, A.V.I & Clough, M (2007), Learning and practice, in the school science laboratory: analysis of research, theory, and Practice, In N Lederman, And S.Abel (Eds), Handbook of research, theory, and Practice.

Mæland, K., & Espeland, M. (2017). Teachers' Conceptions of Improvisation in Teaching : Inherent Human Quality or a Professional Teaching Skill ? Teachers' Conceptions of Improvisation in Teaching : Inherent Human Quality or a Professional Teaching Skill ? *Education Inquiry*, Online journal, *8*(3), 192–208.

Matthews, W. J. (2003). Constructivism in the classroom: Epistemology, history, and empirical evidence. *Teacher Education Quarterly*, 51–64.

Mboto, F., Ndem, N., & Stephen, U. (2011). Effects of Improvised Materials on Students' Achievement and Retention of the Concept of Radioactivity. Journal of *African Research Review*, *5*(1), 342–353. https://doi.org/10.4314/afrrev.v5i1.64531

McKee, E., Williamson, V. M., & Ruebush, L. E. (2007). Effects of a demonstration laboratory on student learning. *Journal of Science Education and Technology*, V*16*(5), 395–400.

Millar, R. (2009). Analysing practical activities to assess and improve effectiveness:

The Practical Activity Analysis Inventory (PAAI). York: Centre for Innovation and Research in Science Education, University of York. Available from http://www.york.ac.uk/depts/educ/research/ResearchPaperSeries/index.htm

Millar, R. (2004) The Role of Practical work in the teaching and Learning of Science; high school science laboratories, Role and Vision, Washington DC,USA

Momon,G.D(2005),School Headship: Managerial Challenges. Kaduna polytechnics press.

Muhammad, B. A (2014) Impact of Conceptual Instructional Method on Students' Academic Achievement in practical Chemistry among Secondary School Students in Zaria Educational Zone Kaduna State Nigeria, Journal of Education and Human Development June 2014, Vol.3, No. 2, pp. 351-360 ISSN: 2334-296x(Print), 2334-2978(Online)

Muna, A (2017). Principles of "Constructivism" in Foreign Language Teaching. Journal of Literature and Art Studies, 7(1),97–107.https://doi.org/10.17265/2159-5836/2017.01.013.

Musa, A., Shaheen, S., & Elmardi, A. (2018). Item difficulty & item discrimination as quality indicators of physiology MCQ examinations at the Faculty of Medicine Khartoum University Abstract :, (October).Kahartum medical journal, V11(2) pp. 1477 - 1486

Mustafa, C.(2008): Constructivist Approaches to learning in science and their implications for science pedagogy: Literature Review, international journal of environmental and science education, V3(4).

Nachmanovitch, S. (2006). Improvisation as a Tool for Investigating Reality, Keynote address – International Society for Improvised Music University of Michigan, Ann Arbo, (December), 1–15.

Naik, T.R., Kraus,R.N & Siddique (2003) Use of wood ash in cement-based materials. CBU-2003-19 (REP-513), Center for By-Products Utilization (CBU) Report, University of Wisconsin, Milwaukee.

Nancy, I. L. Karen, C. B, & George, M. A. (2005) SPSS of intermediate statistics: use and interpretation, Lawrence Erbaum associate, publishers.

National academy of science (NAS) (2011), Prudent practices in the laboratory: handling and managements of chemical hazards. Updated version. Book on shelf NBK55878

Nbina, J. (2012). Analysis of Poor Performance of Senior Secondary Students in Chemistry in Nigeria. *African Research Review*, *6*(4), 324–334. https://doi.org/10.4314/afrrev.v6(4). p 22

Nbina, J. & Viko, B (2010). Effect of Instruction in Meta cognitive Self- assessment Strategy on Chemistry Self-efficacy And Achievement of Senior Secondary School Students in Rivers State, Nigeria: Academic leadership online journal, *8*(4).

Nbina, J. B., Viko, B., & Biravil, S. T. (2010). Developing improvisation skills for alleviating poverty in Nigeria: The place of chemistry in entrepreneurship education. *Academic Leadership*, The Online Journal: Vol. 8 : Iss. 4, Article 18.Available at: https://scholars.fhsu.edu/alj/vol8/iss4/18*8* (4).

Ndihokubwayo, K. (2017), Investigating the status and barriers of science laboratory activities in Rwandan teacher training colleges towards improvisation practice. Hiroshima University Rwandan Journal of Education, V4 (1), Rwanda

Ndihokubwayo, K., Uwamahoro, J. & Ndayambaje, I. (2018). Use of improvised experiment materials to improve Teacher Training College students' achievements in Physics, African journal of education studies in mathematics & sciences, Rwanda, *14*, 71–85.

Ngala, J. S. (2019). The Impact of Laboratory Based Teaching Method on Secondary Schools Biology Students ' Acquisition of Science Process Skills in Littoral Region of Cameroon, International journal of contemporary applied researches, *6*(12), 90–116.

Njelita, C.B.(2008). Enhancing science process skills Acquisition in Volumetric Analysis using Cooperative-learning Strategy. Paper presented at the workshop organized by Sciences teachers Association of Nigeria (STAN) AWKA Zone from 26th -28th September.

Ochonogor E.C (2012) Improvised indicators for chemical analysis. STAN Annual conference proceedings.

Ochonogor, E.C (2000), Improvised Indicators for chemical analysis, In Akale, M.A.G (200)(ed) Enriching science, Technology and Mathematics Education(STAN proceedings, Ibadan: Heinemann Education books(Nig.)plc.pp.149-152

Ojediran, I. A., Oludipe, D. I., & Ehindero, O. J. (2014). Impact of Laboratory-Based Instructional Intervention on the Learning Outcomes of Low Performing Senior Secondary Students in Physics. *Creative Education*, *5*(4), 197–206. https://doi.org/10.4236/ce.2014.54029.

Okafor, P. N. (2001) Laboratory Resources and Utilization as Correlates of Chemistry Student's learning Outcomes, 4lst Annual Conference Proceedings of the Science Teachers Association of Nigeria.

Okori, O. A., & Jerry, O. (2017). Improvisation and utilization of resources in the teaching and learning of science and mathematics in secondary schools in cross-river state, Global journal of education research, V16 (Ahmed 2008), 21–28.

Oladipupo, J.A. (2002) Factor affecting the poor performance of secondary school students in chemistry. An unpublished M.ED. Dissertation, University of Ibadan

Olutola, A, Daramola, D. & Bamidele, E. (2016). Comparative Effects of Practical and Alternative to Practical Methods on Students' Academic Performance in Biology. International journal of educational benchmark. 3. 2489-4162.

Olufunke, B. T. (2012). Effect of Availability and Utilization of Physics Laboratory Equipment on Students' Academic Achievement in Senior Secondary School Physics, *2*(5), 1–7, https://doi.org/10.5430/wje.v2n5p1

Omiko, A (2015), Laboratory Teaching: Implication on students' achievement in chemistry in secondary schools in Ebonyi state of Nigeria. Journal of Education and practice. ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) V6 (30).

Omiko, A (2007) Job orientation and placement: The role of Science in a developing Economy.Abakaliki: Larry and Caleb publishing House.

Onassanya, S.A & Omosewo, E.O (2011), Effect of improvised and standard instructional materials on secondary school students' academic performance in physics in Ilorin, Nigeria. Singapore journal of scientific research 1(1),p 68-78.

Orla, K. (2005). The development, implementation & evaluation of alternative approaches to teaching & learning in the Chem. lab.Andrew_Kelly.pdf - Orla_Kelly.pdf. *Unpublished*, *2*. Retrieved from http://doras.dcu.ie/17958/1/Orla_Kelly.pdf

Orey, P.M (2010), Emerging Perspectives on learning teaching and technology. Global textbook.

Orhan, T. Y., & Sahin, N. (2018). The impact of innovative teaching approaches on biotechnology knowledge and laboratory experiences of science teachers. Journal of *Education Sciences*, *8*(4). https://doi.org/10.3390/educsci8040213

Orimogunje, T. Oke, O. K. & Alam, G. M. (2010). An investigation in to students' study habit in volumetric analysis in the senior secondary provision: A case study in Ondo state, Nigeria. African journal of Pharmacy and Pharmacology, *4*(6), 324–329.

Orimogunje, T (2014), analysis of students' achievement in analytical chemistry among the university students in Nigeria, International Journal of Education and Research V 2(2).

Otor, E. E., Ogbeba, J., & Ityo, C. N. (2015). Influence of Improvised teaching Instructional Materials on Chemistry Students' Performance in Senior Secondary Schools in

Vandeikya Local Government Area of Benue State, Nigeria. *International Research in Education*, *3*(1), 111.

Özmen, H. (2008). Determination of students' alternative conceptions about chemical equilibrium: A review of research and the case of Turkey. *Chemistry Education Research and Practice*, *9*(3), 225–233. https://doi.org/10.1039/b812411f

Özmen, H (2004), Some students' misconceptions in chemistry: A literature review of chemical bonding. Journal of science education and technology, V13 (2).

Pallant, J. (2005). SPSS survival Manual: A step-by-step guide to data analysis using SPSS for Windows (Version 12).

Pallant, J. (2010). Survival Manual. McGraw-Hill Education.

Park, E. J., Light, G., Swarat, S., & Denise, D. (2009). Understanding learning progression in student conceptualization of atomic structure by variation theory for learning. Learning Progression in Science (LeaPS) Conference, (June), 1–14.

Plass, J.L.,Milne, C., Homer, C.,B.D.,Schwartz, R.N.,Hayward, E.O., Jordan, T., & Barrientos,J. (2012). Investigating the Effectiveness of computer Simulations for chemistry learning,Journal of research in science teaching *49*(3), 394–419. https://doi.org/10.1002/tea.21008

Pavesic, B.J (2008) achievement, differences, and experimental work in classes in Slovenia as evident in TIMSS studies in education Evaluation. 34(2), 94-104.

Pyatt, K & Sims, R (2007), Learner performance and attitudes in traditional versus simulated laboratory experiences, Department of Education, Eastern Washington University. *Proceedings* ascilite *Singapore.*

Rahmawati, y & Koul, R. (2011). Students' Perceptions For The Chemistry Laboratory Environment Improvement. Journal Riset Pendidikan Kimia. 1.

Ravid, R. (2011) practical statistics for educator, 4th edition, Rowman and little field publishers, Inc.

Reid, N., & Shah, I. (2007), The role of Laboratory work in university chemistry. Chemistry Education Research and Practice, 8(2), 172-185.

Reid, N., & Shah, I. (2014). The role of laboratory work in university chemistry, journal of chemistry education research and practice(September). https://doi.org/10.1039/B5RP90026C

Reck, R. M., Sreenivas, R. S., & Loui, M. C. (2019). Evaluating the effectiveness of an affordable and portable laboratory kit for an introductory control systems course. *Advances in Engineering Education*, *7*(3), 1–35.

Rodr, D. A.-, Gonz, D., Viviana, L., & Nino, M. (2017). Change in Elementary School Students' Misconceptions on Material Systems after a Theoretical-Practical Instruction, International electronic journal of elementary education, *9*(3), 499–510

Samba R.M.O & Eriba.O (2011), Laboratory Techniques and the Art of improvisation. Makurdi: His masters Servant Media Apostolate publications.

Saxner, D., & Robertson, T. (2010). Laboratory Activities for Secondary Science Education in Rural Thailand. Online journal

Shadish, W. R., Cook, T. D. & Campbell (2002). QUASI-EXPERIMENTAL FOR GENERALIZED DESIGNS CAUSAL INFERENCE from Experiments Causal Generalized inference. *Handbook of Industrial and Organizational Psychology*, *223*(0),623.Retrievedfrom http://pubs.amstat.org/doi/pdfplus/10.1198/jasa.2005.s23

Sharma, S.& Bansal, D. (2017), Constructivism as a paradigm for teaching and learning. International journal of physical education, sports and health, V 4 (5): p209-212.

Shitaw, D. & Birhan, D. (2017). Practices and challenges of implementing locally available equipment for teaching chemistry in primary schools of north Shewa zone in Amhara, African journal of chemical education, 7(1),17-30

Singh, D., & Singh, V (2015), Urena lobata Flowers: A Green Route to Volumetric Analysis.Journal of Green and Sustainable chemistry.5,1-5 http://dx.doi.org/10.4236/gsc.2015.51001

Signh, G (2014) Review of Research on School Science Laboratory Work With Special Emphasis on Physics Education, - 10.13140/RG.2.2.24199.91047, Book

Sindhu, R. & Khatakar, B.S (2018), Effects of Chemical Treatments on Storage Stability of Lemon (*Citrus Limon*) Juice, International Advanced Research Journal in Science, Engineering and Technology, Vol. 5, Issue 2,, ISSN (Print) 2394-1588.region. *African Journal of Chemical Education*, *7*(1), 17–30.

Skoog, D. A.; west, M.; Holler, F. J & Crouch. S (2004), Fundamental of analytical chemistry, 8th edition, stand ford, san Jose state, Kentucky and Michigan state university respectively.

Skoumios, M., and Passalis, N. (2010) Chemistry Laboratory Activities : The Link between practice & theory, The International journal of Learning, *17*(6).

Solomon, W. (2016), Correlation study of students' performance in Ethiopian secondary schools by using data mining algorithm, m.sc. thesis, department of information science, college of natural sciences, Addis Ababa University, Addis Ababa, Ethiopia.

Souza, K. A. F. D., & Porto, P. A. (2012). Chemistry and Chemical Education Through Text and Image: Analysis of Twentieth Century Textbooks Used in Brazilian Context. *Science and Education*, *21*(5), 705–727. https://doi.org/10.1007/s11191-012-9442-z

State, E., Ataha, U. C., & Ogumogu, A. E. (2013). An Investigation Of The Scientific Attitude Among Science Students In Senior Secondary Schools In Edo South Senatorial, journal of education and practice, *4*(11), 12–17.

Stolk, M. J., de Jong, O., Bulte, A. M. W., & Pilot, A. (2011). Exploring a Framework for Professional Development in Curriculum Innovation: Empowering Teachers for Designing Context-Based Chemistry Education. *Research in Science Education*, *41*(3), 369–388. https://doi.org/10.1007/s11165-010-9170-9

Tabor, K. S.(2009)Challenging Misconceptions in the Chemistry Classroom : Resources to Support Teachers El repte de les conceptions alternatives enquímica : Recursos per ajudar al professorat.Science education

Tafa, B. (2012). Laboratory activities and students practical performance : The case of Practical Organic Chemistry in course of Haramaya university, AJCE, *2* (July), 47–76.

Talti, Z., & Ayas, A (2012).Virtual chemistry laboratory: Effect of constructivist learning environment. Turkish Online journal of Distance Education, *13*(1), 183–199.

Temechegn, E. (2012) Development of low-cost educational materials, African Journal of chemical education,AJCE, *2* (January), 48–59.

Tesfaye, B. T., Yitbarek, S., & Tesfaye, A. (2010). Status of Science education in city government of Addis Ababa education bureau. Online Journal

Tsaparlis, G. (2001) Theories in science education at the threshold of the third millennium, university of Ioaning, Department of chemistry,Journal of chemistry education and practice, Greece V2 (1). https://doi.org/10.1039/B1RP90003J

Thomas, O. O., & Israel, O. O. (2012). Improvisation of science equipment in Nigerian schools, universal journal of education and General Studies, *1*(3), 44–48.

Tanvir, A (2014), a cultural historical activity theory frame work for understanding challenges experienced by student teachers of science at secondary level of education in Bangladesh. Education journal, V14 (2).

Üce, M., & Ceyhan, I. (2019) Misconception in chemistry Education and practices to eliminate them: Literature Analysis, Journal of education and train studies, *7*(3), 202–208. 10.11114/jets.v7i3.3990

Uduafemhe, M. E. (2015). Comparative Effects of Scaffolding and Collaborative Instructional Approaches on Secondary School Students ’ Psychomotor Achievement in Basic Electronics in North-Central Nigeria, IOSR journal of engineering, *5*(6), 23–31.

Ural, E.(2016) The Effect of Guided-Inquiry Laboratory Experiments on Science Education Students’ Chemistry Laboratory Attitudes, Anxiety and Achievement. Journal of Education and Training Studies, 4(4), 217–227.

Uzezi, J. G., & Zainab, S. (2017). Effectiveness of guided-inquiry laboratory experiments on senior secondary schools students' academic achievement in volumetric analysis. American Journal of Educational Research, 5(7), 717–724. https://doi.org/10.12691/education-5-7-4

Woody. E (2009) practical work in school science-Why is it important? : Biozone Learning Media (UK) Ltd. *School Science Review*, 91 (335), 49-51.

Yıldırım, N. (2016). Opinions of Pre-service Classroom Teachers towards Laboratory Using in Science Instruction and Their Preferences towards Laboratory Approaches. *Journal of Education and Training Studies*, *4*(3), 208–222. https://doi.org/10.11114/jets.v4i3.1304

Yitbarek,S.(2012)Low-cost apparatus from locally available materials for teaching science, African journal of chemical education(AJCE),*2* (January), 32–47.

Zengele, A. G. B. (2016). The Status of Secondary School Science Laboratory Activities for Quality Education in Case of Wolaita Zone, Southern Ethiopia. *Journal of Education and Practice*, *7*(31), 1–11.

Zudonu, O. C, & Njoku, Z. C (2018), Effect of laboratory instructional methods on students' attitudes in some chemistry concepts at senior secondary school level, global scientific journals, ISSN 2320-9186, V 6(7).online journal.

Appendix- 1 Experiments to be performed

The following four experiments were done by using locally available materials for schools with absence or/ and shortage of laboratory equipment or for schools that are newly launched and that are found at rural areas and schools at urban with conventional materials in the same socioeconomic status and culture. The experiments have been taken directly from "grade-twelve "chemistry book and theoretical aspect of the experiment organized from different related books and some internet source that related volumetric analysis and some other topic associated with. Experiments to be performed listed as follows. These are

- Investigating the solubility of Nacl
- Preparation of solutions of known concentrations
- Preparation of Solution of lower concentration from saturated Stock solution
- Acid-Base titration

Experiment-1

Title: - Investigating the solubility of Nacl

Theory

Solubility of Substances

Solutions

A solution is a mixture of two or more substances, one or both of, which usually are liquids. The mixture is uniform throughout the solution i.e. looks the same throughout. I n solutions, particles are evenly distributed in liquid throughout the mixture. Since particles are too small to diffract light that indicates the solution is clear. The solution looks like pure water, not cherry for example cola, and salt solution. The two terms employed term and familiar with solution science are solvent and solute. The solvent is greatest in quantity of solution. The solute is the lesser quantity in solution.

Dissolving:

The process of dissolving a solid in a liquid is very common; sugar in water, salt in soup is two obvious examples, but what the dissolving process. First let's define a few terms.

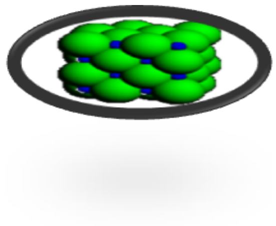
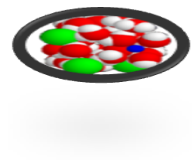
	
NaCl	Na^+ and Cl^- ions in water

Figure 1=Nacl crystal lattice

A solution is a homogeneous physical mixture of solvent and solute.The solute particle sizes are ions, atoms, molecules small combinations of these units.

Let's say you added some salt to a cup of water. The salt seems to disappear as you stir. How does this happen? The individual ions are said to be aqueous. An aqueous particle is completely surrounded by water.

In the second picture the green spheres, the negatively charged chlorine ions are attracted to the positive side of the water molecule, the hydrogen side, depicted as white spheres. The positively charged sodium ions, shown as blue spheres, are attracted to the negative side of the water molecule, the oxygen side, depicted as red spheres.

The Dissolution Process:

What makes a solute soluble in a solvent? Water is a great solvent, especially for ionic and polar compounds. This is because water is polar, has positive and negative ends. The hydrogen end moves in and grabs the anion (the negative end) and the oxygen goes in and grabs the cation (the positive end.). A law of physics is that describes entropy. The second law of thermodynamics states that the all things will move from a state of order to a state of disorder spontaneously. In other words, things want to become more disordered. Moreover, if the conditions are right disorder will form from order. Entropy is the measure of disorder in a system. More disorder more entropy. A messy room is simply following the second law of thermodynamics. So, solids tend to want to dissolve to follow this law of entropy.

Solubility

When two substances mixed or dissolved in to one another and the ability to measure its dissolution process called Solubility. There are terms included in this process: these are dissolving of a solute substance in solvent. Dissolution employed either solid or liquids as a solute and a liquid considered as a solvent. Water molecules surround certain particles and that particle at the end said to be aqueous. Two substances that mix to form a solution are said to be soluble substances and those substances do not mix to form a solution are insoluble. There is also another terminology we employed in the scientific world for this describtion.these is miscibility and non-miscibility, which employed for two liquids mixed together. When two liquids mixed like water and alcohol they are said to be miscible otherwise they are called non-miscible for example, oil and water do not mixed together and the process is called miscibility. However, both are non-miscible Solution is said to be saturated when a solute will dissolve in a particular a solvent until its solubility limit reach at a given temperature. For example, sodium chloride in water. This is dependent on the solute, the solvent and the temperature. The change in anyone of these factors, amount of solid, which can be dissolved, will change.

Under certain conditions, the solution must be handled gently as the solute may precipitate out under any stressful situation. This condition is said to be supersaturated solution. At this condition, temperature increases the solubility also increases. However, it not happens in the case of gases. Look at the following diagram.

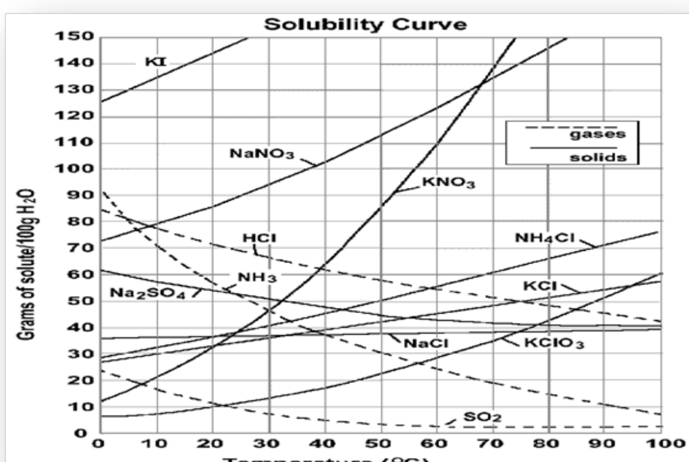


Figure-2:-Solubility curve

Objective:-To determine the solubility of sodium chloride in water

Apparatus:-Beaker, Evaporating Dish, Measuring cylinder/syringes, glass rod, Filter paper, Analytical balance, and burner or200ml Volumetric Flasks/High land/,Stirrers, Beakers Measuring Cylinders/syringes/ Balance, Sodium chloride,sugar, and water
Chemicals: - Sodium Chloride and Water

Figure- 3 Experimental set up for the determination of the solubility

Procedure:

Take an evaporating dish and weigh it

Take 100ml of water in a beaker and add Sodium chloride to it. Stir the solution vigorously with the glass rod, until undisolved sodium chloride is left in the beaker.

Take 50ml of the supernatant the saturated solution (assume that 50ml of the solution is equal to 50ml of the solvent) and transfer it to a evaporating dish.

Heat the solution in the evaporating dish as shown in the fig-1, till all the water has evaporated and dry Nacl is left in the evaporating Dish. Cool the evaporating dish containing dry Nacl to room temperature and weigh it again.

Observation and analysis:

I. Volume of Nacl solution________________________

II. . Weight of the empty evaporating dish___________________

III. Wt of evaporating dish + Nacl collected after evaporating the solvent___________

IV. Calculate the solubility of Nacl in water and express the results in grams of Nacl/100grams of water.

V. Calculate the percentage error of the system if the solubility of sodium chloride is 36.2

Experiment Two

Title: Preparation of Solutions of known concentrations

Objective: To prepare 1 molar Nacl solution and a 1molar table –sugar solution

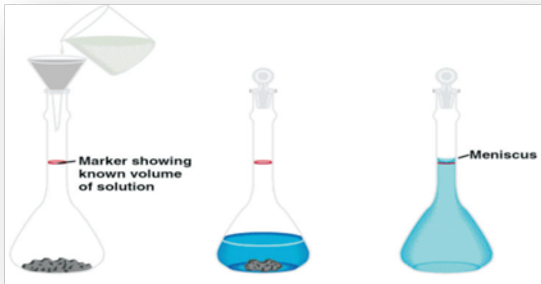
Apparatus and Chemicals:

200ml Volumetric Flasks, Stirrers Beakers Measuring Cylinders Balance, Sodium chloride, sugar, and water

Theory

A common task in school, medical, industrial and other chemical laboratories is the preparations of known concentrations. For aqueous solutions, distilled, demineralized or deionized water is used. Other solvents can also be used, depending on the solution specified. Solutions are usually prepared from solutes of liquids or solids. Occasionally, they are prepared from gases. First, the gas is accurately weighed and transferred to a volumetric flask, then water is added through a funnel in (fig -2 a). Next the solid is slowly dissolved by gently swirling the flask (figure-2b)..After all the solid has dissolved; more water is slowly added to bring the level of solution exactly to the volume mark (fig-2c). Knowing the volume of the solution in the flask and the quantity of compound (the number of moles), one can calculate the molarity of the solution using the formula of molarity.

Molarity = $Numberofmolesofsolute/Volume(L)ofsolution$



a b c

Figure four: preparation of a solution of known molarity

A one molar solution of Nacl can be prepared by dissolving 58.5g of Nacl in water until the solution becomes one liter.

Procedure

I. Weigh 11.7 g of sodium chloride, using a balance, and add to a beaker.
II. Add about 50ml of water to the beaker containing the Nacl and dissolve it by stirring.
III. Using a funnel, transfer the solution to the volumetric flask.
IV. Slowly add more water to the volumetric flask until the solution reaches the volume mark.

Observation and analysis

I. How many moles of sodium chloride did you use to prepare the solution?
II. What are the molarity and normality of the solution?

Procedure 2

1. Weigh a beaker and record its mass. Then add 50g of water. Perform the measurement and calculations:

a) Mass of beaker____________________

b) Mass of beaker +mass of water_______________

c) Mass of water________________

I. Weigh 17.1g of table sugar________________

II. Dissolve the 17.1g of table sugar in the beaker containing 50g of water, by string.

Observation and analysis:

a. Mass percent of the solution
b. Mole fraction of the solution
c. Molality of the solution

Experiment 3

Title:-Preparation of solution of lower concentration from saturated stock solution

Objective: To prepare diluted solution of sulpheric acid/Citric acid

Apparatus:-burette/syringe/beaker/cup/Stirrer, funnel/plastic material/, Stand with clamp

Chemicals: 18M $H_2SO_{4/}$ citric acid from lemon or market available or from car battery, from, distilled water

Theory

Concentrated solutions are often stored in the laboratory as “stock” solutions for use as needed. Frequently we dilute this solution before working with them. Dilution is the procedure for preparing a less concentrated solution from a more concentrated one. In carrying out a dilution process, it is useful to remember that more solvent to a given amount of a stock solution changes (decrease) the concentration of the solution without changing the number of moles of solute present in the solution. In other words, Number of moles of solute before dilution = Number of moles of solute after dilution.

Since number of moles of solute = molarity x volume of solution

$$M \times V$$

Number of moles of solute before dilution = M_iV_i

Number of moles of solute after dilution = M_fV_f

Therefore, dilution can be expressed as $M_iV_i = M_fV_f$

Or more generally, $C_iV_i = C_fV_f$

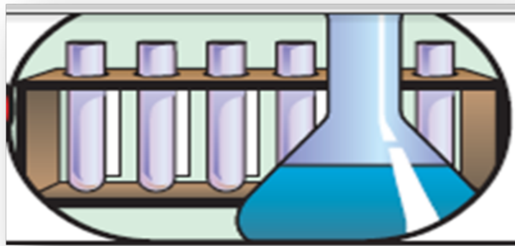


Figure-five: Preparations of solution of lower Concentration from saturated stock solution

Procedure

I. Carefully add the concentrated acid in to the burette
II. Slowly add with stirring 10ml of the acid in to a beaker containing 50ml of distilled water
III. Transfer the new solution in to a volumetric flask (1L) and add water up to the mark.

Observations and analysis

From procedure 1 and 2

I. Why are acid added to the water not the water to the acid?
II. Explain whether volume, mass or number of moles of the solute is changed or not in the process.
III. What is the new concentration of the sulpheric acid?

From procedure 3:

i. Calculate concentration of the new solution.

Experiment 4

Title: - Acid-Base Titration

Objective: To find the normality of a given hydrochloric acid solution/or citric acid by titrating against 0.1N standard sodium hydroxide solution/ abase obtained from charcoal OH-(strong base).

Apparatus and chemicals

10mL pipette, burette, 150mL Erlenmeyer flask, beaker, funnel, burette clamp and metal stand./Syringes, flasks from nearby hospital or health centers, plastic beakers and funnel from high land water , burette clamp and wood stand / hydroxide ion solution from ash of burned charcoal, purified water solution of ash after subsequent filtration with fluted filter paper. Citric acid solution prepared from Lemon after subsequent filtration with fluted filter paper, water extract of flower as an indicator, phenolphthalein indicator, citric acid and NaOH.

Theory

Acid-base titrations

Acid base titrations are based on the neutralization reaction between the analyte and an acidic or basic titrant. The most commonly used measuring instruments are a pH indicator, a pH meter, or a conductance meter to determine the endpoint. In our experiments, we will use phenolphthalein or some other aqueous solution of leaf of flowers to detect the equivalent point of the reaction. Neutralization is a chemical reaction, also called a water forming reaction, in which an acid and a base or alkali (soluble base) react and produce a salt and water (H_2O).

Acid + Base →Salt + Water

For example, the reaction between hydrochloric acid and sodium hydroxide solutions:

Hydrochloric acid + sodium hydroxide →sodium chloride + water

HCl (aq) + NaOH (aq) → Nacl (aq) + H_2O (l)

Before starting the titration, a suitable pH indicator must be chosen. The endpoint of the reaction, when all the products have reacted, will have a pH dependent on the relative strengths of the acids and bases.

- The pH of the endpoint can be roughly determined using the following rules:
- The PH of neutral solution at its end point, which is formed from strong acid and strong base, is equal to seven (pH=7)
- The PH of a solution at its end point, which is formed from strong acid and weak base, is always less than seven (pH <7)
- The PH of a solution at its end point, which is formed from weak acid and strong base, is always greater than seven pH>7).

When a weak acid reacts with a weak base, the endpoint solution will be basic if the base is stronger and acidic if the acid is stronger. If both are of equal strength, then the endpoint pH will be neutral. Frequently, during a titration it is also useful to monitor the progress of the titration with a graph. This graph is known as a titration curve. Such a curve reflects the changes in pH that occur as titrant is added from a burette to the analyte in the beaker below the burette. There are two different types of acids that can be titrated, besides being strong or weak. They are known as being Monoprotic or polyprotic: Monoprotic acids contain only one acidic hydrogen: hydrochloric acid HCl, nitric acid HNO3, acetic acid CH3COOH etc.

A suitable indicator should be chosen, that will experience a change in color close to the end point of the reaction. pH indicators are generally very complex organic molecules (frequently weak acids or bases). When introduced into a solution, they may bind to H+ or OH-ions. They will contain a structural component that is called a chromophoric group. This group, or chromophore, will have a structure that changes slightly when the pH of the system changes. The indicator will have one structure through one range of pH values, and a 3 second structure through a second range of pH values. When the structure changes, as a response to pH, the chromospheres will also change its color (for more information seee.g.http://www.bcpl.net/kdrews/titration/indicators.html).

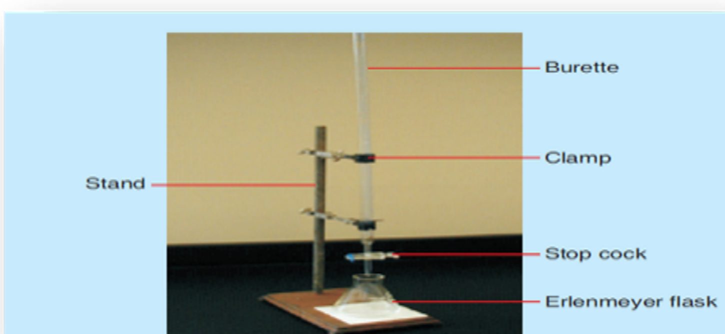


Figure six: Titration set up

Table 4:1 volume of NaOH (aq) added to HCl (aqa)

Volume of 0.5 M NaOH added (mL)	0.00	5.00	10.00	15.00	20.00	25.00	30
pH	0.30	0.52	0.77	1.15	7.00	13.45	?

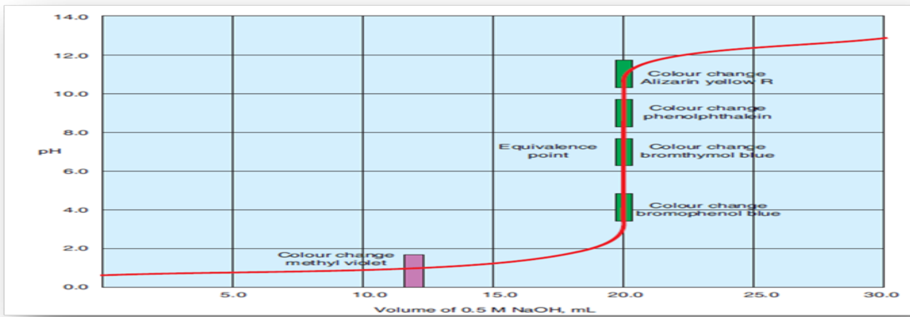


Figure seven Titration curve of 20 mL of 0.5 M HCl by 0.5 M NaOH

Table 4:2 volume of NaOH added to acetic acid (CH_3COOH)

Volume of NaOH added (mL)	0.00	5.00	10.00	20.00	25.00	30.00
pH	2.57	4.26	4.47	8.37	12.74	?

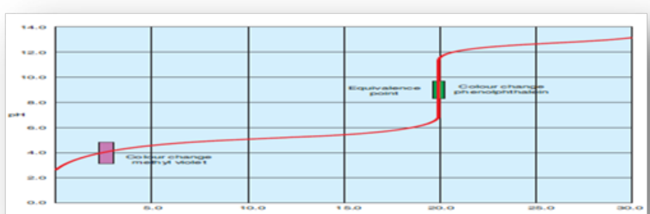


Figure eight:- Titration curve of 20.00 ml of 0.5 M CH3COOH by 0.5 M NaOH.

Procedure:

1) Clean the burette with distilled water and rinse it with the 0.1N sodium hydroxide solution; and fix the burette clamp in vertical position

2) Using a funnel, introduce 0.1N sodium hydroxide solution in to the burette. Allow some of the solution to flow out and make sure that there are no air bubbles in the solution (why). Record the level of the solution, corresponding to the bottom of the meniscus, to the nearest 0.1mL. Measure exactly 10ml of hydrochloric acid solution(given) with the help of a10ml pipette and add it in to a clean 150ml Erlememeyer flask and add two or three drops of phenolphthalein indicator.

Caution: When you suck hydrochloric acid or any reagent solution, in to a pipette, have the maximum caution not to suck it in to your mouth.

Titration: First, hold the neck of the Erlememeyer flask with one hand and the stopcock with the other. As you add the sodium hydroxide solution from the burette, swirl the content of the flask gently and continuously. Add sodium hydroxide solution until the first faint pink color comes which disappears on swirling. Add more sodium hydroxide drop wise until the pink color persists for a few seconds. Find the difference between the initial level and the end point level of the burette.

Observations and analysis

a) Color change at the end point is from__________to_____________
b) What is the volume of sodium hydroxide added at the end point?
c) What is the normality of hydrochloric acid at the end point?
d) What is the similarity and difference between equivalence point and end point level after reaching the end point?

Appendix-2: Achievement test questions

Choose and circle the best answer from the following questions

1. Which of the following is not true about a dynamic equilibrium exist during dissolution

$$\text{solid/solute} \underset{\text{crystalization}}{\overset{\text{dissolutions}}{\rightleftharpoons}} \text{Dissolved ions}$$

   A. The rate of dissolution and crystallization is the same
   B. No more solute is dissolved in the solvent
   C. The solution is saturated
   D. The process of dissolution is continuous.
2. Why do you think that supersaturated solutions are usually prepared at elevated temperature?
   A. In order to dissolve excess solute since the solubility of solute increases with temperature.
   B. In order to saturate the solution solubility decrease with increasing temperature
   C. .It is only traditional, but temperature has no effect on solubility
   D. None
3. Which of the following parameter remains constant during dilution of agiven volume of concentrated solution?
   A. Concentration B. amount of solute
   B. Volume D.Mass of solvent
4. How many milliliter of water should be evaporated from 50ml of 0.1M HNO3 in order to obtain 3M HNO3?
   A. 1.67 B. 0.06 C. 49.94 D. 48.33
5. Which of the following is responsible for the color change of phenolphthalein from colorless in acidic solution to pink in basic solution? It is because
   A. The [H+] of the indicator decreased in the basic solution
   B. The [H+] of the indicator increased in basic solution
   C. The [OH] of the basic solution increased
   D. Both [H+] and [OH] ion are equal in the solution

6. Which of the following chemical should be in the burette during titration of unknown concentration of HCl (aq) by 0.5M NaOH (aq)

A. HCl (aq) B. NaOH (aq) C.Phenolphathalein D. Water

7. How many milliliters of 18 M H2SO4 stock solutions should be taken to prepare 300ml of 3M H2SO4 solution?

A. 600ml B. 20ml C. 100ml D. 50ml

8. How many milliliter of water was added to 30ml of 18M H2SO4 stock solution to prepare 3M H2SO4 solution?

A. 180ml B. 150ml C. 100ml D. 200ml

9. What is the HCl (aq) solution, in the titration of an unknown concentration of HCl(aq) with 5M NaOH (aq)?

A. Titrant B. analyte C. Titration D. None

10. How many gram of AgNO3 be needed to prepare 500ml of 3M solution?

A. 170g B.127.5g C. 255g D. 340g

11. The solubility of NaNO3 at 25^0c is 90g/100g of H2O. What is the type of solution formed by dissolving 150g of NaNO3 in 200g of water at the same condition?

A. Supersaturated B. Saturated C. Unsaturated D. Concentrated

12. A student prepares 100ml of saturated solution by dissolving Nacl in water. He takes 50ml of the saturated solution and heat it on the evaporating dish until all the water has been evaporated, and dried Nacl was left in the dish. Finally, after cooling the evaporating dish containing dry Nacl to room temperature he weighs it. If the mass of empty evaporating dish and that of evaporating dish plus dry Nacl collected after evaporation as 20 g and 30.1g respectively. What mass of Nacl was dissolved in the experiment?

A. 50.1gm B. 30.1gm C. 10.1gm D. 20gm

13. Based on question "Number 12" The concentration of original 50ml of Nacl solution before drying in molarity (M) is

A.17.12 B. 3.42M C. 10.3Ml D. 6.84M

14. How much mole of the acid will left uncombined if 35ml of 0.5M NaOH (aq) is added to 50ml of 0.5M HCl (aq) solution?

A. 0.0175 B. 0.025 C. 0.0075 D. 17.5

15. A solution was made by dissolving 36gm of sodium sulphate, Na_2SO_4 in 0.200kg of water. What is the mass percentage of the solute in this solution?

A.15.25% B. 99.45% C. 36% D. 20%

16. What mass in gram of H_2SO_4 is required to neutralize 250ml of 1.6M NaOH(aq) solution completely?

A. 49gm B. 19.6gm C. 98gm D. 9.8 gm

17. What is the normality of a solution which contains 20.52gm of Aluminum sulphate, $Al_2(SO4)_3$

A. 0.96N B. 0.24N C. 9.6N D. 0.48N

18. Which of the following best describes the equivalent point of strong acid –strong base titration? It is the point at which

A. The indicator changes color

B. The acid and base starts to react

C. The acid reacts with the base completely

D. A slight increase in PH is observed

19. Rate of dissolution is largely dependent upon:

A. the inter-particle forces

B. the surface area of solid solute

C. the temperature of the system

D. the pressure of the system

20. The ratio of the number of moles of solute divided by the total number of moles gives:

A. the mole fraction of the solute

B. the molarity of the solution

C. the molality of the solution

D.The normality of the solution

21. Which of the following substances are not readily miscible within each other?

A. C6H6 and CCl4 C. C2H5OH and H2O

B. C2H5OH and CCl4 D. CH3OH and H2O

22. Which of the following statements is not correct?

A. pressure has little effect on the solubility of liquids and solids

B. the solubility of most solids increases with increasing temperature
C. the solubility of gases in water increases with increasing temperature.
D. none of the above

23. Which of the following practices will lead to an error when titrating a solution of sodium hydroxide with dilute hydrochloric acid?

A. Washing the burette with distilled water, then with a little of the acid and then filling with the acid.
B. Always reading to the bottom of the meniscus in the burette.
C. Washing the pipette with distilled water then using it to dispense the sodium hydroxide solution.
D. Using only a small amount of indicator

24. The solution in the conical flask in titration experiment is

A. Titration B. Titrant C. Titrand D all

25. In the experiment involving the titration between sodium carbonate solution and hydrochloric acid solution, a student asked why phenolphthalein indicator could not be used instead of methyl orange. Which of the following statements give best explanation?

A. The end point would occur before the equivalent point.
B. The end point would occur after the equivalent point.
C. The end point and the equivalent point would occur at the same time.
D. There would be no equivalent point due to the incorrect use of an indicator.

26. During a titration experiment, the results below were obtained when a 25.00ml aliquot of barium hydroxide solution was titrated with a0.1000M hydrochloric acid solution.

$$2HCl (aq) + Ba(OH)_2(aq) \longrightarrow BaCl_2(aq) + 2H_2O(L)$$

Burette readings(ml)	1st titration	2nd titration	3rd titration
Final reading	24.53	25.48	25.34
Initial reading	1.00	2,01	1.84
Change of Volume	23.53	22.47	23.5

The concentration of barium hydroxide solution was

A. 0.04700 B. 0.04706 C. 0.09400 D. 0.09412

27. Which of the following is correct about titration of a polyprotic weak acid such as orthophosphoric (H3PO4) with a strong base such as NaOH?

A. H3PO4 titration curve has only one equivalence point.

B. H3PO4 titration curve has only two equivalence points.

C. H3PO4 titration curve has only three equivalence points.

D. H3PO4 titration curve does not have any equivalence point.

E. H3PO4 titration curve has only seven equivalence points.

28. Which of the following can be used to measure a more accurate volume of a liquid?

A. Beaker B. Graduated cylinder C. Burette D. ALL

Short answer

29. List at least three safety rules students take precaution during chemistry in the laboratory (1point)

____

30. Write short answer for the following questions (1point)

i. The point at which the stoichiometric amount of reactant has been added in the titration experiment is ____

The procedure for preparing a less-concentrated solution from a more concentrated one is

____

31. A student conducts an experiment to prepare solution of known concentration according to the procedure below (1.5 each)

Procedure

1. Weigh 11.7 g of sodium chloride, using a balance, and add to a beaker.
2. Add about 50ml of water to the beaker containing the Nacl and dissolve it by stirring.
3. Using a funnel, transfer the solution to the volumetric flask.
4. Slowly add more water to the volumetric flask until the solution reaches the volume mark.

A. How many moles of sodium chloride did you use to prepare the solution?

B. What are the molarity and normality of the solution?

Appendix-3: item index and Discrimination power of achievement test from pilot study

Item number	Item index	Discrimination power
1	0.58	66
2	0.7	78
3	0.6	72
4	0.48	64
5	0.6	60
6	0.58	62
7	0.54	54
8	0.42	58
9	.42	56
10	.54	54
11	0.48	52
12	0.44	56
13	0.42	60
14	0.56	60
15	0.52	60
16	0.7	70
17	0.62	70
18	0.62	66
19	0.6	68
20	0.56	56
21	0.46	62
22	0.46	70
23	0.58	70
24	0.5	78
25	0.58	90
26	0.52	84
27	0.52	80
28	0.62	82
29	0.54	78
30	0.44	72
31	0.54	78
32	0.48	68
33	0.34	46

Appendix-4 SQCL-Questionnaire to be filled by learners before and after treatment

Personal information

Sex________________

Age________________

Marital status______________

Dear respondents

The purpose of SQCL-questionnaire is to assess the preview information about practicals in chemistry to evaluate their perception before and after treatment and use it to triangulate the result obtained by achievement test. I would like to get your view regarding the approach how to deliver or conduct the experiments before the pre-test, to find mechanism to minimize the poor achievement and benefits students by looking for the alternative approach to acquire suitable knowledge in chemistry education.

The success of the study to a great extend depends on your genuine and firmly responses to each question. Therefore, you are kindly requested to fill the questionnaire honestly and responsibly. Be sure that all the information you provide will be remaining confidential and used for research purpose only.

Items				1	2	3	4	5
Category-1	Students' attitude on getting process skills from laboratory experiments	1	Lack of observation skills from practical result in poor achievement in volumetric analysis					
		2	The reading skill in chemistry experiments especially measuring in volumetric analysis is one of the causes of poor achievement					

		3	I can develop recording skill from laboratory activities of volumetric analysis so that I achieve a good result					
		4	I can develop interpretation skill from laboratory practice of volumetric analysis					
		5	During laboratory sessions other students collect different data than I do for the same problem					
		6	We follow rules and procedures during practical work					
		7	I do chemistry practical to learn how to handle apparatus					
Items								
Category-2	Students' attitude on the support of teachers and management body on laboratory issues	8	Our teacher has no interest to teach laboratory activities in chemistry textbook					
		9	School administrators do not give attention to laboratory work in chemistry subject to be taught to increase the students' achievement					

		10	I, myself unwillingly participate in practical activity in chemistry.					
Category-3	Students ' previous knowledge	11	I apply my theoretical knowledge on Science in my practical work					
		12	Inability to determine mole ratio from stoichiometric equations contribute to a poor achievement					
		13	Spelling errors in balanced equation in chemistry attributed to low achievement					
Items								
Category-4	Student' s attitude on laboratory facility of chemistry	14	Students get on well in the laboratory					
		15	The experiments we do are related to topics in the syllabi					
		16	The chemicals and equipment that I need for my experiments are readily available					
		17	Everyone takes part in doing practical work					
		18	We have practical experiment for every topic that we do in Chemistry class					
		19	We don't have chemistry laboratory session at all					

		20	I am always protected (safety) during practical work.					
		21	In the laboratory everyone is doing experiments on his/her own					
		22	We clean and pack the equipment and chemicals after each session					
		23	Our laboratory is crowed when we are doing experiments					
Items								
Category-5	Students ' opinion on improvisation of laboratory equipments	24	Teaching experiments with low cost/local materials the equity problem of quality education in urban and rural areas					
		25	Teachers and students have to design alternative practical method to alleviate the problems in practical activities due to the absence of regular materials					
		26	In the laboratory I am required to design my own experiments to solve given problems					

Appendix-5 TQ-questionnaire to be filled by teachers

Personal information

Sex_________________

Age________________

Marital status____________

Dear respondents

The purpose of this five point Likert scale questionnaire is to assess information or opinion about practicals in chemistry from the teachers. Through this questionnaire, I would like to get your view regarding the approach how to deliver or conduct the experiments, mechanism to minimize the poor achievement and benefits to the learners in chemistry education at senior secondary school.

The success of the study to a great extend depends on your genuine and firmly responses to each question. Therefore, you are kindly requested to fill the questionnaire honestly and responsibly. Be sure that all the information you provide will be remaining confidential and used for research purpose only.

SN	The perception of teachers' in chemistry laboratory works(volumetric analysis) and its effect on students achievement	Alternatives				
		1	2	3	4	5
Process skills from teaching chemistry laboratory (volumetric analysis)		1	2	3	4	5
1	The use of chemistry practical is to learn how to handle apparatus					
2	Poor achievement in volumetric analysis in chemistry is due to lack of observational skills in experimental works					
3	Chemistry practicals can develop students' reading skills and observational skills					
4	Students can develop recording skill from laboratory practice					
5	The laboratory practices develop students interpretation skill					
Teachers ' perception based on Improvisation		1	2	3	4	5

6	Reluctant to improvise because of your poor knowledge of improvisation					
7	Students can easily understand the practicals in chemistry when they do experiments with local materials in the absence of regular materials					
8	you encourage students to improvise					
9	Teaching with low cost local materials solve the equity problem for quality education for both urban and rural schools					
Advantage of teaching chemistry practical		1	2	3	4	5
10	Chemistry practical prove a theory aspect of the lesson					
11	Chemistry practicals benefit students because they give for the students ideas related to chemistry					
12	Students easily learn how to conduct experiments when they exposed to practical activities					
Comparing actual practical model and alternative practical model		1	2	3	4	5
1	Students can get practical knowledge with conventional method as equally as alternatively designed method.					

Appendix-6 Test Questions

This was test questions to check the willingness of teachers assist in research work

1. Are you interested in assisting doing the research work entitled" comparative effectiveness actual practical and alternative practical chemistry teaching models of students' achievement in volumetric analysis? A. Yes B. NO
2. Have you taught as a chemistry teacher with improvised local materials?
   A. Yes B. no
3. Confidentiality in research work is important and mandatory. So how much you confident in doing this research work? A. very great B. Great C. Not confidential
4. Have you done an experiment ‘‘ titration’’ using local materials Lemmon, flowers as indicators, and ash of charcoal as a base after dissolving in pure water?
   A. yes B. No

5. What you suggest to other teachers in your school in the absence of laboratory facilities like equipment and chemicals to teach science experiments?

Appendix-7 lesson plan

<table>
<tr><td colspan="4">Subject: Chemistry –volumetric analysis Date of Lesson:</td></tr>
<tr><td colspan="4">Title of Lesson: titration Experiment Level of Class: 12th
Duration: 2hr</td></tr>
<tr><td colspan="4">Specific Learning Objectives: upon completion of this lesson, the students will be able to:
• Describe the difference between solubility and solution</td></tr>
<tr><td>Contents</td><td>Teacher Activity</td><td>Time</td><td>Student Activity</td></tr>
<tr><td rowspan="3">Experiment one

Solubility of substances</td><td>Introduction
• Asking prior learning/Experience (Brainstorming)
• Reviewing the previous lesson by involving students inviting students to review)
• Connecting with the previous lessons using few questions, examples</td><td>5 mints</td><td>• Responding to questions
• Reflecting or responding to questions, reviewing the lesson
• Responding to questions from the previous lesson, giving examples
• Doing experiments</td></tr>
<tr><td>Presentation
• Discussing main points
• Giving examples to clarify the concept
• Demonstration
• Assigning to pair/group or discussion
• Make groups present result of discussion</td><td>20 mints</td><td>• Reacting to teacher's discussion in form of questions/approval/nodding/ disapproval
• Participating in demonstration(reporting)
• Doing experiments
• Participating in pair discussion/group discussion
• Participating in group work and exchanging results</td></tr>
<tr><td>Stabilization
• Giving class work
➢ Giving feedback
• Supervising students while making corrections during doing experiments
• Summarizing by involving students(asking</td><td>8 mints</td><td>• Doing class work
• Making correction and requesting for clarification
• Responding</td></tr>
</table>

	questions)		
	Assessment • Asking oral questions • Giving problems • Telling students to do laboratory reports	7 mints	• Answering questions • Solving problems • Writing laboratory reports
Experiment -2 Preparations of solutions of known concentrations	Introduction • Asking prior learning/Experience (Brainstorming) • Reviewing the previous lesson by involving students(asking questions, inviting students to review) Connecting with the previous lessons using few questions, examples		• Responding to questions • Reflecting or responding to questions, reviewing the lesson Responding to questions from the previous lesson, giving examples
	Presentation • Discussing main points • Giving examples to clarify the concept • Demonstration • Assigning to pair/group or discussion Make groups present result of discussion		• Reacting to teacher's discussion in form of questions/approval/nodding/ disapproval • Participating in demonstration(reporting) • Doing experiments • Participating in pair discussion/group discussion Participating in group work and exchanging results
	Stabilization • Giving class work ➢ Giving feedback • Supervising students while making corrections during doing experiments Summarizing by involving students(asking questions)		• Doing class work • Making correction and requesting for clarification • Responding
	Assessment • Asking oral questions		• Answering questions • Solving problems

	• Giving problems • Telling students to do laboratory reports		Writing laboratory reports
Experiment-3 Preparation of solutions of low concentration from saturated stock solution	Introduction • Asking prior learning/Experience (Brainstorming) • Reviewing the previous lesson by involving students(asking questions, inviting students to review) Connecting with the previous lessons using few questions, examples		• Responding to questions • Reflecting or responding to questions, reviewing the lesson Responding to questions from the previous lesson, giving examples
	Presentation • Discussing main points • Giving examples to clarify the concept • Demonstration • Assigning to pair/group or discussion Make groups present result of discussion		• Reacting to teacher's discussion in form of questions/approval/nodding/ disapproval • Participating in demonstration(reporting) • Doing experiments • Participating in pair discussion/group discussion Participating in group work and exchanging results
	Stabilization • Giving class work ➢ Giving feedback • Supervising students while making corrections during doing experiments Summarizing by involving students(asking questions)		• Doing class work • Making correction and requesting for clarification • Responding
	Assessment • Asking oral questions • Giving problems • Telling students to do laboratory reports		• Answering questions • Solving problems Writing laboratory reports
Experiment-4 Acid-base titration	Introduction • Asking prior learning/Experience (Brainstorming) • Reviewing the previous lesson by involving		• Responding to questions • Reflecting or responding to questions, reviewing the lesson Responding to questions

	students(asking questions, inviting students to review) Connecting with the previous lessons using few questions, examples		from the previous lesson, giving examples
	Presentation • Discussing main points • Giving examples to clarify the concept • Demonstration • Assigning to pair/group or discussion Make groups present result of discussion from laboratory experiments		• Reacting to teacher's discussion in form of questions/approval/nodding/ disapproval • Participating in demonstration(reporting) • Doing experiments • Participating in pair discussion/group discussion Participating in group work and exchanging results
	Stabilization • Giving class work ➢ Giving feedback • Supervising students while making corrections during doing experiments Summarizing by involving students(asking questions)		• Doing class work • Making correction and requesting for clarification • Responding
	Assessment • Asking oral questions • Giving problems • Telling students to do laboratory reports • Encouraging students to improvise appropriate apparatus and chemicals to respective experiments		• Answering questions • Solving problems Writing laboratory reports Students improvise apparatus and chemicals for respective experiments

Appendix- 8 Ethical clearance

UNISA | college of science, engineering and technology

Dear Mr. Doelaso, E. A. (55780490)

Date: 2014-09-10

Application number:

2014_CGS/ISTE_019

REQUEST FOR ETHICAL CLEARANCE: (Comparative Effectiveness of Actual Practical and Alternative Practical Chemistry Teaching Models of Students' Achievement in Volumetric Analysis.)

The College of Science, Engineering and Technology's (CSET) Research and Ethics Committee has considered the relevant parts of the studies relating to the abovementioned research project and research methodology and is pleased to inform you that ethical clearance is granted for your research study as set out in your proposal and application for ethical clearance.

Therefore, involved parties may also consider ethics approval as granted. However, the permission granted must not be misconstrued as constituting an instruction from the CSET Executive or the CSET CRIC that sampled interviewees (if applicable) are compelled to take part in the research project. All interviewees retain their individual right to decide whether to participate or not.

We trust that the research will be undertaken in a manner that is respectful of the rights and integrity of those who volunteer to participate, as stipulated in the UNISA Research Ethics policy. The policy can be found at the following URL:
http://cm.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf

Please note that the ethical clearance is granted for the duration of this project and if you subsequently do a follow-up study that requires the use of a different research instrument, you will have to submit an addendum to this application, explaining the purpose of the follow-up study and attach the new instrument along with a comprehensive information document and consent form.

Yours sincerely

Prof Ernest Mnkandla
Chair: College of Science, Engineering and Technology Ethics Sub-Committee

Prof IOG Moche
Executive Dean: College of Science, Engineering and Technology

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2015 -02- 13
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College of Science, Engineer
and Technology

University of South Africa
College of Science, Engineering and Technology
The Science Campus
C/o Christiaan de Wet Road and Pioneer Avenue,
Florida Park, Roodepoort
Private Bag X6, Florida, 1710
www.unisa.ac.za/cset

UNISA | college of science, engineering and technology

Appendix-9a the consent of education sector in Sidama zone

Sidaamu Zoone Gashshooti
Sidaamu Zoone Rosu Diddishsa
በሲዳማ ዞን አስተዳደር
የሲዳማ ዞን ትምህርት መምሪያ

Ref No 7ዐ/3-1062/12
Date 20/04/2007

TO WHOM IT MAY CONCERN

Subject: APPROVAL LETTER

This Approval letter is given to Bekele Albejo Doelaso upon his quest as a PHD student at the university of South Africa (UNISA) on date 28/12/2014 to use all the materials, equipment, and spare time with regard to laboratory issues (work) to do the PHD research work entitled" the comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis." Based on his quest the Sidama zone educational office permits him to use all the materials, equipment, chemicals and spare time as well as for data collection in schools for his study. Finally as a head of office, I wish a good success to the student on the behalf of Sidama zone educational office in his all journey of the study.

With regards

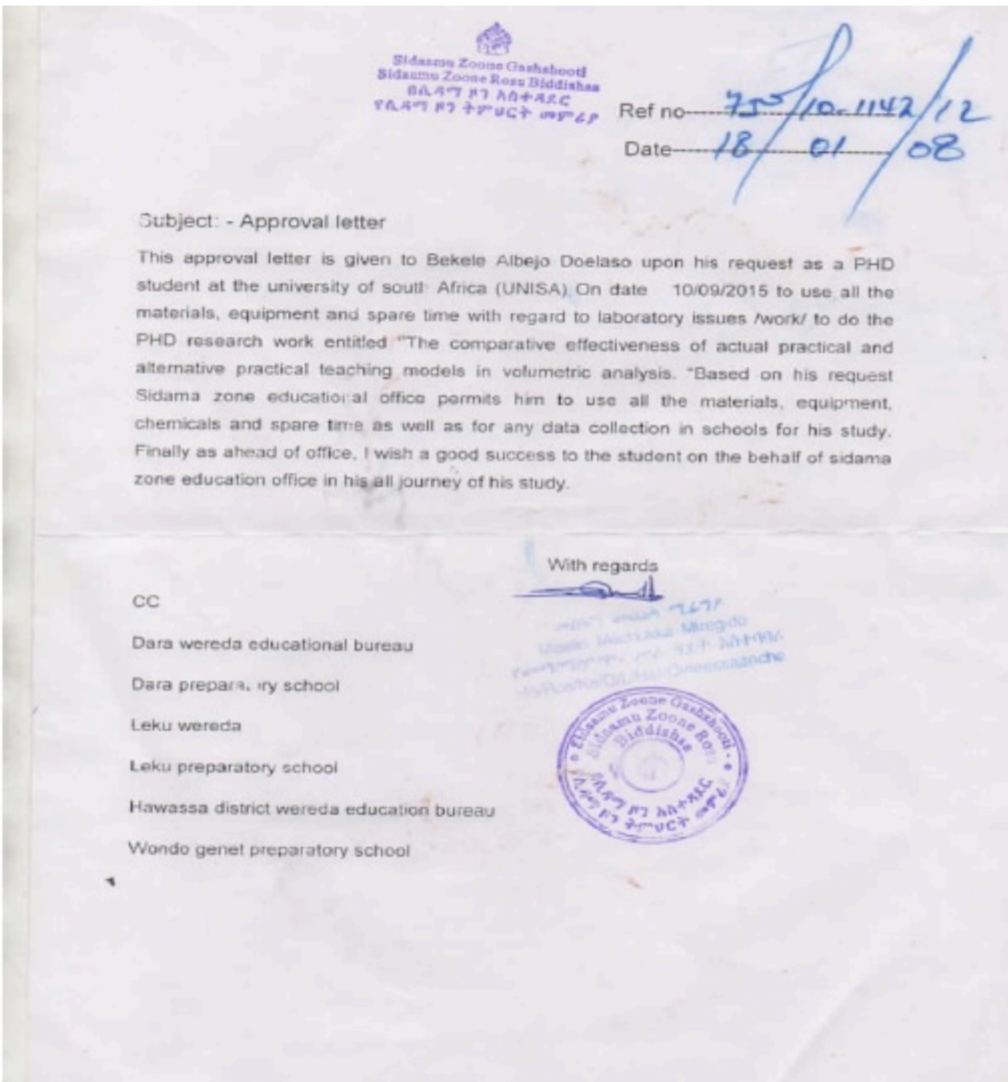
Tesfin Mechukka Miregido

o/Rue/Ke/Q/L/Har/Qinessaancho

CC

- Bansa wereda educational bureau
- Bansa preparatory school
- Yiregalem wereda educational bureau
- Yiregalem preparatory school
- Arbegona wereda educational bureau
- Arbegona preparatory school

Appendix-9b The consent of Education sector in sidama Zone



Sidaamu Zoone Gashshooti
Sidaamu Zoone Rosu Biddishsa

Ref no 75/10-1142/12
Date 18/01/08

Subject: - Approval letter

This approval letter is given to Bekele Albejo Doelaso upon his request as a PHD student at the university of south Africa (UNISA) On date 10/09/2015 to use all the materials, equipment and spare time with regard to laboratory issues /work/ to do the PHD research work entitled "The comparative effectiveness of actual practical and alternative practical teaching models in volumetric analysis. "Based on his request Sidama zone educational office permits him to use all the materials, equipment, chemicals and spare time as well as for any data collection in schools for his study. Finally as ahead of office, I wish a good success to the student on the behalf of sidama zone education office in his all journey of his study.

With regards

CC

Dara wereda educational bureau

Dara prepara. ry school

Leku wereda

Leku preparatory school

Hawassa district wereda education bureau

Wondo genet preparatory school

Appendix-10 profile of assistant teacher in Shebedino/Leku school

Ref No 24/11-4/35

Date 14-6, 2015

To whom it may concern

Name of assistant teacher Negalegn Kedir

Service year 8

Salary per month

School Leku

The above mentioned teacher is one of the chemistry teacher assigned as a research assistant for a researcher (Bekele Albejo Doelaso) in his PHD study on duties will be handled in our school on the research work entitled "comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis. Finally, I wish a good success to the student in his research work.

With regards

CC

- Assistant teacher

Yohannes Youne Markos

Admi Vice Director

Appendix-11 profile of assistant teacher in W/genet school

Ref No 044/09043/12

Date 3/20/08

To whom it may concern

Name of assistant teacher Aklilu Bekele

Service year

Salary per month 4867

School W/G/P (school)

The above mentioned teacher is one of the chemistry teacher assigned as a research assistant for a researcher (Bekele Albejo Doelaso) in his PHD study on duties will be handled in our school on the research work entitled "comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis. Finally, I wish a good success to the student in his research work

With regards

CC

- Assistant teacher

Appendix-12 profile of assistant teacher in Yirgalem school

Ref No 1/11120/1/12

Date 19/8/2007

Sidama Zone Educational Department Yirgalem Secondary & Preparatory School

To whom it may concern

Name of assistant teacher Asirat Tadese

Service year 8 (eight)

Salary per month 3278

School Yirgalem S&P. School

The above mentioned teacher is one of the chemistry teachers assigned as a research assistant for a researcher (Bekele Albejo Doelaso) in his PHD study on duties will be handled in our school on the research work entitled "comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis. Finally, I wish a good success to the student in his research work.

With regards

Principal

CC

- Assistant teacher

Appendix-13 profile of assistant teacher in Arbegona school

Ref No 1/823/85

Date 12/08/07

To whom it may concern

Name of assistant teacher Kelemu Honja

Service year 8(eight)

Salary per month 3278

School Arbegona S/S/Prep/School

The above mentioned teacher is one of the chemistry teacher assigned as a research assistant for a researcher (Bekele Albejo Doelaso) in his PHD study on duties will be handled in our school on the research work entitled "comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis. Finally, I wish a good success to the student in his research work.

With regards

Solomon Siyum Gossaye

DIRECTOR

CC

- Assistant teacher

Appendix-14 profile of assistant teacher in Bansa/kewena gata school

To whom it may concern

Name of assistant teacher Adane Bretuna

Service year 8(eight)

Salary per month 3278

School Kewena Gate S/S and Preparatory School

The above mentioned teacher is one of the chemistry teacher assigned as a research assistant for a researcher (Bekele Albejo Doelaso) in his PHD study on duties will be handled in our school on the research work entitled "comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis. Finally, I wish a good success to the student in his research work.

With regards

CC

- Assistant teacher

Sidama Zone Education Department Kewena Gata Preparatory and Senior Secondary School

አለማየሁ ቡጣ አዲቆ

Alemayehu Butta Adiko

Academic & Cop/V/Director

Appendix-15 Confirmation letter regarding research work was done in school w/Genet

Date- October 1/4/2017

Ref number

To institute for science and technology Education (ISTE), university of South Africa (UNISA)

Subject: Consent letter

Mr. Doelaso BA requested our school to get letter of consent from the participants in his research work in the year 2015. The school principals on the behalf of the school communicated all the students (Grade 12 students) and teachers in the school to give their permission to participate in the study by explaining his research project. Accordingly, the students and teachers had shown positive response to participate on the project work and the researcher conducted his research work based on the permission was given to him by the school principals and also the positive response of students and teachers.

Therefore, we would like to inform your institution that Mr Doelaso BA was allowed and conducted his PHD project in our school considering intact group after taking predetermined measure in allocating the number of students in a class. After all these measure was taken the above mentioned researcher effectively collected all necessary data from the intended participants.

With best regards

TESHALE REFERA REGASS

PRINCIPAL

Appendix-16a pilot study in Hayole school

HAYOLE EDUCATION PROJECT

FURRA MODEL ACADEMY

Date [illegible]/3-685/3
Ref 02/09/09

To: UNIVERSITY OF SOUTH AFRICA (UNISA) - ISTE-DEPARTMENT OF CHEMISTRY EDUCATION

Subject: **Recommendation letter on Evaluation of reliability of achievement test and questionnaire**

Name of the researcher BEKELE ALBEJO DOELASO

Title of the research Comparative Effectiveness of Actual Practical and Alternative Practical Chemistry Teaching Models of Students' Achievement in Volumetric Analysis

The above mentioned researcher request the letter on April 6,2017 about his accomplishment of the piloting of achievement test and questionnaires on comparative study of effectiveness of actual practical(teaching using industrially processed materials) and alternative practical(teaching using local material). According to his request, the Hayole Education Project Furra Model Academy General secondary and Preparatory school has given the recommendation letter on the evolution of reliability of the achievement test and questionnaires on grade 12 students from November 15, 2014 to November 20, 2014 as piloting to evaluate the reliability of instruments. So, you kindly accept his evaluation result of piloting of the instruments.

With regards

Belayneh Sarmiso Sare

Secondary School Principal

Cc: Mr. Bekele Albejo

WHEN REPLY WRITE OUR REFERENCE NUMBER!

TEL. 0468222364; 0911098808; 0468209629 *P. O.BOX: 2202*

16b Profile of assistant teacher in w/g/s

Sidaamu Zoone R/Biddishshia Wondo
Genetete Woradi Wondo Genet
Qixxaaworenna Xaphphoomu
2ki Dirimi R/Mine

Ref No- 044/09043/12

Date- 3/10/08

To whom it may concern

Name of assistant teacher Lijmarez Degemu

Service year

Salary per month 4269

School W/G/P/ School

The above mentioned teacher is one of the chemistry teacher assigned as a research assistant for a researcher (Bekele Albejo Doelaso) in his PHD study on duties will be handled in our school on the research work entitled "comparative effectiveness of actual practical and alternative practical teaching models in chemistry in volumetric analysis. Finally, I wish a good success to the student in his research work.

With regards

Isegaye Hajamo Yoteru
Rosu Mini Muricha

CC

- Assistant teacher

Appendix-17confirmation about research work was done in banasa school

Sidama Zone Education Department
Gala Senior Secondary School

Date

Ref number

To institute for science and technology Education (ISTE), university of South Africa (UNISA)

Subject: Consent letter

Mr. Doelaso BA requested our school to get letter of consent from the participants in his research work in the year 2015. The school principals on the behalf of the school communicated all the students (Grade 12 students) and teachers in the school to give their permission to participate in the study by explaining his research project. Accordingly, the students and teachers had shown positive response to participate on the project work and the researcher conducted his research work based on the permission was given to him by the school principals and also the positive response of students and teachers.

Therefore, we would like to inform your institution that Mr Doelaso BA was allowed and conducted his PHD project in our school considering intact group after taking predetermined measure in allocating the number of students in a class. After all these measure was taken the above mentioned researcher effectively collected all necessary data from the intended participants.

With best regards

Aseffa Bakkaaye Gurraachcha
Director

Appendix-18 Confirmation letter regarding research work was done in school Arbegona

Date 11/03/2010

Ref number 1/307/15

To institute for science and technology Education (ISTE), university of South Africa (UNISA)

Subject: Consent letter

Mr. Doelaso BA requested our school to get letter of consent from the participants in his research work in the year 2015. The school principals on the behalf of the school communicated all the students (Grade 12 students) and teachers in the school to give their permission to participate in the study by explaining his research project. Accordingly, the students and teachers had shown positive response to participate on the project work and the researcher conducted his research work based on the permission was given to him by the school principals and also the positive response of students and teachers.

Therefore, we would like to inform your institution that Mr Doelaso BA was allowed and conducted his PHD project in our school considering intact group after taking predetermined measure in allocating the number of students in a class. After all these measure was taken the above mentioned researcher effectively collected all necessary data from the intended participants.

With best regards

Glasachew Girma Taddesse

Adm/Vice Principal

Appendix-19 Confirmation letter regarding research work was done in Yirgalem school

Sidama Zone Educational Department
Yirgalem Secondary & Preparatory School

Date: [illegible]

Ref number: 01/03 [illegible]

To institute for science and technology Education (ISTE), university of South Africa (UNISA)

Subject: Consent letter

Mr. Doelaso BA requested our school to get letter of consent from the participants in his research work in the year 2015. The school principals on the behalf of the school communicated all the students (Grade 12 students) and teachers in the school to give their permission to participate in the study by explaining his research project. Accordingly, the students and teachers had shown positive response to participate on the project work and the researcher conducted his research work based on the permission was given to him by the school principals and also the positive response of students and teachers.

Therefore, we would like to inform your institution that Mr Doelaso BA was allowed and conducted his PHD project in our school considering intact group after taking predetermined measure in allocating the number of students in a class. After all these measure was taken the above mentioned researcher effectively collected all necessary data from the intended participants.

With best regards

Addisu Abebe Gobena
Principal

Appendix-20 Confirmation letter regarding research work was done in school Kebedo

Date 10/02/2010

Ref number 1/245/15

To Institute for science and technology Education (ISTE), university of South Africa (UNISA)

Subject: Consent letter

Mr. Doelaso BA requested our school to get letter of consent from the participants in his research work in the year 2015. The school principals on the behalf of the school communicated all the students (Grade 12 students) and teachers in the school to give their permission to participate in the study by explaining his research project. Accordingly, the students and teachers had shown positive response to participate on the project work and the researcher conducted his research work based on the permission was given to him by the school principals and also the positive response of students and teachers.

Therefore, we would like to inform your institution that Mr Doelaso BA was allowed and conducted his PHD project in our school considering intact group after taking predetermined measure in allocating the number of students in a class. After all these measure was taken the above mentioned researcher effectively collected all necessary data from the intended participants.

With best regards

Zelalem Gizachew Kidane

Principal

Appendix 21confirmation letter concering the research in the school Leku

Subject: Consent letter

Mr. Doelaso BA requested our school to get letter of consen
research work in the year 2015. The school principals o
communicated all the students (Grade 12 students) and te
their permission to participate in the study by explai
Accordingly, the students and teachers had shown positive
the project work and the researcher conducted his res
permission was given to him by the school principals and a
students and teachers.

Therefore, we would like to inform your institution that Mr D
conducted his PHD project in our school considering
predetermined measure in allocating the number of studen
measure was taken the above mentioned researcher effect
data from the intended participants.

With best regards

Kokeb Beyene H/Giorgis

Acd/ Vice Director

SNNPR State Sidama Zone Edu. ... Leku Senior Secondary & Preparatory School

Appendix-22 Achievement test face and content validity evaluator-1

To whom it may concern

Subject Recommendation letter

I read all the achievement test questions that are constructed from the intended topic and sub topics based on one of the three blooms taxonomy of teaching that including all six cognitive domains in its order. Hence the questions are very good and measure the intended objectives of the research work on the topic entitled 'the Comparative Effectiveness of Actual Practical and Alternative Practical Chemistry Teaching Models of Students' Achievement in Volumetric Analysis

Name of the evaluator Belay Abushe

Title Mr

Academic Rank lecturer

Education Background Bed, Msc

Work experience in high school 2 Years

Work experience in university 11 Years in teaching

Appendix-23 Achievement face and content validity Evaluator-2

To whom it may concern

Subject Recommendation letter

I read all the achievement test questions that are constructed from the intended topic and sub topics based on one of the three blooms taxonomy of teaching that including all six cognitive domains in its order. Hence the questions are very good and measure the intended objectives of the research work on the topic entitled 'the Comparative Effectiveness of Actual Practical and Alternative Practical Chemistry Teaching Models of Students' Achievement in Volumetric Analysis

Name of the evaluator Wondimagagn Tegese

Title Mr

Academic Rank lecturer

Education Background Bed, Msc

Work experience in high school (college) 4 Years

Work experience in university 6 years in teaching

Appendix-24 Questionnaire evaluator

To whom it may concern

Subject Recommendation letter

I read the entire questionnaire that are constructed for the intended project work and administered before and after treatment to evaluate students' perception. Hence the items are very good and measure the intended objectives of the project work on the topic entitled 'the comparative effectiveness of actual Practical and alternative practical chemistry teaching models of students' achievement in volumetric analysis.

Name of the evaluator Solomon Boko Signature ______

Title Mr

Academic Rank lecturer

Education Background Bsc, Msc

Work experience in university 8 year teaching in statistics

Appendix-25 Achievement test face and content validity evaluator-3

To whom it may concern

Subject Recommendation letter

I read all the achievement test questions that are constructed from the intended topic and sub topics based on one of the three blooms taxonomy of teaching that including all six cognitive domains in its order. Hence the questions are very good and measure the intended objectives of the research work on the topic entitled 'the Comparative Effectiveness of Actual Practical and Alternative Practical Chemistry Teaching Models of Students' Achievement in Volumetric Analysis

Name of the evaluator Workneh Mengeshe

Title Mr

Academic Rank lecturer

Education Background Bed, Msc

Work experience in high school 4 Year

Work experience in university 12 Yeer in teaching

Appendix 26a learners consent in Kewado School to participate in research

Attendance and students consent to participate in teaching methodology in kewado school in 2008/2015				
SN	Name of the sudents			Signature
1	SEID	ALI	ARGUMA	
2	BEZAWIT	KIFLE	KERSIMA	
3	ABATHUN	CHANIE	TAREKEGN	
4	NATNAEL	ASCHALEW	TEFERA	
5	KASIM	MOHAMMED	MUZEYIN	
6	HABTAMU	LEGIDE	LALIMA	
7	ABENEZER	ARGATA	BILATE	
8	DEREJE	DANGISO	BAYU	
9	ASHEBIR	AMENU	ATARA	
10	NETSANET	MARKOS	NARAMO	
11	TESHALE	TESFAYE	WONDYIFRAW	
12	ABINET	BEFIRDU	ALEMU	
13	GETAHUN	SHIBRU	DANGISO	
14	ABIDLAK	NURI	SAID	
15	ADDISU	TSEGAYE	ARIFAYINE	
16	ABIY	DEFAR	WELDETSADIK	
17	HABTAMU	YIRGALEM	YIFIRU	
18	NIGUSE	GOSAYE	TILAHUN	
19	DANIEL	ELIAS	FIRE	
20	AKALU	ARGETA	AMELO	
21	ALEMSEGED	ZERHUN	BEYENE	
22	AMARE	ADNEW	AMANO	
23	HENOK	HAILU	HAMESO	
24	ASTER	ARGISO	AMAJE	
25	KAYAMO	LIMASA	GAMADA	
26	SINTAYEHU	SINKE	SIRE	
27	ADUGNA	ASEFA	NARE	
28	ASMAMAW	AFEWORK	BEKELE	
29	ASHEBIR	SIRE	SIKAMO	
30	MULUKEN	TADELE	TEKA	
31	KEFELEGN	ABERA	ALEMU	
32	SITOTA	LAMISO	HIRBORA	
33	SAMUEL	WACHAMO	WANSARA	
34	HAYMANOT	ZENEBE	TESFAYE	
35	YETNAYET	NEGUSSIE	TILAHUN	
36	SIMAGEGN	GETACHEW	LEMMA	
37	FREW	DIBEKULU	MENBERE	
38	TIGIST	SISAY	DOGISSO	
39	MESAFINT	SHALA	GERMAMO	
40	FIKIRU	BOLKA	BOTALA	
41	FISAHA	FELEKE	FELA	
42	BIRUK	MULUGETA	MAMO	
43	SEYIFEWONGEL	ASSEFA	DINGAMA	
44	ASTAREKEGN	BELAYNEH	SHOOLA	
45	REDIET	ENDALELET	AMALO	
46	FETENE	FANTAYE	YUTA	
47	ABEBECH	ALEMU	KENA	
48	TIRSET	ABEBAYEHU	YIRDAW	
49	MAMUSH	MENGESHA	LUTO	
50	KEEYALEW	KAYESO	KAKE	

Appendix 26b learners’ consent to participate in research in bansa/Kewena gata

Attendance and students consent to participate in teaching methodology in kewena Gata/Bansa school in 2008/2015

	Name of students			Signature
1	ABULE	TAFESE	TEFERI	
2	PETROS	FENA	TURO	
3	WENDIMAGEGN	ADMASU	MENGSTE	
4	NEGASH	GIMBO	MEKISA	
5	LIDYA	YONAS	HEGENA	
6	BEGASHAW	BENTI	HAMESSO	
7	PETROS	FUYALA	SEDA	
8	ADANECH	TESHOME	GARMAMO	
9	TAMIRAT	BUWA	BULO	
10	MENGISTU	BETENA	HODHO	
11	SAMUEL	AREGA	WOBISA	
12	MALKA	MARASA	MAGO	
13	SAMUEL	HAILU	BATE	
14	DANGAMO	KIA	BENA	
15	WUBETU	GISHIRE	ALE	
16	MULUGETA	AYELE	WARITU	
17	ASHENAFI	MATHEWOS	BUKULA	
18	BELAINEH	BORCHE	BORU	
19	SAMUEL	BOLKA	DIKALE	
20	SANTE	MASHUKA	LEGIDE	
21	DESALEGN	DAWIT	GEDA	
22	ABUSH	LAGIDE	DIKALE	
23	ADEM	BIFTU	GUYE	
24	SAMULE	WOTAR	GORA	
25	YOSEPH	BIRU	WARE	
26	SANBATO	KOROSO	KONSO	
27	SAMUEL	BUCHE	KARE	
28	SAMUEL	KANTASHO	SILO	
29	SANTE	ARGO	TUMICHA	
30	DAWIT	TESEMA	HATIYA	
31	DANIEL	DAKA	DASHARU	
32	EYASU	BUKURE	RACHO	
33	TARIKU	TAMIRE	TEFERA	
34	SAMUEL	TAMIRAT	ALE	
35	SHALAMO	SHANA	YONTA	
36	SAMUEL	TAMIRU	BARASA	
37	DAMOZE	DAFURSA	WAE	
38	ABERA	ABATE	FICHE	
39	MENGISTU	BASHA	BARSO	
40	SANBATO	KILISA	RIKIWA	
41	SOLOMON	DEMISSE	KANU	
42	MENGESHA	MERASA	BARASO	
43	DEMELASH	FENEGA	FARESO	
44	BEYENE	BEKE	DEBESSA	
45	BELAYNEH	RIKIBA	DASA	
46	ASEFA	GIMBO	MEKISA	
47	NIGUSE	NARAMO	NOE	
48	SEFU	GADA	GASARE	
49	KEFIYALOW	TESUFAYE	HARO	
50	YONTORA	DAFURSA	CHEA	

Sidama Zone Education Department Kebena Gata ... & Senior Secondary School

Appendix26c Learners' willingness or consent to participate in research in leku school

Attendance and students consent to participate in teaching methodology in Leku school in 2008/2015

SN	Name of students			Signature
1	REBECCA	SISAY	GEBRETSADIK	
2	DANIEL	MATHEWOS	BARASA	
3	LEOUL	HAILU	TEMTIME	
4	ANTENEH	ALEMU	GAGA	
5	BEREKET	BEYENE	BALANGO	
6	DEGIFE	WOMA	WONAGO	
7	DANIEL	KUWASO	KUMALO	
8	MECHAL	YIRDAW	WOLDEHAWARIAT	
9	MARIKOS	MESELE	MATA	
10	TEMESGEN	GIRMA	TOLOSHA	
11	ALEMAYEHU	ADMASU	HANCHACHA	
12	DERIBE	WOLESA	LATAMO	
13	KALKIDAN	BIRMEJI	BERJA	
14	NEJEMEDIN	MUDE	KIYAR	
15	KALID	ASHENAF	LELAMO	
16	ERMIAS	YUKENA	MULATU	
17	LEUEL	HABTEAB	WORKU	
18	ZELEKE	ZERFU	ASFAW	
19	ESAYAS	DEJEN	GEBRE	
20	KIBRU	DANIEL	HATIYA	
21	MATHEWOS	LEGESE	LAMISO	
22	MELKAMU	MENGISTU	HUMMESSO	
23	DEREJE	DAWIT	MERISA	
24	DIRSHAYE	DANCHA	DARZA	
25	YOFTAHE	ASFAW	GATIRA	
26	BAHAILU	SIME	BARASO	
27	HANA	ASEFA	BEKELE	
28	MANTI	TALO	TADAMO	
29	FILO	FIRDAMO	HURISO	
30	BEREKET	BERHANU	FARESSO	
31	BEREKET	ALEMAYEHU	ABEBE	
32	DERBE	NAMARO	YAWO	
33	SINTAYEHU	ASEFA	BARARA	
34	ATINAFU	SHANURA	GIKISO	
35	EYOB	YOHANNES	GATISO	
36	FIKIRU	BORENA	BORISAMO	
37	EYOEL	HAILU	LALAMO	
38	ABEL	PETROS	SHUBISHA	
39	DENEKE	YOHANNES	BOKORA	
40	DERESECH	SAMUEL	ALEMU	
41	BERHANU	SAMUEL	TONA	
42	DEMIRE	DESALEGN	DAKA	
43	TARIKU	SHIMELIS	GANAMO	
44	WASIYIHUN	YISIHAK	YUMAYO	
45	HAILEYESUS	GEBISO	HANAKO	
46	EYASU	MANO	MAYIDA	
47	MINTESINOT	MICKAEL	ASHIRO	
48	YOHANNIS	YETERA	SHALLAMO	
49	KASAHUN	EYASU	MUDE	
50	ELIAS	EBISO	MANJA	

Appendix26 d –Learners consent to participate in research in wondogenet school

SN	Attendance and students consent to participate in teaching methodology in WondoGenet school in 2008/2015			
	Name of students			Signature
1	GETU	ERMIYAS	GABISO	
2	TABITA	YACOB	MEGARO	
3	HENOCK	YOSEPH	DIMA	
4	BEREKET	DIDAMO	SARMISA	
5	HAILE	HALCHO	MORKA	
6	HIRPO	LAGIDE	GAMATO	
7	ESAYAS	HEWISO	TOSA	
8	HENOK	PHILPOS	BUNKURA	
9	ZERIHUN	EGATA	DOYAMO	
10	ALEMU	AMAN	ADEM	
11	MINTESNOT	KEBEDE	FANTU	
12	MEDIHANIT	GEMECHU	BULICHA	
13	HERUT	ESATU	AMBESO	
14	YOSEPH	GENALA	GABESSO	
15	TINSAE	TOMAS	TURCHE	
16	TAMIRAT	HAILE	HANKANA	
17	KERESO	KARISA	KIFALA	
18	MELESE	KARRU	WONGAMO	
19	NIGATU	TEREFE	TILAHUN	
20	KELIL	KEDIR	GALGALU	
21	KAWISO	YETERA	RIKE	
22	ADERA	WENA	MULU	
23	YONAS	AYELE	AMELO	
24	TEGEGN	ERMIAS	BAREDO	
25	KAFALA	HISKEL	RIKE	
26	YEMISRACH	TESFAYE	MEKONNEN	
27	YOSEF	YOHANIS	LEDAMO	
28	TARIKU	TADESSE	KORBESSA	
29	ENDALIKACHEW	ALEMU	ABEBE	
30	URAGO	UTE	KIFALA	
31	MESERET	AJEME	KEBEDE	
32	KEDIR	GUYE	BADASO	
33	IYASU	IYOB	GINBO	
34	ALEMU	EBISO	LEDE	
35	AMANUEL	TILAHUN	TEMESGEN	
36	ZERITU	YACHISO	TULE	
37	TAGESE	ALEMAYEHU	ABIDE	
38	MILKIYAS	EDASO	KIMO	
39	PETROS	PAULOS	LAGIDE	
40	BIRUKTAWIT	CHERU	EJERO	
41	MESERET	BEKELE	BERASA	
42	HANA	TEWODROS	TEDISO	
43	GELATIAS	GALFATO	TULLU	
44	ESHETU	ANORE	TIRKASO	
45	SHANBEL	ELIAS	DALACHA	
46	EYUEL	DANIEL	KAYIMO	
47	HAYALINESH	HAILU	HATISO	
48	SHEWAZER	SHIFERAW	DUDURA	
49	DUGUNA	KITE	HURISO	
50	WOMITU	BETISA	GALIGALU	

Appendix26e-Learners consent to participate in research in Arbegona school

Attendance and students consent to participate in teaching methodologies in Arbegona school grade 12 in 2008/2015

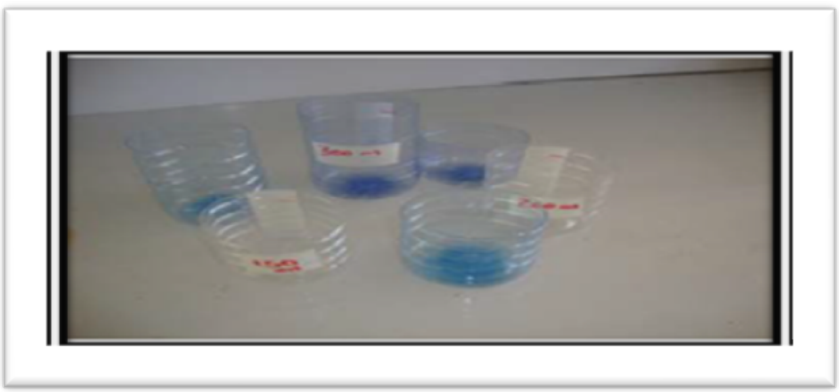
	Name of students			Signature
1	ABULE	TAFESE	TEFERI	
2	PETROS	FENA	TURO	
3	WENDIMAGEGN	ADMASU	MENGSTE	
4	NEGASH	GIMBO	MEKISA	
5	LIDYA	YONAS	HEGENA	
6	BEGASHAW	BENTI	HAMESSO	
7	PETROS	FUYALA	SEDA	
8	ADANECH	TESHOME	GARMAMO	
9	TAMIRAT	BUWA	BULO	
10	MENGISTU	BETENA	HODHO	
11	SAMUEL	AREGA	WOBISA	
12	MALKA	MARASA	MAGO	
13	SAMUEL	HAILU	BATE	
14	DANGAMO	KIA	BENA	
15	WUBETU	GISHIRE	ALE	
16	MULUGETA	AYELE	WARITU	
17	ASHENAFI	MATHEWOS	BUKULA	
18	BELAINEH	BORCHE	BORU	
19	SAMUEL	BOLKA	DIKALE	
20	SANTE	MASHUKA	LEGIDE	
21	DESALEGN	DAWIT	GEDA	
22	ABUSH	LAGIDE	DIKALE	
23	ADEM	BIFTU	GUYE	
24	SAMULE	WOTAR	GORA	
25	YOSEPH	BIRU	WARE	
26	SANBATO	KOROSO	KONSO	
27	SAMUEL	BUCHE	KARE	
28	SAMUEL	KANTASHO	SILO	
29	SANTE	ARGO	TUMICHA	
30	DAWIT	TESEMA	HATIYA	
31	DANIEL	DAKA	DASHARU	
32	EYASU	BUKURE	RACHO	
33	TARIKU	TAMIRE	TEFERA	
34	SAMUEL	TAMIRAT	ALE	
35	SHALAMO	SHANA	YONTA	
36	SAMUEL	TAMIRU	BARASA	
37	DAMOZE	DAFURSA	WAE	
38	ABERA	ABATE	FICHE	
39	MENGISTU	BASHA	BARSO	
40	SANBATO	KILISA	RIKIWA	
41	SOLOMON	DEMISSE	KANU	
42	MENGESHA	MERASA	BARASO	
43	DEMELASH	FENEGA	FARESO	
44	BEYENE	BEKE	DEBESSA	
45	BELAYNEH	RIKIBA	DASA	
46	ASEFA	GIMBO	MEKISA	
47	NIGUSE	NARAMO	NOE	
48	SEFU	GADA	GASARE	
49	KEFIYALOW	TESUFAYE	HARO	
50	YONTORA	DAFURSA	CHEA	

Appendix 26f Learners' willingness to participate in research in Yirgalem school

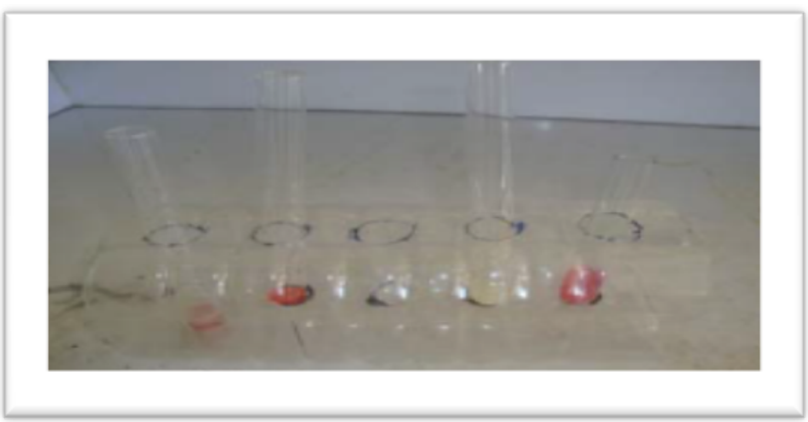
Attendance and students consent to participate in teaching methodology in yirgalem school in 2008/2015				
SN	Name of students			Signature
1	BINYAM	BERHANU	KURKA	
2	FASIL	KINFE	AREDA	
3	SOLOMON.	HAYESO	HAMERO	
4	YISHAK	NIGUSSIE	YOUNKURA	
5	FIREW	TADESSE	WUBE	
6	AYIHENDO	BEKELE	BIRRU	
7	ZERIHUN	KAWATO	AKKE	
8	ABDUSELAM	JEMAL	TEREFE	
9	TESHALE	TSEGAYE	GALFATO	
10	ATKELT	ABEBE	GUJO	
11	MELAKU	MANISA	MACHO	
12	WOYESA	WOKA	WORANA	
13	ABEBAYEHU	AWOL	SEID	
14	HILINA	TADESSE	MERGIYA	
15	TEDLA	TESFAYE	DORA	
16	AYNALEM	GETU	SUNBASO	
17	EPHREM	TEFERA	TESSEMA	
18	MICKYAS	GEBEYEHU	MULAT	
19	ABEBAYEHU	ASHENAFI	ARFASA	
20	TSION	HAILEMICHAEL	BORSAMO	
21	MILKIAS	CHONOSA	DUBISO	
22	HANA	TESHOME	NEGASH	
23	ADMASU	ASFAW	BALANGO	
24	KIBRET	GOSAYE	HAYLEMARIAM	
25	KEFITU	SIYUM	BERASA	
26	SHALLA	KASSA	BUNKURA	
27	DAGMAWIT	DEGIFE	WOLDE	
28	ABRAHAM	NEGASH	DAWAKO	
29	MINYAHIL	ENDESHAW	HABTEYFS	
30	NATNAEL	GENANAW	WENDIMU	
31	BIRUK	ESHETU	TONE	
32	YONAS	ESHETU	MANCHLOT	
33	YAKOB	PHAWULOS	UKE	
34	MOHAMMED	AWOL	TAHIR	
35	AMANUEI	PAWUIOS	BETA	
36	TEKOLLA	DUGUNA	GALFATO	
37	KALEAB	ZELALEM	CHERNET	
38	DAGIM	ZERGAW	GELEGALO	
39	DERIBE	DAWIT	REGASSA	
40	EDEN	DEGIFE	WOLDE	
41	MOGES	ABEBAYEHU	WOLDEYOHANS	
42	MILLION	KIBEBU	DEKAMO	
43	MICHAEL	BEDILU	GEBREMESKEL	
44	FIREW	KASAHUN	WONICHANO	
45	TSIGEREDA	GUGSA	TESFA	
46	ABENEZER	BELAY	KEBEDE	
47	FASIL	GARAMO	GODANA	
48	TEKALIGN	SHORA	BARAMO	
49	DESALEGN	YAEKOB	BORODA	
50	EYASU	NADAMO	NAKE	

Appendix- 27Learners doing titration experiments by using locally improvised materials

Appendix-28 Locally produced beakers by Yitebarek 2012

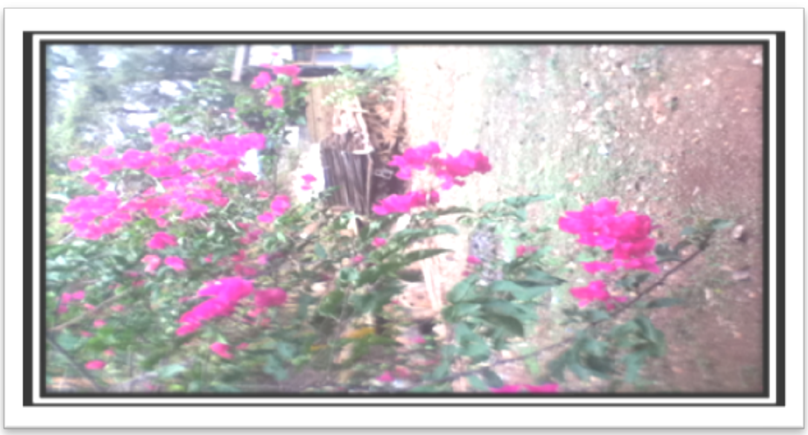


Appendix-29 Locally produced Rack from highland water container

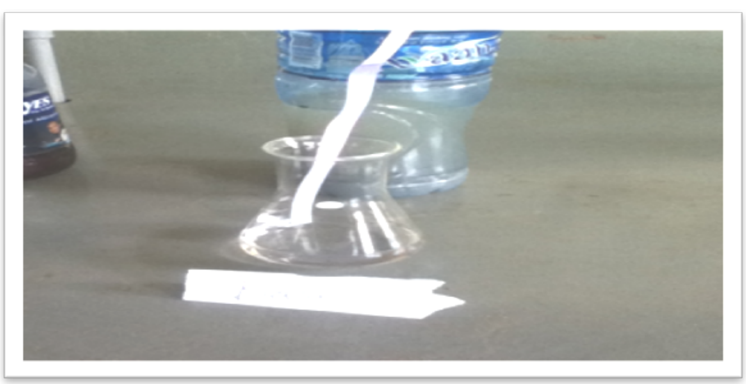


Appendix30 low cost burette, which is produced by reconstruction (Hamisi, 2011)

Appendix-31 Red rose (Rosa chinensis spontanea) flower used for production of a local indicator



Appendix-32 Neutral litmus paper change in to blue litmus in base prepared from ash of charcoal



Appendix-33 Citric acid extracted from Lemmon juice

Appendix-34 Filtrate of Acid, Indicator and Base from the aqueous solution of local materials after extraction