TEACHING AND LEARNING OF PRACTICAL CHEMISTRY IN AFRICAN (NIGERIA, KENYA, SOUTH AFRICA, AND ETHIOPIA) SECONDARY SCHOOLS: A REVIEW

Teame Hadgu[1,*], Goitom Gebreyohannes[2], and Gebrekidan Mebrahtu[3]

[1, 2, 3] Department of Chemistry, Mekelle University, Mekelle, Ethiopia

[*]*Corresponding author: teamehadgu623@gmail.com*

ABSTRACT

The practical activity in chemistry is a new approach of chemistry teaching and learning, which relates to the curriculum of chemistry in basic education. The purpose of the review was to collect evidence and challenges for teaching and learning of practical chemistry practices in the African secondary schools. A literature search of articles related to teaching and learning of practical chemistry were conducted using three data bases, such as Google scholar, Web of science (WOS), and ERIC. The selected articles were carefully read many times and analyzed them from the perspective of the review questions. The review has identified the impact of practical activities, constrains for practices and challenges for implementing practical works in teaching and learning of practical chemistry. Based on the findings collected, in detailed discussion was presented. It is concluded that the quality of chemistry practical work has a significant positive effect on learner's performance in secondary school chemistry. *[African Journal of Chemical Education—AJCE 14(2), May 2024]*

INTRODUCTION

Background of the Review Study

In order to exploit or use the resources in environment, education has a vital role. Based on this education perhaps considered as one of life's most important component. Accordingly, Ethiopia, is one of the countries in Africa, that started and revised the educational and training policy for a couple of decades. One from many, the aims of the Ethiopian education policy is to improve people's physical and mental potential as well as problem solving abilities through the principle that says education for everyone. The most notable of these policies and programs is the consecutive and progressive education sector development plan (ESDP IV). The abilities and talents of the society will be acquired partly through educating pupils in science. For applying education, schools, institutions, educated teachers and other inputs must be available.

According to the study, one of the inputs for high quality education is the use of laboratory activities [1], which are the common instructional method for all levels of science education. Laboratory activities are one of the active teaching and learning methods that supports learners to participate and acquire their own knowledge in the academic activities [2]. Practical work is an essential feature of secondary school science education [3], hence a high proportion of chemistry lesson time in secondary schools is given to practical work, with assumption that they lead to

distinctive attainments in students. Although the practical approach is generally effective in getting students to do things with apparatus and materials, it is also seen as relatively ineffective in developing their conceptual understanding of the associated chemistry ideas and concepts.

Quality of chemistry practical work refers to the degree of learner involvement during chemistry practical. That is, experiments in chemistry lessons are done by students individually, in pairs, in groups of five or in groups of more than five students. Most school chemistry curriculums specify that practical work and investigative activities must be carried out by students. However, there is a gap between policy and practice, between what is written in curriculum documents, what teachers say they do, and what students actually experience. Although the importance of practical work in school science is widely accepted, it is also important that the nature and quality of the practical work be supportive to learning [4]. For many students, what goes on in the laboratory in form of chemistry practical work is said to contribute little to their learning of chemistry or to their learning about chemistry and its methods [5].

Generally, the status of teaching practical chemistry in African countries can vary significantly depending on factors such as resources, infrastructures, and educational polices. In some African countries, practical chemistry is an integral part of the curriculum and is taught in

schools with well-equipped laboratories. These countries have dedicated science teachers who are trained to deliver practical chemistry lessons effectively.

However, in many African countries, there are challenges in teaching practical chemistry due to limited resources and infrastructures. To improve practical chemistry education, enhancing laboratory facilities, providing adequate resources, and promoting teacher training programs could be beneficial. Additionally, fostering partnerships with educational institutions and organizations may contribute to better access to equipment and materials for practical experiments.

Importance of the Quality of Chemistry Practical Work

Many studies have been conducted on the importance of practical work while teaching science. The role of practical work in science education has been detailed by some researchers [6,7]. Currently, science educators and teachers agree that practical work is indispensable to the understanding of science. The main purpose of practical work in science education is to provide students with conceptual and theoretical knowledge to help them learn scientific concepts, and through scientific methods, to understand the nature of science. Multiple studies showed that practical work confers many advantages, including developing laboratory skills and scientific knowledge, as well as understanding science concepts and theories [8,9].

Like other sciences, chemistry teaching and learning is supported by laboratory practical work [10]. Chemistry practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract [11]. Reports emphasize that teaching science with the help of practical work makes science to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture [12]. Students have a lot to benefit from practical work which may include increasing students' interest and abilities in chemistry as well as their achievement in chemistry [13]. Reports emphasize that teaching science with the help of practical work makes science to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture [12].

Good quality practical work gives students an opportunity to engage in deep learning [14]. Using quality practical work provides an opportunity of identifying the main objectives of the work and in planning and executing it, of identifying the conceptual and practical difficulties encountered, recording and discussing the results and observations and of suggesting practical alterations and improvements [15]. The latter, thus, could result in a significant positive impact on a students' ability to learn both the desired practical skills and also the underlying theory. Likewise, if teachers do not select appropriate practical work, may result in practical work of doubtful quality leading to an

approach that is de-motivating for students and a poor use of teaching resources and probably end up with poor performance in the subject.

AIMS AND OBJECTIVES OF THE REVIEW STUDY

This study is intended to review teaching and learning of practical chemistry in African secondary schools, particularly in Nigeria, Kenya, South Africa and Ethiopia. As a result, its overall aims are to:

- collect evidence how teaching and learning of practical chemistry practices in the African secondary schools;
- know the challenges for implementing practical activities in the African secondary schools.
- The specific objectives of the review are to:
- mention the impacts that practical activities have on teaching and learning of chemistry in African secondary schools; and
- identify and suggest to the factors affecting the implementation of practical activities in teaching and learning of chemistry in African secondary schools.

SIGNIFICANCE OF THE REVIEW STUDY

As per the importance of practical activity in teaching and learning of chemistry, this literature review contributes to the research community. The importance of practical work in science is widely accepted and it is acknowledged that good practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge, and conceptual understanding [16].

REVIEW QUESTIONS

In this review, the following review questions were addressed:

RQ1. What was the impact of practical activities on teaching and learning of chemistry in the selected African secondary schools?

RQ2. What were the factors affecting the implementation of practical activities in teaching and learning of chemistry in the selected African secondary schools?

RQ3. What were the challenges of implementing practical activities in teaching and learning of chemistry in the selected African secondary schools?

METHODS OF THE REVIEW STUDY

Literature Search

We conducted a literature search of articles related to teaching and learning of practical chemistry. The selection of search terms required several test rounds and discussions until we found a relevant results. Given that the number of studies concentrating on teaching and learning of practical chemistry was quite small, we decided to include studies like “practical work activities as a method of assessing learning in chemistry teaching”, which we consider to be close to practical chemistry works. we limited the context of the studies to high schools in Africa in the selected countries above and used various sets of terms to capture the studies of practical works and the topic of teaching and learning practical chemistry. we accepted only the years (2016 to 2022) and closely related studies done in African secondary schools in the selected countries.

We conducted the review using three databases: Google scholar, Web of Science (WoS), and ERIC. Besides, we searched for articles published in practical chemistry directly on the journal website. The search criteria we used for Google scholar, WoS, and ERIC were the same to that of the journal website, where the research criteria would have produced 53 matches that appeared largely irrelevant. Therefore, in searching, we focused on the terms relating to practical chemistry

("practical works" or "practical labs" or "practical activities") was mandatory, which improved the validity of the search results.

The final search was conducted, and it yielded 39 matches: Google scholar-12, WoS-11, ERIC-9, journal website-7, seem to be even more beneficial for teaching and learning of practical chemistry. After removing duplicates, we were left with 24 articles. we read through the articles and excluded those that did not match my scope. During this step, we were often able to exclude the paper based on the abstract, but sometimes the decision of exclusion versus inclusion required an examination of the full text. The reasons for exclusion were that the study was not a recent study (n = 7), the teaching and learning were not mentioned or described in the study (n = 4) and the study was not about practical works (n = 3). After this exclusion round, we ended up with 10 articles. In total, we had 10 articles for the final data analysis. However, while reading the full articles, we still had to exclude three articles, mainly because they did not sufficiently describe the teaching and learning of practical chemistry for the needs of my analysis. In the end, 7 articles were selected for the review. Figure 1 visualizes my article selection process.

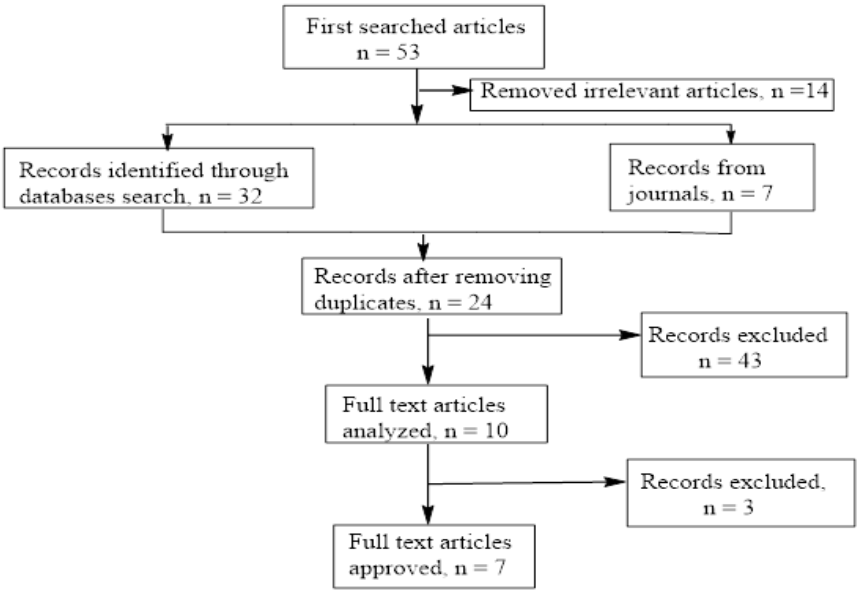

Fig. 1: Procedure search process

Data Analysis

We carefully read the selected articles many times and analyzed them from the perspective of our review questions. We collected the key findings of each article from a large summary table. During reading, we realized that some general information, that is, their publishing year and the rationale of the study might be needed to understand the articles better.

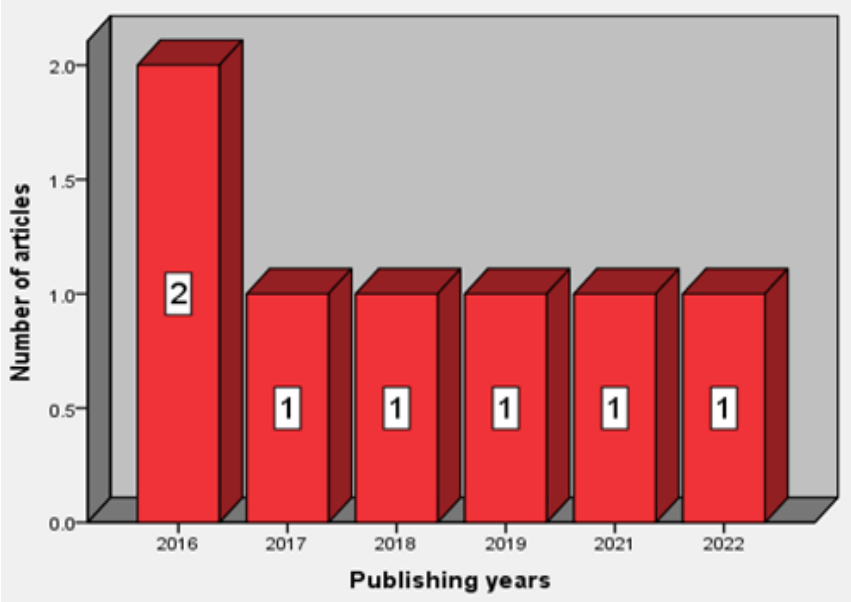

Fig. 2. Number of articles versus publishing years

Limitations of the Review Study

Our review has certain limitations. At the beginning, in database search, we used tighter search criteria because of the large number of articles matches. Even though the matches were largely irrelevant, it is possible that we missed some useful articles. In addition, the number of duplicates between the databases was relatively small, meaning that we probably did not identify all the relevant articles.

Another limitation is that many articles that matched the final criteria provided little detail about practical works in teaching and learning of chemistry. This is a common observation in other reviews. The lack of details was partly explained by the fact that practical work was the focus of all the articles under review. Vague descriptions left for various interpretations, but we solved unclear cases through an in-depth reading. We have selected research studies performed in four African countries (Nigeria, Kenya, South Africa, & Ethiopia). Reasons for the selection of the mentioned countries were the relevance of the articles and the coverage our review.

FINDINGS AND DISCUSSION

Findings

Based on the publishing years of the articles, the title of teaching and learning practical chemistry has received increasing attention (Fig.2).

We found seven different rationales for studying teaching and learning of practical chemistry (Table 1). The first rationale was that the students' and teachers' perceptions were a challenge to implement the practical activities by which learners can themselves acquired Knowledge and transform their mental abilities into academic skills. Students' and teachers' perceptions towards practical works were mandatory concept for using practical lab to make the abstract concepts of

chemistry solid or understandable. This research was touched the practical work. The second rationale was practices and challenges of activities for successful practical lab. Here, some problems in laboratory organizations and utilizations need to be resolved through research. Such problems include, for example, poor teaching methodology. This research was touched upon practical work. The third rationale was explicitly focused on the extent use of practical activities. The third rationale was to an investigation to the extent use of practical activities in teaching chemistry. The fourth rationale was related to challenges encountered by chemistry teachers in teaching practical chemistry, such as less commitment and interest to the practical lab works. The fifth rationale was the quality of chemistry practical work on students' performance in chemistry. Therefore, addressing the quality of the practical work was vital to make abstract concepts solid by focusing on practical works. The sixth rationale was also having some problems, such as students' challenge in understanding concepts of chemistry, and need to be resolved by research, and this research was also touched upon practical work. The seven rationale was in that practical work activity considered as a method of assessing learning in chemistry teaching. It is for assessing not for conceptual understanding of the chemistry topics. Besides, almost in all, there was no written topic saying "rational of the study". We found the rationality of the studies by in-depth reading of the full text of the research.

Table 1: RATIONALES FOR CONSIDERING THE STUDIES OF PRACTICAL CHEMISTRY.

Rational of the study	Studies
Students' and teachers' perception towards the practical works drives the consideration of the study	Hussen Seid M.et al. (2022)
The study is considered as a result of the challenges in practicing activities for successful practical lab work in chemistry.	Getnet N. et al. (2021)
The extent use of practical activities in teaching chemistry drives the consideration of the study.	Okorie, E.U et al. (2019)
The study is considered as consequence of challenges encountered by chemistry teachers in teaching practical chemistry.	Nwaka I.et al. (2018)
The quality of chemistry practical work on students' performance in chemistry drives to consider the study	John T., PhD (2017)
The study is considered as a result of the factors influencing practical work in chemistry	Mathewos A.et. al. (2016)
Practical work activities as a method of assessing learning in chemistry teaching derives to consider the study	Thomas D. T. S. (2016)

RQ1. What was the impact of practical activities on teaching and learning of chemistry in the selected African secondary schools?

a) Comparing methods and materials

One-seventh (14.29%) of the studies, that is, one study [17], was used quasi- experiment of the pre-test and post-test design. The researcher used two groups such as experimental group,

applying class experiments method to them and controlled group, applying teacher demonstration method to them. The study was used teacher made student achievement tests (SATs) to see the effect of quality of chemistry practical work in teaching chemistry. Multi-stage cluster sampling and purposive sampling were used by the study to collect the data.

The rest six-seventh (85.71%) of the studies [18-23], were used descriptive survey design. These studies have similar research approach. In the first study [18], the researcher was used stratified random sampling technique, and questionnaire, classroom observation and interview were used as instruments to collect the data. The researcher was used mixed (qualitative and quantitative) research approach to analyze the data. In the second study [19], there was no clearly stated or entitled sampling techniques. But similarly, mixed research approach was used to analyze the data. Questionnaire, observation document analysis and focused group discussion were employed in the second study. In the third study [20], the only instrument used was a questionnaire. And, the sampling techniques were not specifically stated. The sampling technique seems there but untitled. In the fourth study [21], the instrument used was structured questionnaire. This study was a little bit vague in understanding the use of analysis method. By deep reading, we have understood that a quantitative method of analysis was used in the study. In the fifth study [22], a mixed approach method was used to analyze the data. The study was used simple random and purposive sampling

techniques. Besides, questionnaire, focused group discussion and interviews were administered as means of data collection instruments. Ethical considerations were stated only in the fifth study. Finally, in the sixth study [23], purposive sampling techniques and questionnaire were clearly mentioned and used. The methods and materials of the studies under review are summarized in the table below.

Table 2: SUMMARIZED METHODS AND MATERIALS USED IN THE STUDIES UNDER REVIEW

Studies	Methods and materials
Students' and Teachers' Perception and Practice towards Laboratory Work in Chemistry Teaching-Learning: Evidence from Secondary Schools in North Wollo Zone, Ethiopia.	Descriptive survey design; stratified random sampling; mixed method approach; questionnaire, observation & interview
Practices and challenges of activities for successful practical lab work in chemistry at Debre Markos preparatory school, east Gojjam, Ethiopia.	Descriptive survey design; purposive sampling; mixed method approach; questionnaire, observation & FGD
An investigation into the Extent of use of Practical Activities in Teaching Chemistry in Nigerian Schools.	Descriptive survey design; stratified random sampling; quantitative method of analysis; structure questionnaire
Challenges encountered by chemistry teachers in teaching practical chemistry in secondary schools in Enugu East local Government area of Enugu state.	Survey research design; purposive sampling; quantitative method of analysis; structure questionnaire
Effect of Quality of Chemistry Practical Work on Students' Performance in Chemistry in Public Secondary Schools of Machakos and Nairobi Counties in Kenya.	Quasi experiment design; multi stage cluster & purposive sampling; Pre-test & post test
Assessment of factors influencing practical work in chemistry: A case of secondary schools in Wolaita zone, Ethiopia.	Descriptive survey design; purposive sampling; mixed method approach; questionnaire, observation & FGD
Practical Work Activities as a Method of Assessing Learning in Chemistry Teaching.	Descriptive approach design; purposive sampling; qualitative method of analysis; observation & interview

During reviewing, what we have understood is that the practical work has a positive impact or influence on teaching and learning of chemistry in African secondary schools. According to the study's findings, both students and teachers believe that chemistry practical experiments are important for students' learning. For example, the majority of respondents agreed that theories alone are sufficient to develop students' chemistry knowledge; teaching must prepare students to do laboratory activities; and laboratory work is good in theory but difficult to carry out effectively in practice. The majority the students believe that chemistry laboratory classes are relevant and beneficial to their learning.

Regardless of the negative side of the teachers, students, the school managements and the laboratory environment to practical work, learners after their theoretical chemistry class if engaged continuously in practical activities, a satisfactory situation will be observed. Because, the conceptual topics of chemistry assisted by the parallel practical activities, that made the abstract concepts solid or understandable. This is to the fact that, students' acquired knowledge and skills by the principle "learning by doing". Across the findings of the studies [17-23], avoiding the side effects or the constrains, practical activities have a positive impact on teaching and learning of chemistry.

RQ2. What were the factors affecting the implementation of practical activities in teaching and learning of chemistry in the selected African secondary schools?

According to the studies mentioned above, major factors that can potentially affect the implementation of practical activities or works in the selected African country secondary schools are identified by the researchers through their research procedures. We have collected a lot of factors from the studies under review and come up with the major ones. The factors were derived from different angles such as from students, teachers, lab technician and the lab situation.

Laboratory work, like any other educational issue in the teaching-learning process, may have drawbacks or limitations during its implementation. The most serious potential factors influencing the implementation of laboratory work in secondary schools are a lack of resources, a lack of time to practice laboratory work, and a lack of student participation in laboratory activities. A lack of resources is ranked as the first major factor affecting laboratory implementation in secondary schools. Accordingly, it is the most significant impediment to laboratory work practice. Enough teaching resources should be available to carry out laboratory work as needed. Teachers can devote more time to assisting students in their quest to learn if appropriate resources and support from schools and higher officials are available. Almost in all studies, in this regard, 100% of the teachers polled said they were limited in their ability to use laboratory work due to the lack of adequate

resources. The next mentioned factor is the lack of time. Regarding this issue, both groups of respondents (Teachers and students) agreed that it was the most serious impediment to the implementation of laboratory work.

In the study [24], teachers were dissatisfied with the educational system because there was no time for experimental work. Similarly, in a study [25], a specific teacher mentioned time as a constraining factor, claiming that the syllabus is too broad and that he would like to devote more time to experiments. Another major factor influencing laboratory work practice is the lack of participation in laboratory activities. Concerning this issue, both groups of respondents agreed that it was the most significant impediment to the effective implementation of laboratory work. The question here is why students are not participating in laboratory activities? It was found that students were not given activities to participate in laboratory work, there was a lack of follow-up, and feedback was not provided. According to study [25], laboratory work was either not presented to students in an appealing manner or students appeared to be more concerned with the mark they would receive.

RQ3. What were the challenges of implementing practical activities in teaching and learning of chemistry in the selected African secondary schools?

Practical chemistry has suffered (challenged with) great negligence in many secondary schools in the selected African countries. According to the studies, this is due to the unwillingness of some chemistry teachers to conduct practical works, some chemistry teachers are incompetent and lack manipulative skills, some teachers who are not graduates of chemistry but equally teach chemistry, lack of skill to improvise unavailable laboratory equipment and materials are the varies teacher's factors that imped the teaching of chemistry practical in the selected African country secondary schools.

Students have also some contributes to challenges of implementing practical activities. Some of the major challenges are as follows: most students perceive chemistry as a difficult subject with many theories; students who offer chemistry easily get discourages by the poor outcome their results; students' sudden loss of interest in chemistry retards effective chemistry practical teaching; and students' inconsistency in attendance to practical classes challenges the teaching of chemistry practical. Insufficient sitting space for all students is another challenge to carry out laboratory activities. Based on the studies, the seats were uncomfortable, the classroom lay out was not designed to facilitate laboratory work, and there was in sufficient laboratory equipment. School administration

was another challenge for implementing practical activities. They don't pay attention to the practical activities. They know nothing about what is going on in the laboratory and then unable to support it. Follow up is needed by the school administrators. Otherwise, the challenges or burden will be laid only on the chemistry teachers. Challenges like unsafe laboratory rooms, lack of laboratory equipment, chemicals, and personal protective safety equipment and lack of policy and regulation of waste management are related with budgets that the school administrators concern. Another challenge is the expired chemicals and contaminated equipment in the workplace of their laboratory unsafely stored for the long period of years, because of this chemistry teachers as well as students worry about themselves rather than conducting practical work in the laboratory room.

Discussion

The students' role in the laboratory work is to learn by doing. To engage students in learning activities, the classroom should be well-equipped with furniture and movable desks for each student to use in different classroom layouts. In this regard, the arrangement of desks and tables should allow movement and communication and should be changed as needed. However, in the studies under review, there was insufficient sitting space for all students to carry out laboratory activities, the seats were uncomfortable, the classroom layout was not designed to facilitate laboratory work, and there

was insufficient laboratory equipment (chemicals and instruments) in the laboratory classes. It is obvious, with practical activities, the impact on chemistry teaching is positive. However, as the constrains mentioned in the findings the positive impact perhaps challenged due to various factors.

Practical work in science has several purposes, including practicing skills, developing specific knowledge and understanding of science, and developing an understanding of the processes of scientific inquiry. It has the potential to contribute to meaningful learning in science [25].However, the findings of the studies were considered a number of factors that influence practical works in the chemistry of the selected African country secondary schools. The key factors among them were teachers poor knowledge of practical work, full-time occupancy of chemistry teachers by the theoretical classes, absenteeism of the teacher at practical classes, late commencement of teaching practical class; lack of awareness and motivation from school managements and unsafe working environments, lack of separate chemistry laboratory, lack of equipment in the laboratory, too short period allocated for practical work and lack of knowledge and familiarity of chemistry teachers to modern technology.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the findings, although practical/laboratory work is thought to be important for students learning chemistry, it is rarely used. The laboratory room should be well-furnished, and there should be movable desks for each student to use in different classroom layouts. In addition, there was enough laboratory equipment (chemicals and instruments) in the laboratory classes. However, the results of the studies revealed that the laboratory rooms lacked those resources. In terms of the key factors influencing laboratory work implementation, a lack of resources (such as chemical and laboratory equipment), a lack of time to practice laboratory work, and lack of students' engagement in laboratory activities were found to be detrimental.

As the findings showed that the quality of chemistry practical work has a significant positive effect on learners' performance in secondary school chemistry. This implies that there is a positive linear relationship between the quality of practical work and learners' performance in secondary school chemistry. Therefore, the quality of practical work should be considered when teaching and learning chemistry. That is, consistent planning and use of quality practical work by teachers should take place if the students' performance in chemistry is to improve. That is, teachers should have a tacit knowledge of how to do practical work themselves. The findings confirm that the use of good

quality practical work is an effective way of improving learners' performance in secondary school chemistry.

It can be concluded that: teachers-related factors that influence practical work in chemistry are teachers' poor knowledge of practical work, full-time occupancy of chemistry teachers by the theoretical classes, absenteeism of the teacher at practical classes, late commencement of teaching practical class; lack of awareness and motivation from school managements and unsafe working environments in the schools. Laboratory-related factors are a lack of separate chemistry laboratory, lack of equipment in the laboratory, too short period allocated for practical work and low attitude of students towards practical works in chemistry.

Recommendations

Based on my review, there is a need for further research on how to implement practical works of teaching and learning of practical chemistry. We call for new innovative practical work designs that build on contemporary research and boldly challenge the traditional approaches. We also recommended that different stakeholders in education sector and other concerned bodies should support the schools in organizing and utilizing chemistry laboratory practical activities for the effective teaching and learning of the subject. Besides, secondary schools should adopt the use of

computer-based learning technologies in teaching of practical chemistry alongside with traditional methods. Also, teacher education in university should restructure their curriculum to include the technology in teachers training. This will improve the application of the technology in the selected African secondary schools.

REFERENCES

[1] Bindayna, K. M., Qareeballa, A., and Joji, R. M., et al, "Student perception of microbiology laboratory skills learning through a problem-based learning curriculum," *Arabian gulf university experience, Advances in Medical Education and Practice*, 11(11), 963–968, 2020.

[2] Niyitanga, T., Nkundabakura. P., and Bihoyiki. T, "Factors affecting use of practical work in teaching and learning physics assessment of six secondary schools in Kigali city, Rwanda," *African Journal of Educational Studies in Mathematics and Sciences,* 17(1), 61–77, 2021.

[3] Abrahams, I., and Millar, R," 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,* 30(14), 1945-1969, 2008.

[4] Dillon, J, *A review of the research on practical in school science,* Kings College, London, 2008.

[5] Millar, R, "Analyzing 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, 2009.

[6] Lazarowitz, R. and Tamir, P, *Research on using laboratory instruction in science,* ERIC, New York, 1994, 94-128.

[7] Lunetta, V.N, *The school science laboratory: Historical perspectives and centers for contemporary teaching*, Kluwer Academic Publishers, Dordrecht, 249-264, 1998.

[8] Fadzil, H.M., and Saat, R.M, "Phenomenographic study of students' manipulative skills during transition from primary to secondary school," *Sains Humanika*, 63(2), 71-75, 2013.

[9] Schwichow, M., Zimmerman, C., Croker, S., and Härtig, H, "What students learn from hands-on activities?" *Journal of Research in Science Teaching*, 53(7), 980-1002, 2016.

[10] Reid, N. and Shah, I, "The role of laboratory work in university chemistry," *Chemistry Education Research and Practice,* 8 (2), 172-185, 2007.
[11] Elliott, M. J., Stewart, K. K. and Lagowski, J. J, "The role of the laboratory in chemistry instruction," *Journal of chemical education,* 85(1), 145-149, 2008.
[12] Hofstein, A, "The laboratory in chemistry education: Thirty years of experience with developments, implementation, and research," *Chemistry Education Research and Practice,* 5(3), 247-264, 2004.
[13] Pavesic, B. J, "Science achievement, gender differences, and experimental work in classes in Slovenia as evident in TIMSS studies," *Studies In Educational Evalution,* 34(2), 94-104,2008.
[14] Gunstone, R.F. & Champagne, A. B, *Promoting conceptual change in the laboratory*, Routledge, London, 1990, 159-180.
[15] Teixeira-Dias, J. J. C., Pedrosa de Jesus, M. H., Neri de Souza, F. and Watts, D. M, "Teaching for quality learning in chemistry," *International Journal of Science Education,* 27(9), 1123-1137, 2005.
[16] Science Community Representing Education, *Practical work in science: a report and proposal for a strategic framework,* SCORE, London, 2007.
[17] Mwangi, J. T, "Effect of Quality of Chemistry Practical Work on Students' Performance in Chemistry in Public Secondary Schools of Machakos and Nairobi Counties in Kenya*," International Journal of Science and Research (IJSR),* 7(9), 2319-7064, 2017.
[18] Mohammed, H.S., Yalalem, A., Beshir, L.M., Bekalu, T.M., Ermiyas, T.B., Yared, F., Shouket, A.T. and Mohammed, R.A, "Students' and Teachers' Perception and Practice towards Laboratory Work in Chemistry Teaching-Learning, Evidence from Secondary Schools in North Wollo Zone, Ethiopia, *Hindawi Education Research International*, 2022, 14, 2022.
[19] Getnet, N. and Demisachew, S, "Practices and challenges of activities for successful practical lab work in chemistry at Debre Markos preparatory school, east gojjam, Ethiopia," *AJCE*, 11(1), 2227-5835, 2021.
[20] Okorie, E.U. and Ugwuanyi, A.A, "An investigation into the Extent of use of Practical Activities in Teaching Chemistry in Nigerian Schools," *Journal of CUDIMAC (J-CUDIMAC),* 6(1), 37-44, 2019.
[21] Nwaka I. and Dr. Ngozi M.E, "Challenges encountered by chemistry teachers in teaching practical chemistry in secondary schools in Enugu East local Government area of Enugu state," *The intuition,* 8 (1), 331-343, 2018.

[22] Mathewos, A., Mesfin, B., Abedelfeta, M. and Berhanu, K, "Assessment of factors influencing practical work in chemistry, A case of secondary schools in Wolaita zone, Ethiopia," *I.J. Education and Management Engineering*, 6(6), 53-63, 2016.

[23] Thomas, D. T. S, "Practical Work Activities as a Method of Assessing Learning in Chemistry Teaching," *EURASIA Journal of Mathematics Science and Technology Education*, 13(6),1765-1784, 2016.

[24] Osborne, J. and Collins S, "*Pupils' and parents' views of the school science curriculum,*" King's College London, London, 2000.

[25] Borrmann, T, (2008) "Laboratory education in New Zealand," *Eurasia Journal of Mathematics, Science and Technology Education*, 4(4), 327–335, 2008.