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Contributions of Laboratory Practical Works to Quality of Science Teaching-learning Process and Student Learning Engagement in Hawassa City Administration

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Abstract

Purpose: *The study examined contribution of laboratory practical works on quality of science teaching-learning process and student's learning engagement in secondary schools' classrooms.* ***Methodology****: The study employed mixed method with quantitative driven embedded mixed (QUAN+qual) design. The researchers selected seven secondary schools from sixteen secondary schools using simple random sampling technique. The researchers selected 477 samples: 75 natural science teachers, 7 laboratory technician, 5 supervisors, 10 principals and 380 students using simple random sampling, availability, purposive and stratified followed by simple random sampling techniques. The researchers collected data from both primary and secondary sources using self-constructed questionnaires, unstructured interview, observation and document reviews. The researchers analyzed quantitative data using descriptive and inferential statistics and narrated qualitatively.* ***Results:*** *The findings showed that laboratory practice is important for proper implementation of biology, chemistry and physics curricula.The learning experiences and activities of teachers and students did not align with the learning objectives. While the application of laboratory has values to the quality of teaching-learning process, the shortages of apparatus and equipment caused poor performance of students and inequitable quality of teaching-learning process.* ***Recommendations:*** *The study recommends that principals, supervisors, science teachers and laboratory technicians should be responsible bodies to improve students and teachers' participation in laboratory practical works by fulfilling necessary laboratory facilities and equipment.*

Keywords: F*acilities and equipment; laboratory practice; student learning engagement; teaching-learning process; pedagogical knowledge and skills*

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I. Introduction

Education is essential to consider for the reason that can open up the potential possessed by the students for better understanding of the world and to overcome existing problems. Education improves one's self quality; it requires a process of learning science (Mena et al., 2016; Kilinc et al., 2017; Girma, 2022). In addition, at the center of accelerating UN SDG4, education transforms the experiences and competencies of groups of people from one generation to the next generation (UN, 2015). The SDG4 targets toward transforming quality of education (UNESCO, 2019). Excellence in education, curriculum, school and teaching philosophies demand dialogic and collaborative forms of practices and prominent contextualization of innovative ideas of teachers and learners (Al-Balushi, 2017; Girma, 2022). Enhancing the quality of science teachers creates competent teachers having deep-rooted knowledge, skills and attitudes required in classrooms at any time.

The teaching and study of sciences encourage and enable students to attain broader objectives of science which cover scientific inquiry to design and carry out scientific investigations and evaluate scientific evidence to draw conclusions, communicate scientific ideas, arguments and practical experiences, demonstrate attitudes and develop values of honesty and respect for themselves, others and shared environment (Ezeh, 2016).The development of science over the years exerted influences and dominated every aspect of human endeavor in such a way that individuals devoid of science literacy find out very difficult to survive in the contemporary society (Chinyere et al., 2014). The laboratory practical work enables learners to engage actively in practice and lead them towards conceptual comprehension activities (Millar, 2010).

The paradigm shift from teacher-centered method of teaching to student-centered learning is indispensable to make students take the position of constructivists through developing positive interdependence, self-confidence, communication and information processing skills and critical thinking because of higher order thinking and learning practices (Girma, 2022). In science, hands-on and minds-on practical works provide learners with opportunities to question, observe, experience and experiment with scientific phenomena (Rec, 2019). Learners tend to appreciate things seen more than spoken. A student can easily understand the concepts when he/she is involved in the practical activities that are following certain procedures, data collection and conclusions. The theoretical and practical parts of science need not to be isolated but taught as segments portions of a subject and not as a different entity. A practical work is beneficial to learners through interactions, hands-on activities, and application in science (Hampden & Bennett, 2013).

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In the Ethiopian context, biology, chemistry and physics teaching with the help of laboratory seems to have been recognized long ago. In secondary school curriculum many effort has been done at different time in view of achieving these aims of science teaching either by designing new or by revising existing curricula. The policy document of Ethiopia emphasizing the importance of science education sates that, the teaching and learning of science enables students to understand scientific concepts and there by inter-dependability develop rational thinking and problem solving in their daily life and develop scientific skills to achieve scientific judgments (MoE, 2018). Learning science is enhanced and the understanding level is improved when students are engaged in science laboratory for practical experiments (Hofstein & Lunetta, 2004). Science (biology, chemistry and physics) laboratory practical works enable learners to evaluate and test scientific concepts, develop scientific skills via hands-on and minds-on interventions. Science practical work is enjoyable for learners and enhances the effectiveness of learning science which further improves student engagement to reach positive outcomes (Gunuc & Kuzu, 2016). Therefore, although few studies about science laboratory practical works on teaching-learning and student engagement and achievement were conducted worldwide, related problems are not thoroughly investigated in Ethiopian in Hawassa City administration.

Rationales behind the problem

Although science is grounded on inquiry-based approaches, experiments and practical laboratory, the researcher experience and observed that the effectiveness of these practices are not satisfactory in the teaching-learning process in secondary schools. Although laboratory practical work has pivotal roles in enhancing science concepts and sharing learning experiences in teaching and learning process (Kurt, 2020). The appropriate use of school-based laboratory practice improves science skills of students in classrooms. The implementations of laboratory practice in science education at secondary schools in many countries are effective because of the attention given to it (Beyessa, 2014). However, in the Ethiopian context, the implementation process of science instruction is limited and students perform poorly in science subjects (Samuel & Welflord, 2000). Laboratory practice is necessary in secondary schools to help students understand the theoretical knowledge of science and provides relevant experiences to learners. Therefore, it encompasses a combination of instructions, accompanied by practical demonstrations and range of laboratory activities. In line to this, experience is critical as learning occurs through discovery and active participation since knowledge is created through transformation of experience (Kolb, 2005; Kurt, 2020).

Contextually, the implementation of laboratory practical work in our context is full of drawbacks which inhibit the achievement of science objectives. Many students face problems to perform well in science lessons because of lack of practical lessons, inadequacy of instructional material such as laboratories, chemicals, models, apparatus, local specimens and shortage of textbooks (Muleta et al., 2016). For instance, the shortage of allocated practical time and irregularity of carrying out practical lessons by science teachers affect student performance and understanding (Owino et al., 2014). A secondary school laboratory needs recent equipment necessary to conduct meaningful experiments and teachers' skills and knowledge that enable them share students' full laboratory experiences with appropriate accommodation and laboratory assistants (Tenaw, 2015). This shows that the 21st century science laboratory requires the 21st century latest laboratory rooms equipped with modern laboratory technologies, apparatus, chemicals and innovative pedagogical knowledge and skills.

The researcher was motivated and inspired to conduct this study because study conducted in the local surrounding has conceptual, knowledge and methodological gaps though they put milestones. The existing laboratory practices or experiments did not able to improve secondary schools' students practical knowledge and skills, and unable to gear their potentials towards science and technology driven instructional system. The researcher conducted this study to create possible solutions to improve the quality of teaching-learning process via proper implementation of science laboratory practical work. Therefore, this study examined the contribution of laboratory practice on quality of science teaching-learning process and student's learning engagement in government secondary schools' classrooms in Hawassa city administration, Ethiopia.

Objectives

The main purpose of the study was to examine the contribution of laboratory practice on quality of science teaching-learning process and student's learning engagement in secondary schools in Hawassa City administration. More specifically, the study helps to:

1. Evaluate the quality of science teachers' and laboratory technicians' pedagogical skills to plan and implement laboratory in secondary schools.
2. Examine the extent to which science teachers and students are motivated to implement laboratory in secondary schools.
3. Examine the extents to which laboratory facilities, equipment and materials are accessible to implement laboratory in secondary schools.
4. Evaluate participation passion of students in science laboratory practices in secondar schools.
5. Identify major factors affecting science laboratory practical work and student-learning engagement.

Research questions

The central research question was 'to what extent does laboratory practices improve quality of science teaching-learning process and student's learning engagement in secondary schools in Hawassa City administration?' In addition, the study answered the following specific questions. These are:

1. What do the pedagogical skills of science teachers and laboratory technicians look-like to plan and implement laboratory to improve quality of teaching-learning process?
2. To what extent are science teachers and students motivated to implement biology laboratory practical work to improve quality of teaching-learning process?
3. To what extents are laboratory facilities, equipment and materials accessible to implement laboratory?
4. To what extents are secondary schools' students engage in laboratory practical work?
5. What major factors affect science laboratory practical work and student engagements?

Significance

The study has policy, academic and practical significance. It helps natural science (biology, chemistry and physics) teachers, principals and laboratory assistants recognize the problem encounter implementation of science laboratory and set relevant strategies to solve the existing problems. It enables students to explore learning opportunities that focus on interacting with learning materials and improves students' understanding of science concepts and problem solving-skills. This research work helps policy makers, curriculum developers and other concerned bodies can devise means to create solutions alleviate the existing problems. It further helps the schools to use the findings of the study to improve laboratory practice and fulfill laboratory equipment.

Research design

Research design is a plan and techniques for inquiry that extent decisions from broad assumptions to detailed methods of data collection and analysis (Creswell, 2014). Accordingly, the researchers used quantitative driven embedded mixed (QUAN+qual) design throughout this study (Creswell & David, 2018). It is less time consuming because both qualitative and quantitative data collection occurs concurrently (Creswell & David, 2018) happened with the dominant leading practices of quantitative investigation.

Research method

For this study, the researcher employed mixed method because mixed method is convenient for social and human science as distinct research, which is used to cover a basic deficiencies and description of the study (Creswell, 2014). Mixed methods studies are studies that are products of the pragmatist paradigm and that combine the qualitative and quantitative approaches with in different phases of the research process (Tashakkori & Teddlie, 2008).

Sources of data

To obtain valid and reliable information, the uses of appropriate data sources are vital. Therefore, in this study, both primary and secondary data were used for triangulation (Cohen, Manion & Morrison, 2018).

Primary sources of data

The primary sources of data include: grade ten and eleven students, grade ten and eleven science (biology, chemistry and physics) teachers, supervisors, principals and laboratory technicians were included in this study.

Secondary sources of data

The secondary sources of data were collected from articles, published and unpublished thesis, reports, journals, student's roasters, attendance, documents and books written on the issues of laboratory work of science education.

Population, sample and sampling techniques

In this study, the source population includes science teachers, students, principals and laboratory technicians. Science teachers and students were considered important personnel in secondary schools who play pivotal roles in the implementation and operation of the teaching-learning process including laboratory practice. Similarly, principals have significant responsibilities in planning and formulating overall school-level academic policy in their respective schools. In addition, laboratory technicians serve in the schools as teachers' supporters and assist science teachers while preparing specimens, arranging the equipment, arranging laboratory materials, chemicals and log records of laboratory works.

The researcher selected seven schools out of sixteen secondary schools using simple sampling technique. The researcher determined a sample size for the large target population (e.g. students) by using the Cochran (1977) from the total of 7680 students, 380 students were selected using simple random sampling technique. Out of 120 science teachers 75 teachers were selected using simple random sampling, 5 supervisors and 10 principals were selected using purposive sampling techniques based on their appropriate position to give relevant data, whereas 7 laboratory technicians were selected using availability sampling techniques because of their manageable size. The data were collected using questionnaires, interview, and observation. The researcher analyzed the data using descriptive statistics using tables and triangulated it qualitatively by thematic narration. The researchers further determined a sample size for the large target population (e.g. students) using Cochran (1977) to decide the numbers of sample students as $n = \frac{N}{1+N(e)2}$. The researcher determined to select 380 samples from 7680 grades 10 and 11 students. Then, the researcher selected the samples using stratified sampling technique and proportionality followed by simple sampling random sampling technique from each stratum. Of this figure, 380 sample secondary school students actively participated in the study.

Data collection tools

This study used different data collection tools to enrich each other. This helps to solve inadequacies of data (Creswell & David, 2018). These include: interviews, questionnaires, observation and document review.

Questionnaires: Self-constructed questionnaire helped the researchers to obtain first-hand information about the perception of teachers and students (Creswell, 2014); both open and closed ended items that cover a wide range of themes prepared and administrated to students and science teachers. To cross-check the reliability and validity of questionnaire, the draft questionnaires administered to students and science teachers from non-sample group had been piloted. After the questionnaires were filled by the respondents each questionnaire examined to detect unclear ideas and statements. Finally, based on the feedback from the pilot test, some of the items were improved and lastly the refined copies of the questionnaires distributed for sampled respondents.

Interview: Any person to person interaction between two or more individuals with a specific purpose in mind is an interview (Yin, 2018). The researcher made unstructured interview with supervisors, principals and laboratory technicians face-to-face by taking note and recording their voices based on their willingness.

Observation: Observations check lists were employed to gather necessary data concerning laboratory equipment's, facilities of laboratory, practices, and instructional methods of science (biology, chemistry and physics) curricula.

Document reviews: To confirm the primary data with the facts available in documents, guideline, reports and checklists were considered as a source of information. Document analyses were used to cross check the correspondence between what respondents responded and what they practically did.

Data collection procedures

In order to obtain adequate information in this study, the researcher prepared data gathering instruments. The questionnaires were prepared in English because all respondents understood the ideas and concepts of the questionnaires and filled out them on time. The responses were also obtained through observation, interview and document analysis.

Validity and reliability of data collection instruments

Validity was checked by educational experts through proof reading whereas reliability was checked through Cronbach alpha results post pilot testing. A pilot study was conducted before the actual study in none-sample two government secondary schools. This pilot test helped to check up the reliability of the instruments and to know the existing states of potential respondents with respect to the problem under study. The calculated alpha values for teachers and students were .807 and .843 respectively. Therefore, the researchers modified some questionnaires before final data collection.

Method of data analysis

The data gathered through primary and secondary sources were analyzed using mixed data analysis methods. The quantitative data collected using closed-ended questionnaires were analyzed quantitatively using SPSS-26. The researchers' used and descriptive (percentage, mean, standard deviation), and inferential statistics (t-test). The data were collected from 477 respondents (75 science teachers, 5 supervisors, 10-principals, 7-laboratory technicians, and 380 students). The qualitative data were obtained from open-ended questionnaires, interviews and observation, and supported by secondary data collected via document reviews, and qualitatively narrated in themes using NVivo-14 software. The data collected through closed-ended questionnaire were analyzed using descriptive and inferential statistics using SPSS version-26 .

Results

Based on embedded mixed design (QUAN+qual) procedures, the results of the study were discussed by analyzing the results of different sources such as questionnaires, unstructured interview, observation and document review.

Background information of respondents

Table 1 Category of the respondents

Categories		Frequency	Percent	Cumulative Percent
Respondents	Teachers	75	15.72	15.72
	Principals	10	2.10	2.10
	Supervisors	5	1.05	1.05
	Laboratory technician	7	1.47	1.47
	Students	380	79.66	79.66
	Total	477	100.0	100

Table 1 showed that the respondents: science teachers, principals and laboratory technicians accounted 97 (20.34%) and students accounted 380 (79.66) of the total participants of the study.

Table 2 Genders of student respondents

Categories		Frequency	Percent	Cumulative Percent
Gender	Male	204	53.68	53.68
	Female	176	46.32	46.32
	Total	380	100.00	100.00

Table 2 showed that regarding the gender of respondents, 204 (53.68 %) of the respondents were males and, 176 (46.32%) of the respondents were females. Both sexes are nearly approaching to each other, so that the researchers obtained relatively accurate information from both sexes.

Table 3 Ages of respondents

Categories		Frequency	Percent	Cumulative Percent
Age	15-20	380	79.66	79.66
	21-30	44	9.22	9.22
	31-40	19	3.98	3.98
	40-50	22	4.61	4.61
	Above 50	12	2.52	2.52
	Total	477	100.0	100.0

Table 3 showed that 380 (79.66%) of students were between the age of 15-20, 44 (9.22%) were between the age of 21-30, 19 (3.98%) respondents were between the age group of 31-40, 22 (4.61%) respondents were between the age of 41-50 and lastly, 12(2.52%) of the remaining respondents were above the age of 50.

Table 4 Educational status of the respondents

Educational status		Frequency	Percent	Cumulative Percent
Students	Grade 10 and 11	380	79.66	79.66
Laboratory technicians	Diploma	40	8.39	8.39
Teachers	First Degree	40	8.39	8.39
	MSc/MA	7	1.47	1.47
Principals	MSc /MA	10	2.10	2.10
Total		477	100.0	100.0

Table 4 showed that grades 10 and 11 students accounted for 380 (70.66%). 40(8.39%) were of respondents were diploma holders, 40 (8.39%) respondents first degree holders, and the remaining 17 (3.57%) were MSc/MA. The education level of respondents relate to their profession and academic status so that we can assume that the information provided by the respondents was valid and reliable.

Table 5: Work Experience of principals, supervisors science teachers and technicians (n=97)

Categories	Work experience	Frequency	Cumulative Percent
Experiences	1-5	12	13.04
	6-10	38	41.30
	11-15	22	23.91
	16-20	6	6.52
	28 and Above	19	15.22
	Total	97	100.0

Table 5 revealed that the work experience of the respondent, 12 (13.04 %) of them have work experience between 1-5 years, 38 (41.30%) of the respondents have work experiences between 6-10 years, the other 22 (23.91%) of the respondent has work experience above 11-15 years, 6(6.52%) of the respondents have work experience of 16-20. In addition, 19 (15.22%) of the respondents have 21 and above work experience.

Awareness and motivation about science laboratory practices

The data collected from a total of 477 respondents: 455 respondents using questionnaires and 22 participants using interview covered four themes: awareness and motivation of teachers regarding the significance of laboratory practices, the status of laboratory practice, accessibility of laboratory facilities and students learning engagement and achievement.

Table 6 Awareness and motivation of science teachers (n=445)

Sources of Variation	Category of the Respondents	n	Mean	Std. Deviation	Std. Error Mean
Awareness and motivation of science teachers regarding laboratory practical work implementation	Teachers	75	2.58	.436	.075
	Students	380	2.1	.444	.026

Mean value: Note: Mean value :< 3.00-Poor; 3.00-Ideal (average); 3.01-3.49 - Good; > =3.50- Very good.

Table 6 showed that the mean responses of both teachers and students lied below the expected ideal mean regarding the awareness and motivation of science teachers about the implementation of laboratory practical work (MT= 2.58, & MS =2.16).This shows that there was relatively low awareness and motivation which ranged from very poor to poor level awareness and motivation.

Table 7 Independent sample t- test of awareness and motivation of science teachers (n= 455)

Sources of variation	Variances	t-test for Equality of Means							
	F	Sig.	T	DF	Sig. (2-tailed)	Mean Difference	Std. Error	95% CI of the Difference	
								Lower	Upper
Awareness and motivation of science	.009	.923	.231	453	.101	.125	.080	-.139	.176

Table 7 showed that there was no a statistically significant difference between the means of teachers and students indicating that there were low awareness and motivation about laboratory practice where the difference [M (t)= .125 > .101)]. This indicates there are no opinion differences

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between science teachers and students indicating that there poor awareness and motivation

In addition, while responding to the question "how do you evaluate motivation and commitment of science teachers, laboratory technicians and students on the implementation of laboratory?", one of the principal interviewee stated that

> 'Science teachers, laboratory technicians and students lack commitments and motivation to implement science practical work. I think science teachers are not preparing themselves and willing to implement laboratory practical work in laboratory rooms because it is time taking and tiresome' (ISP1, March, 20/ 2023).

Unlikely, the other principal interviewee discussed that

> 'Science teachers, laboratory technicians and students are committed, motivated and are participating actively in the laboratory experimental work in my school. Therefore, it is a good opportunity for students to develop their practical knowledge and skills by actively participating in the experiments' (ISP5, February, 28/ 2023).

..From observation, the researcher witnessed that there was no any commitment and motivation regarding secondary school laboratory practical work except that of one laboratory technician and some students' interests towards the practice (Ob1, Ob2 & Ob6, February-March, 2023).

The quantitative and qualitative data deduced that the awareness, motivation and commitment of science teachers, lab technicians and students towards implementation of laboratory practical work is not encouraging to ensure quality of teaching and learning process.

Status of science laboratory practice

Table 8 The status of science laboratory practice (n=445)

Sources of variatio	Categor y of the Respond	N	Me an	Std. Deviat ion	Std . Err
The status of scienc	Teacher s	7 5	2.3 9	.483	.07 9
	Student	3 8	1.8 9	.431	.02 5

Mean value: Note: Mean value :< 3.00-Poor; 3.00-Ideal (average); 3.01-3.49 - Good; > =3.50- Very good.

Table 8 showed that the mean responses of both science teachers and students lied below the expected ideal mean regarding the status of biology laboratory practical work implementation (MT= 2.39, & MS =1.89). This showed that there is low status which ranged from very poor to poor average means of science teachers laboratory implementation.

Table 9 Independent sample t- test on the status of science laboratory practice (n=455)

So urc	Var ianc	t-test for Equality of Means

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es of variation	es								
	F	Sig.	t	DF	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI of the Difference	
								Lower	Upper
The status of science laboratory practice	.419	.518	2.48	453	.014	.195	.078	.040	.349

Table 9 showed that there was no a statistically significant difference between the means of science teachers and students indicating that there are low status of laboratory practical work implementation where the difference [M (t) = 0.195 > 0.014)]. This indicates there are no opinion differences between teachers and students.

In addition, while responding to the question "how do you evaluate the pedagogical knowledge and skills of teaches and lab technicians in the implementation of laboratory practical work?" one of the principal interviewee stated that

> 'The pedagogical knowledge and skills of science teachers and laboratory technician are not encouraging to implement the practical laboratory works in classrooms. I think they have meager experiences, attitudes, knowledge and skills of pedagogical practices in laboratory classrooms' (ISP3, March, 20/ 2023).

The other principal interviewee further demonstrated that

> 'Science teachers and laboratory technician lacked specific pedagogical knowledge and skills in order to implement laboratory practical work. I am sure that they lack experiential learning while they were taking training and learning in their previous colleges. This shortage constrained their pedagogical experiences of laboratory practice in laboratory sessions' (ISP5, February, 28/ 2023).

..From observation, the researcher witnessed that laboratory rooms were old, dilapidated and not conducive for practice. It is important that the practical learning environment is conducive for teachers and learners to become interested in laboratory practice. An ideal secondary school laboratory must be clean and not decayed. A number of students are greater than the standard to conduct practical work in laboratory rooms (Ob1, Ob2 & Ob6, February-March, 2023).

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Both quantitative and qualitative data revealed that the status of science laboratory practice in the sample secondary schools was poor because of several shortcomings such as decay of the physical facilities being aged and old, large number of students beyond the standard of MoE (1:25), failure of updating with new technological and pedagogical facilities.

Accessibility of laboratory facilities

Table 10 Accessibility of laboratory facilities (n=455)

Sources of Variation	Category of the Respondents	N	Mean	Std. Deviation	Std. Error
Accessibility of laborat	Teachers	75	2.12	.673	.115
	Students	38	1.93	.602	.035

Table 10 showed that the mean of responses of both teachers and students lied below the expected ideal mean regarding the accessibility of laboratory facilities (MT= 2.12, & MS =1.93). This ranged from poor to very poor indicating that there are shortages of laboratory facilities to conduct biology practical work in the laboratory.

Table 11 Independent sample t- test on accessibility of laboratory facilities (n=455)

Sources of Variation	Variances		t-test for Equality of Means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI of the Difference Lower	95% CI of the Difference Upper
Accessibility of laboratory facilities	.528	.468	1.76	453	.041	.195	.110	-.022	.412

Table 11 showed that there was no a statistically significant difference between the means of teachers and students indicating that there are low status of science laboratory practical work implementation where the difference [M(t)= .195 > .041)].

In addition, while responding to the question "To what extent does your school provide laboratory facilities to the effective implementation of science laboratory practical work?" One of the laboratory technicians suggested that

> 'There is no adequate chemical and apparatus in my school. I think that

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> the principals do not have willing and commitment to fulfill the laboratory materials to improve quality of science learning. They think fulfilling the laboratory as high expenditure of resources (ILT1, Feb 28, 2023)

Later on, the other laboratory technician interviewee discussed that

> 'The lack of laboratory equipment, apparatus and chemicals made the practice difficult for science teachers to teach practical work in the laboratory. Relatively, biology and chemistry equipment are available although they are outdated unlike to physics' (ILT4, March, 20/2023).

..From observation, the researcher witnessed that laboratory facilities, e.g., apparatus were insufficient and inadequate supply of chemicals. Most laboratories have expired chemicals. The laboratory was not well organized (Ob1, Ob2, Ob3, Ob4 & Ob6, February-March, 2023).

Moreover, the document analysis showed that there is no alignment between teacher guide, student's textbook and the real practices. And, also from the seven sample schools, only one school has laboratory manuals and reports (Feb- March 2023).

Therefore, one can come up with the existing realities based on quantities and qualitative data that the accessibility of laboratory facilities was below ideal mean indicating that science teachers, lab technicians and students were not properly implementing laboratory practical work in the sample secondary schools.

Student's learning engagements and achievement

Table 12 Student's Learning engagement and achievement (n=455)

Sources of Variation	Category of Respondents	n	Mean	Std. Deviation	Std. Error
Student learning	Teachers	75	1.91	.444	.076
	Students	38	1.85	.830	.048

Table 12 showed that the mean of responses of both teachers and students lied below the expected ideal mean regarding to learning engagement and achievement of students (MT= 1.91 & MS =1.85).This shows that the means of respondents summarize that there was very poor students' learning engagement and achievement of students because of meager experimentation of laboratory activities.

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Table 13 Independent sample t- test learning engagements and achievement (n=455)

Sources of variances	Variances		t-test for Equality of Means						
	F	Sig.	T	DF	Sig. (2-tailed)	Mean Difference	Std. Error	95% CI of the Difference	
								Lower	Upper
Student learning engagement and achievement	.933	.335	.401	453	.000	.058	.145	-.227	.343

Table 13 showed that there was no a statistically a significant difference between the means of teachers and students indicating that there are low status of science laboratory practical work implementation where the difference [M (t) = .058 >0.000)].

In addition, while responding to the question "To what extents are engagements and achievements improved in science laboratory practice? One of the laboratory technicians suggested that 'there is no laboratory practical work implementation at all in science in my school and I think there was no students' participation and academic achievement improvements observed' (ILT4, Feb 28, 2023)

The other laboratory technician interviewee suggested that

> 'The practice of laboratory continues we are observing some changes in students' knowledge, skills, attitudes and other proficiency although it lacks continuity in my school because of lack willingness from the sides of some science teachers, shortages of facilities, even lack of a microscope, stethoscope, thermometer., etc' (ILT6, March, 20/ 2023).

..Moreover, the document reviews showed that there are no changes while observing the quizzes, roasters and final examination results (Feb- March 2023).

Therefore, the quantitative and qualitative findings showed that the students' learning engagements in laboratory practical work is very poor and there is no change in their academic achievement from time to time.

Discussion

The demographic characteristics of respondents showed that although their educational status was enough to respond to the questionnaire and interview, the majority of principals and science teachers were found to be below the standards set in the education road map document of Ministry of Education, Ethiopia, which is MA/MSC/MEd (MoE, 2018). The quantitative and qualitative findings demonstrated that the awareness, motivation and commitment of principals, science teachers, lab technicians and students towards laboratory practical work were not encouraging to ensure qualities of teaching-learning process. Therefore, they lack a clear understanding about the importance of practical work to develop students' competencies and skills. The finding further revealed that the status of science laboratory practices and physical facilities in the sample secondary schools was poor because of several shortcomings associated with decay of the physical facilities of the laboratory, becoming aged and older, lack of teachers' and lab technician's pedagogical training, large number of students beyond the standard of MoE (2018) i.e the ratio is 1:25, failure of updating with new technological and pedagogical innovations.

The findings of the study remarked that the status of students' learning engagements in laboratory practical work in the sample secondary schools was very poor and there was no change in their academic achievement from time to time. The students' learning engagement and outcomes require improvements teachers' continuous professional learning to update their professional and pedagogical competencies, and students' positive interdependence, individualistic accountability, social skills, communication skills and group processing skills (Girma, 2022). In response to this, Holster Mann et al., (2010) further recommended that students who carried out experiments in some science lessons (e.g. detection of products of photosynthesis, and osmosis) were more engaged compared to students who did not conduct experiments. This signifies the importance of student's engagement in laboratory practical work.

The status of laboratory practice in sample government secondary schools was low because of poor engagement of science teachers, lab technicians and students in practical work. According to Lake (2004), students need to be involved in practical activities that will enhance their acquisition of higher-order processing skills rather than lower-order thinking skills. Teachers' professional learning practices improve their professional and pedagogical competencies and skills, and ultimately utilization of learner-centered instruction like cooperative learning, laboratory practical work and group discussion (Girma, 2022). This practice improves students' positive interdependence, individualistic accountability, social skills, communication skills and group processing skills, students' learning engagement and outcomes. Therefore, learners do the practical themselves under teachers' supervision and handle the apparatus during the practical if they are to be successful in practical examinations.

Conclusions

The findings obtained through questionnaires, observation guidelines and document review revealed that there is a statistically significant relationship between the availability of laboratory facilities and students' learning engagements. The traditional teaching strategy is the most dominant way of implementing the practical work in the sample schools. Still a lot of barriers hinders the implementation of laboratory work and force the teachers toward choosing traditional methods which was critically discussed in the literature review. These problems put high pressure on science teachers and students, and negatively influenced intrinsic motivation of learners implementing laboratory practical work. Natural science teachers and laboratory technicians lack pedagogical skills to manage laboratory practical work in the laboratory classrooms. The inadequate laboratory facilities also hindered meaningful science instruction in secondary schools and contributed to persistent poor performance of students.

Recommendations

The researchers observed that the secondary schools have a shortage of resources such as chemicals and apparatus on top knowledge and skill gaps regarding laboratory practice. Therefore, school principals should provide adequate resources needed during practical lessons for better learning of practical work. Principals should visit laboratory in their secondary schools regularly to identify the problems that teachers and laboratory technician are facing while conducting practical work. For instance, the gaps of pedagogical knowledge and skills they face in laboratory rooms.

Natural science teachers and laboratory technicians should ensure that students engagement in practical exercise in their schools through improving own awareness and commitment. However, in the absence of standard laboratory facilities, improvisation should be encouraged and used which may provide the opportunity for creativity and innovations in both the teachers and laboratory technicians. Science teachers are recommended to motivate and encourage students to develop interest in practical activities by providing instructional materials that will challenge them to be actively involved during practical lessons.

Natural science teachers and laboratory technicians should practice the five principles of E's **(5Es)** (engagement, exploration, explanation, elaboration and evaluation) while implementing laboratory practical work in secondary schools. Although all students should be motivated and committed to learn science in practical way, students are recommended to be engaged in science laboratory practice to obtain good results and for the development of future science works. In addition, teachers' College of education is recommended to help science teachers on the assessment of practical skills acquired by the learners, and training workshops for the teachers should be held on how to design practical activities and conduct science experiment in the laboratory rooms. Generally, recommendations should be forwarded for specific groups or concerned bodies who can alleviate the problems mentioned in the study. In this regard the recommendations have to be written again by listing the concerned bodies such as for district education bureaus, principals, teachers and laboratory technicians.

Limitations and implications for scientific communities

This study has not accomplished without limitations and the researchers tried to provide clear picture through making proper analysis of different variables considered although it requires further interventions through lesson-based study.

Competing Interest Statement

We have declared that no competing interest exists.

Availability of Data

The data used to support the findings of this study were included within the manuscript. An author can provide the raw data on request

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