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Research Article

Students' and Teachers' Perception and Practice towards Laboratory Work in Chemistry Teaching-Learning: Evidence from Secondary Schools in North Wollo Zone, Ethiopia

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One of the inputs for a high-quality education is using laboratory activities which are characteristic features of science teaching at all levels of education. Consequently, this study was carried out to investigate the perception and practice centered on assessing the practice of laboratory work and identifying the factors that affect its implementation. To achieve these objectives, data were collected from secondary school students and teachers. In doing this study, quantitative and qualitative research methods and a descriptive survey design were used. Stratified random sampling was used in the selection of study participants. The data were obtained through questionnaires, observation, and interviews. Based on the analyzed data, the findings of the study revealed that both students and teachers perceived that chemistry practical courses (experiments) are relevant to students learning. The findings of the study also showed that despite its relevance, the practice of laboratory work is very low. Furthermore, the lack of resources (such as laboratory equipment), the lack of time to practice laboratory work, and students' lack of engagement in laboratory activities were the major factors that affect the implementation of laboratory work. Finally, recommendations were made based on the major findings to improve the practice of laboratory work.

1. Introduction

In any setting, education is critical to the development of people and society. Without adequate education in their particular contexts, it appears difficult for people to make the best use of environmental resources for life and society. In this regard, education may be considered one of life's most important components. In accordance with this, Ethiopia established the 1994 New Education and Training Policy (NETP), which governed the country's general education system, policy, and strategy for a couple of decades. Since then, several policies and strategies have been devised and implemented. One of the aims of the Ethiopian Education Policy is to improve people's physical and mental potential as well as problem-solving abilities through increasing education for everyone. These abilities and talents will be acquired in part through educating pupils in science. The most notable of these policies and programs is the consecutive and progressive education sector development plan (ESDP IV). It was created with the goal of enhancing the entire education system and performance in general, as well as access to excellent education in particular. As a result, there have been significant advances in the availability of schools, institutions, educated instructors, and other inputs required for a high-quality education system.

According to existing literature, one of the inputs for a high-quality education is the use of laboratory activities [1], which are common elements of scientific instruction at all levels of education. Nowadays, there is a global change in teaching and learning methods. For instance, using laboratory-based demonstration methods supports learners' participation and construction of their own knowledge in all academic activities [2]. The goals and objectives of the laboratory-based learning are designed to target students and teachers in order to create change during instruction [3]. Laboratory learning activities can encompass many forms, including and not limited to, interacting with physical equipment, simulations, and virtual and remote experiments; each approach has different learning and logistical advantages and limitations [4]. The laboratory-assisted class helps to change the teacher-centered teaching model where students only listen to teachers' lectures in the past, reduce the passivity and blindness of interns in internships, help and strengthen interns' understanding and mastery of the knowledge they have learned, and improve students' satisfaction degree [5].

There is overwhelming empirical evidence available in the research literature on the contribution of science laboratories to the attainment of science educational goals [6]. Laboratory activities have priceless values to students, including increased student interest and ability in science courses and increased student accomplishment in science [2, 5, 6].

Laboratories are exemplary sites of modernity. However, they do not only function as passive reflections of an increasingly globalized and digitalized society, but also as active examples, as forces for change whose influence is by no means limited to the natural sciences and the humanities [7]. Schools are not given the opportunities to manipulate the materials and participate actively in doing practical work to prevent them from damaging the limited equipment available. Consequently, learners have to follow teacher demonstrations in the actual classroom setting [2]. Meaningful learning can occur from a given laboratory experiment if students are given ample opportunities to operate various types of equipment and materials that aid in the construction of their knowledge of phenomena and related scientific concepts [8]. Owing to the resource-intensive nature of laboratory experiments in terms of equipment and resources, as well as staff time (students are allocated to group work rather than individual study), students are anticipated to have abundant opportunities to learn practically [7, 9]. On the other hand, teachers' demonstrations can be utilized to reinforce theories and lessons taught in classrooms when there are not enough resources for students to conduct their own experiments [10].

Additionally, as Qu Xin cited, Fan [5] discoursed that there are many shortcomings in the teaching of students using the laboratory. (a) The existing laboratory knowledge education has been unable to keep up with the students' needs of the rapid development of laboratory work. There is a certain gap between the theoretical foundation and practice. (b) In terms of teaching teachers, teaching teachers have different academic levels and work experience, and the quality of teaching is different. Teachers often simply impart knowledge and skills and do not pay attention to the cultivation of learners' initiative, enthusiasm, and potential ability. Students most concerned about the impact of the laboratory activities and their preferences pointed more toward greater independent, participatory, and interactive learning engagements. Authors implied that students should not be left out in science laboratory learning and their views about what obtains in the science laboratories should be routinely monitored to inform such reforms [6].

Some local studies on the importance of chemical laboratories were done. For example, Legesse and Antehun [11] discovered that most students believe chemistry laboratory lessons are relevant and beneficial to their learning. However, certain issues were raised. Some of the issues were poor laboratory report values, a lack of individual work (tasks), proper allocation of time to laboratory experiments, and a lack of teacher follow-up. According to student perceptions of the safety of laboratories employed, organic chemistry laboratories (experiments) are somewhat potentially risky when compared to laboratories (experiments) in other chemistry streams. It is considered that practical chemistry lessons (experiments) considerably aid students' understanding of chemistry theories and concepts. Practical courses, in addition to solidifying students' theoretical knowledge, assist students in identifying and solving issues, learning how to handle chemicals, and operating various equipment and apparatus. They also contribute to the development of students' scientific attitudes and innovative spirit in their future employment. However, it appears that there are issues with the execution of laboratory tasks. Furthermore, according to the researchers' observations, teachers and students do not appear to appropriately implement laboratory activities in secondary school chemistry classrooms. The problem has also taken root at this grade level (grades 9–10); thus, analyzing the issues and providing potential remedies at this time is critical. As a result, the purpose of this study was to learn about the perspectives of laboratory activities, how far they are used, and the variables influencing their implementation in secondary schools in the North Wollo Zone.

When conducting such study, some limitations must be acknowledged, as with all research. Due to space constraints, the researchers of this study would like to inform the audience that the study was limited to assessing only students' and teachers' perceptions and practices of laboratory work in chemistry classes in secondary schools found in North Wollo Zone, Ethiopia. It did not include any other activities related to chemistry teaching and learning. Keeping this in mind, the following leading research questions have been proposed to guide the study's focus and direction. These are as follows:

(1) What do the perceptions of students and teachers about laboratory work look like in chemistry classes?
(2) What laboratory activities have been practiced by teachers and students practiced during chemistry classes?

(3) What are the hindering factors that affect the implementation of laboratory work in chemistry classes?

2. Literature Review

In 1807, Thomas Thomson established the first chemistry teaching laboratory in the United Kingdom at the University of Edinburgh. He joins the University of Glasgow in 1819 and introduces technology to the university. At the University of Giessen, Liebig established a chemistry laboratory. Since that time, practical work was regarded as an essential fulfillment for science teaching after the gradual development of laboratory work in most countries [12]. Laboratories in the world of education are places where the teaching and learning process through demonstration or practical methods can produce learning experiences where students interact with various tools and materials to observe changes that occur due to chemical reactions. In doing practicum, students can work individually or in groups [8].

The scientific community continues to give conflicting impressions about the contribution of laboratory activities to science learning and yet ignores the views of students who are the focus of learning [6]. Science theories are mastered in practice in teaching and learning activities. Teaching and learning through practical work are among methods that undoubtedly facilitate knowledge transfer and skills acquisition in teaching and learning events [2]. Various approaches to science laboratory instruction are found in the literature: inquiry-based learning, teaching for scientific practices, teaching for scientific competencies, and expository approaches, among others. Literature reveals blurred lines between inquiry-based practical experience, scientific practice approaches, or scientific competencies approaches. Gudyanga and Jita [13] settled laboratory-based learning as inquiry-based approaches, scientific literacy, and teaching for scientific competencies.

Laboratory-based learning produces new types of knowledge and competency for people. The multifarious materials of the laboratory environment and its components constituted a counterpoint to the idealism of scientific insights, categories and values, and the increasingly divided nature of the research process contrasted with the ascription of discoveries and achievements to individuals—not only on the level of individual people but also on the level of nations [7]. Laboratory classes comprise experiments that accompany the lecture and discussion portions of science courses [9]. Although the value of laboratory classes has been questioned recently sometimes because there is little evidence of their impact on student learning [9], certain values of teaching and learning are based on the importance of practical works [5]. The laboratory environment allows students to gain a first-hand experience with course concepts and further provides them with the opportunity to explore methods used by scientists in their discipline [9].

The laboratory learning environment has largely been reported in the literature to depict an apprenticeship model, where learners follow a step-by-step procedure after their laboratory instructor or a laboratory manual. This narrows the opportunity and freedom that should be afforded to students in trying out their inquiry techniques, where they make errors, learn from those errors, and make learning more interesting and permanent [6]. Students are guided and trained to think critically about a problem with team members and arrive at reliable solutions [1]; if students are allowed to manipulate equipment and materials as a result, they will learn more. He also claimed that in order for laboratory activities to be meaningful, students must be given the opportunity to reflect on findings, clarify understanding and misunderstanding with peers, and use available resources.

Always starting is not easy but shifting from traditional to modern teaching approaches has been privileged for teachers and learners. The implementation of practical work in teaching and learning has been taken as a method that motivates and brings learners' interest in their learning [2]. Prelaboratory activities should be designed to not only motivate students but also trigger their thought processes about the relevance and purpose of the upcoming laboratory activity. Students can also prepare for the laboratory by identifying the main theoretical ideas in the experiment and reading those underlying concepts from textbooks. This might immerse students into the experiments more and thus provide them with informed justifications for the activities [6].

Previous studies reported that teachers perceived the inclusion of a list of recommended experiments for the physical sciences as positive [13]. On the other hand, since students' experiences in science laboratories are mediated, human–technology–world, through experimental technologies, there is an obvious need to consider how the world can be experienced [14]. Students who involve in inquiry types of activities indicate the importance of group work and group member contribution to the achievement of the general goal of the activity. These students give a wide scope of freedom for exploration and critical analysis of the experiments [6].

The important subject of laboratory in teaching is that students should master the practical core tasks, they should establish correct analysis and problem-solving ideas, and at the same time, they should also improve their practical ability [5]. As to Fan, students can comprehensively and systematically understand and master various inspection operation points, expected professional knowledge and skills, and more cutting-edge knowledge. A positive learning environment in the laboratory will help teachers and students to achieve the best performance in the learning process. Therefore, it is important to evaluate the learning environment in the laboratory [8]. The experiments done through laboratories help students to learn the science concepts as they demonstrated this in their long-term retention of learned content [6].

3. Methods and Materials

The purpose of this study was to evaluate students' perceptions and practices regarding laboratory work in secondary school chemistry classes in the North Wollo Zone, which is located in the northeast part of Ethiopia. The zone is divided into nine woredas (districts), including Bugna, Gedan, Meket, Wadela, Lasta, Dawunt, Gubalafto, Habru, and Raya Kobo, as well as three city administrations, Kobo, Woldia, and Lalibela. The study population was secondary school chemistry teachers and students (grades 9–10) to examine their perceptions and practices on laboratory work in chemistry classes. In this case, a descriptive survey design was used because it allowed the researchers to describe the current state of a study field.

3.1. Sampling Techniques and Procedures. Due to financial constraints, it is impossible to conduct this study in all secondary schools in the North Wollo zone. As a result, the researchers decided to conduct the study at selected schools from selected woredas, as well as the town administration. A stratified random sampling method was used to select the zone woredas and town administration. As a result, three woredas and one town administration were chosen from a total of nine woredas and three town administrations. Then, eight schools were chosen: Gubalafto Woreda (Hara and Sanka Secondary Schools), Habru Woreda (Mersa, Wurgessa, and Sirinka Secondary Schools), Raya Kobo Woreda (Tekulesh Secondary School), Meket Woreda (Flakit Secondary School), and Lalibella town (Lalibela Secondary School). Then, four hundred students and sixteen teachers were included in the study through simple random sampling.

3.2. Instruments and Procedures of Data Collection. Data on students' and teachers' perceptions and practices on laboratory activities in chemistry classes in the secondary schools in North Wollo Zone were collected using a questionnaire, classroom observation, and interviews. The questionnaires were filled out by the students and teachers in the sample. The questionnaires were divided into three sections. The first section of the questionnaire included items designed to examine students' and teachers' perceptions and practices regarding laboratory activities in chemistry classes. Respondents were asked about the extent to which they practiced laboratory activities in the second part of the questionnaire. The respondents were asked about the factors that influence the implementation of laboratory activities in chemistry classes in the third section of the questionnaire.

Furthermore, in order to gather more information, the researcher observed two actual classroom observations of laboratory lessons in each grade level (9–10) of the chosen participants, resulting in two classroom observations in each grade level. "Because of the richness and credibility of the information it can provide, observation is a desirable part of a data gathering instrument," says the author ([15]: 89). As a result, thirty-two actual classroom observations were conducted (8 schools and 16 grade levels). The checklist was used for observation. The observation questions centered on the suitability of laboratory rooms, as well as the activities of teachers and students in the laboratory.

Additionally, the researchers used interviews as a data collection method to supplement and triangulate the data obtained through questionnaires and classroom observation. To that end, two sets of interviews were designed and administered to students and teachers, respectively. Semistructured questions were designed to gather the necessary information in this regard. As a result, of the selected schools, a sample of students and teachers was interviewed. In a semistructured interview, specific core questions are determined in advance from which the interviewer branches off to explore in-depth information, probing according to the way the interview proceeds, and allowing elaboration within limits. Before the interview began, the researcher provided participants with clear information about the study objectives in order to gain their cooperation. Throughout an extended interview, the participants discussed a wide range of topics, with only an occasional clarification question. During the interview, the researcher took careful notes.

3.3. Data Analysis. In this study, both quantitative and qualitative analysis techniques were used. Data collected through questionnaire surveys and classroom observations were quantitatively analyzed using descriptive statistics (frequencies and percentages). On the other hand, the data obtained through interviews were analyzed using the qualitative data analysis method. The collected data were first compiled. Second, in developing the thematic framework, a category system was used based on research questions. Third, the researchers sorted out the quotes of respondents by emphasizing keywords and phrases and performing comparisons both within and between cases. Fourth, remove the quotes from their original context and reorganize similar ideas under the newly developed thematic content. Finally, the researcher narratively mapped and interpreted the data to make intellectual and philosophical sense. The literature supported the respondents' point of view. The findings of such analyses were discussed. Using anonymity codes that indirectly represent study participants, all respondents' confidentiality was protected during data collection and reporting of results. Their names were coded; for example, students' and teachers' names were pronounced as S1, S2,... and T1, T2,...

4. Results

The purpose of this research was to investigate the perceptions and practices of laboratory work in chemistry classes of secondary schools in the North Wollo Zone. Its specific concerns were to study the perceptions, actual practices, and factors influencing its implementation. This chapter, thus, presents the findings and discusses these issues concerning the research questions.

4.1. The Perception of Students and Teachers in Laboratory Work

4.1.1. The Perception of Students. Responses to questionnaires from students and teachers about their perceptions of laboratory work were calculated and presented. Because of individual differences, it is possible that not all students will enjoy the practical chemistry classes equally. Some students are dissatisfied with the relevance or methodology of laboratory classes. Some items were included in the survey questionnaire to determine whether respondents had complaints. According to the survey results, there are some issues with the chemistry laboratory experiments that are available. The responses of the students are shown in Table 1.

Chemistry should be taught with an emphasis on its relevance to everyday life as well as its role in the industry, technology, and society [15]. Only when students understand the significance of a given subject matter can effective teaching-learning take place. However, almost all of the objectives or laboratory experiments in chemistry are designed by experts or academicians from a specific institute, with no student participation. There have also been reports that students' opinions could be a useful tool for determining the relevance of laboratory experiments [15]. As a result, study participants were asked to provide information on the significance of chemistry practical courses offered to them.

According to the results, the majority of students responded that the chemistry practical courses (experiments) are relevant to them. For example, students were asked if they believe that theories alone are sufficient to develop their knowledge of chemistry (item 1). As a result, the majority (48.8%) disagreed and 30.7% strongly disagreed with the idea. They were also asked if teaching should prepare students for laboratory activities (item 3). As a result, most of the majority of students (42.3%) strongly agreed, and 41.3% agreed. Similarly, the participating students were asked whether laboratory work is good in theory but difficult to carry out effectively in practice (item 4). As a result, the students (29.2%) agreed with the statement.

Because laboratory work is essential for student learning, teachers should encourage students to actively participate in laboratory activities. As a result, students were polled to determine whether teachers should encourage students to actively participate in laboratory activities (item 2). As a result, most of the majority of students (66.4%) strongly agreed with the concept. Students, on the other hand, were asked their thoughts on various activities (items 5–8) that make laboratory work difficult to practice. The activities included determining whether laboratory work increases the workload on teachers (item 5), is cost-effective to use in teaching-learning (item 6), necessitates well-trained teachers (item 7), and makes it difficult for teachers to cover the prescribed syllabus (item 8). As a result, for items 5 and 8, the majority of students (34.1% and 36.4%, respectively) disagree with the ideas. They did not, however, respond to Question 6 about whether laboratory work is cost-effective for use in teaching-learning. As a result, the majority of students (28.4%) disagree. Similarly, item 7 asked if the implementation of laboratory activities required the use of well-trained teachers. As a result, the students (62%) strongly agree with the idea.

The remaining item groups (9–12) were designed to elicit students' perceptions of the qualities of laboratory activities. The items were as follows: except for repeating procedures given in manuals, no new knowledge can be learned in laboratory work (item 9); I am afraid that many of the chemicals used in the experiments may pose health risks to me (item 10); laboratory activities waste much of the students' time and most of the activities are teacher-centered (item 11); most of the activities are irrelevant (item 12); the outcomes of the experiments are predetermined and do not vary (item 13); (item 13). As a result, for all items 9, 11, 12, and 13, the majority of the students (36.1%, 33%, 35.9%, and 40.3%, respectively) disagreed with the idea that the activities are relevant to the student learning. However, for item 10, the majority (28.9%) of students agree that they are afraid because many of the chemicals used in the experiments may pose a health risk.

Regarding the relevance of laboratory work, the results also showed that it is significant for their learning. For example, one of the students said that "*the practical part of the lesson helps students not forget the lesson and it motivates us for further practical investigation. He adds that it helps students to develop more knowledge*" (S25). Similarly, another student responded: "*The laboratory supports the theoretical part of the lesson, so it helps us to understand the lesson easily*" (S79).

4.1.2. The Perception of Teachers. Teachers play great roles in the effective implementation of laboratory activities. Hence, they are asked different questions regarding their views on the relevance of laboratory activities and their qualities. Accordingly, the teachers' response was given in Table 2.

In Table 2, the result indicated that the majority of the teachers replied that the chemistry practical courses (experiments) are important to students. For instance, the teachers were asked about their beliefs on whether theories alone are enough to develop students' knowledge of chemistry (item 1). Therefore, the majority (58.3%) of the teachers' responses disagreed strongly, and 41.6% of their responses disagreed. In addition, teachers were asked if teaching should prepare students to perform laboratory activities (Item 3). Therefore, half (50%) of the teachers responded strongly and 33.3% of them replied agree. Similarly, participants' teachers were asked whether laboratory work is good in theory although it is difficult to carry out effective laboratory work in reality (item 4). Consequently, the majority (41.6%) of the students strongly agreed and 33.3% of them agreed with the statement.

Laboratory work is important to students' learning, so teachers should motivate students to actively participate in the laboratory activities. Therefore, teachers were asked about their beliefs on whether teachers must encourage students to participate actively in laboratory activities (item 2). As a result, the majority (75%) of the teachers strongly agreed with the idea.

Teachers were also asked about their views on the different activities (items 5–8) that make laboratory work difficult to practice. The activities were whether laboratory work adds workload on teachers (item 5), is economical to use in the teaching-learning (item 6), requires well-trained teachers (item 7), and makes teachers find it difficult to cover the prescribed syllabus (item 8). Therefore, for items 5, 6, and 8, the majority (50%, 33.3%, and 50%, respectively) of the teachers disagree with the ideas. However, for item 7, the majority (75%) of teachers strongly agreed with the idea that laboratory activities require well-trained teachers.

Table 1: Student response on their perception of laboratory work.

No.	Items	Strongly agree 5		Agree 4		Undecided 3		Disagree 2		Strongly Disagree 1	
		F	%	*F*	%	*F*	%	*F*	%	*F*	%
1	I believe those teaching theories alone are enough to develop students' knowledge of chemistry.	25	6.4	29	7.4	25	6.4	189	48.8	119	30.7
2	It is my belief that teachers must encourage students to actively participate in the laboratory activities.	257	66.4	110	28.4	5	1.2	10	2.5	5	1.2
3	Teaching must prepare students for laboratory activities.	164	42.3	160	41.3	35	9	21	5.4	7	1.8
4	Laboratory works are good in theory, but in reality, it is difficult to carry out effective laboratory work.	59	15.2	113	29.2	95	24.5	90	23.2	30	7.7
5	I Know that laboratory work adds to the workload of teachers.	25	6.4	38	9.8	100	25.8	132	34.1	92	23.7
6	Laboratory work is not economical to use in teaching-learning.	45	11.6	83	21.4	103	26.6	110	28.4	46	11.8
7	The implementation of laboratory activities requires well-trained teachers.	240	62	103	26.6	19	4.9	18	4.6	7	1.8
8	In using laboratory work, teachers find it difficult to cover the prescribed syllabus.	37	9.5	65	16.7	92	23.7	141	36.4	52	13.4
9	Except for repeating procedures given in manuals, no new knowledge can be learned in laboratory work.	36	9.3	37	9.5	42	10.8	140	36.1	132	34.1
10	I Feel fear thinking that many of the chemicals used in the experiments may cause health hazards to me.	76	19.6	112	28.9	55	14.2	99	25.5	45	11.6
11	Laboratory activities waste a lot of students' time, and most of the activities are teacher-centered.	56	14.4	78	20.1	52	13.4	128	33	73	18.8
12	Most of the activities are not relevant.	30	7.7	48	12.4	59	15.2	139	35.9	111	28.6
13	The results of the experiments are predetermined and do not motivate students.	32	8.2	42	10.8	36	9.3	156	40.3	121	31.2

Table 2: Teachers' response on their perception of laboratory work.

No.	Items	Strongly agree 5		Agree 4		Undecided 3		Disagree 2		Strongly Disagree 1	
		F	%	*F*	%	*F*	%	*F*	%	*F*	%
1	I believe those teaching theories alone are enough to develop students' knowledge of chemistry.	—	—	—	—	—	—	5	41.6	7	58.3
2	I believe that teachers must encourage students to participate actively in laboratory activities.	9	75	1	8.3	1	8.3	—	—	1	8.3
3	Teaching must prepare students for laboratory activities.	6	50	4	33.3	2	16.6	—	—	—	—
4	Laboratory works are good in theory, but in reality, it is difficult to carry out effective laboratory work.	5	41.6	4	33.3	1	8.3	2	16.6	30	7.7
5	I know that laboratory work adds a workload on teachers.	—	—	6	50	—	—	6	50	—	—
6	Laboratory work is not economical to use in teaching-learning.	2	16.6	3	25.4	2	16.6	4	33.3	1	8.3
7	The implementation of laboratory activities requires well-trained teachers.	9	75	3	25	—	—	—	—	—	—
8	In using laboratory work, teachers find it difficult to cover the prescribed syllabus.	1	8.3	4	33.3	—	—	6	50	1	8.3
9	Except for repeating procedures given in manuals, no new knowledge can be learned in laboratory work.	—	—	—	—	1	8.3	6	50	5	41.6
10	I feel fear thinking that many of the chemicals used in the experiments may cause health hazards to me.	1	8.3	2	16.6	2	16.6	5	41.6	2	16.6
11	Laboratory activities waste a lot of students' time, and most of the activities are teacher-centered.	—	—	1	8.3	2	16.6	6	50	3	25
12	Most of the activities are not relevant.	—	—	1	8.3	—	—	7	58.3	4	33.3
13	The results of the experiments are predetermined and do not motivate students.							6	50	6	50

The other groups of elements (9–12) were designed to obtain teachers' perceptions of the qualities of laboratory activities. The items were the following: no new knowledge can be learned in laboratory work except repeating procedures given in the manuals (Item 9); I feel fear thinking that many of the chemicals used in the experiments may cause health hazards to me (item 10); laboratory activities waste a lot of students' time and most of the activities are teacher-centered (item 11); most of the activities are not relevant (item 12); the outcomes of the experiments are predetermined and do not motivate students (item 13). Therefore, for all elements 9, 10, 11, 12, and 13, the majority (50%, 41.6%, 50%, 58.3%, and 50%, respectively) of the teachers disagreed with the idea that laboratory chemistry activities are significant for the students' learning.

Teachers were also interviewed to obtain their opinions on laboratory work. Almost all of the teachers explained that it is important for students to learn chemistry. For example, one of the teachers said that *"laboratory work makes students love the subject matter"* (T4). Other respondents also mentioned said, *"laboratory work provides students additional knowledge and it makes students create something new,"* as well as *"laboratory work makes the lesson unforgettable and tangible to students. In addition, it makes everything clear to the students"* (T11 and T13, respectively).

4.2. The Practice of Laboratory Work. The practice of laboratory requires a different role of the students and teacher from what they are used to in other learning contexts. This section analyzes if students and teachers are engaged in different activities that the practical (laboratory) part demands.

4.2.1. Student Response to the Practice of Laboratory Work. One of the objectives of this study was to find out whether laboratory activities are practiced in chemistry classes. Thus, the students were asked different questions that could show whether these activities are practiced in the teaching and learning process. The result is presented and discussed in Table 3.

Analysis of students' responses (Table 3) revealed that chemistry laboratory (practical) work was rarely practiced in schools. For instance, items 1 and 2 require students' opinions on whether laboratory work is practiced and the extent of the practice, respectively. Hence, for both items, the majority (39.2% and 37.2%, respectively) of the students responded that it was rarely practiced. Item 3 was if the students had experience in laboratory work, so the majority (37.4%) of the students replied that they had never had such experience. Items 4 and 5 require students' responses to their and their teachers' level of participation in the laboratory (practical) work. Thus, the majority (28.1%) of the students

Table 3: Student response on the practice of laboratory work.

No.	Items	Always = 5		Often = 4		Sometimes = 3		Rarely = 2		Never = 1	
		F	%	*F*	%	*F*	%	*F*	%	*F*	%
1	Laboratory work is practiced in chemistry classes	55	14.2	14	3.6	106	27.3	152	39.2	60	15.5
2	How often do you practice laboratory activities?	16	4.1	42	10.8	131	33.8	144	37.2	54	13.9
3	I had experience of laboratory work	37	9.5	30	7.7	81	20.9	94	24.2	145	37.4
4	I participate actively in the laboratory session	109	28.1	65	16.7	89	22.9	74	19.1	50	12.9
5	Teachers participate actively in the laboratory work	53	13.7	62	16	59	15.2	63	16.2	150	38.7
6	Laboratory work makes us responsible for our own learning	181	46.7	101	26.1	49	12.6	28	7.2	28	7.2
7	Laboratory work requires a lot of time	121	31.2	85	21.9	86	22.2	61	15.7	34	8.7
8	The implementation of laboratory work requires well-trained teachers	236	60.9	75	19.3	31	8	22	5.6	23	5.9
9	In the report, we write exactly what the teacher tells us	128	33	83	21.4	82	21.1	60	15.5	34	8.7
10	We comment on the results and discuss how it can be improved	57	14.7	46	11.8	65	16.7	77	19.9	142	36.6

responded that they participated actively in laboratory activities. However, the majority (38.7%) of the students responded that their teacher did not participate actively in laboratory work. Item 6 was whether laboratory work makes students responsible for their learning. Thus, the majority (46.7%) of them responded that it always makes them responsible for their learning.

Items 7 and 8 were whether laboratory work requires a lot of time and the implementation of laboratory work requires well-trained teachers, respectively. Consequently, the majority (31.2% and 60.9%, respectively) of the students replied always. Items 9 and 10 were on the qualities of laboratory work. Item 9 was if students write reports exactly what the teacher tells them. Hence, the majority (33%) of the students replied that they always write reports exactly as the teacher tells them. The last item (item 10) was whether students comment on the laboratory results and discuss how they can be improved. The majority (36.6%) of the students responded that they did such an activity.

Regarding the implementation of laboratory work, most of the students' interview results showed that they practiced it rarely. For example, one of the interviewee students says: "*Yeah, there is laboratory work but most of the activities are done by the teacher and the report is written by clever students*" (S2). *Another also explained: "We sometimes did* Laboratory work*. However, the report was presented by the group leader*" (37).

4.2.2. Teachers' Response to the Practice of Laboratory Work. Teachers were also asked different questions that indicate the practice of chemistry laboratory work. The responses are given in Table 4.

Analysis of teachers' responses (Table 4) revealed that chemistry laboratory (practical) work was rarely practiced in schools. For example, for item 1, half (50%) of the teachers responded that laboratory work was rarely practiced in the schools. In addition, teachers were asked whether they had experience in laboratory work, so half (50%) of the teachers replied that they never had such an experience. Item 3 requires teachers' responses on their level of participation in the laboratory (practical) work. As a result, more than half (58.3%) of the teachers responded that they participated actively in laboratory activities. Item 4 was whether laboratory work makes students responsible for their learning. Thus, more than half (58.3%) of the teachers responded that it always makes them responsible for their learning.

Item 5 was whether laboratory work requires a lot of time. Accordingly, the majority (41.6%) of the teachers replied often. On the other hand, teachers were asked (Item 6) if the implementation of laboratory work requires well-trained teachers. Therefore, most (75%) of the teachers replied always. Items 7 and 8 were on the qualities of laboratory work. Item 7 was if teachers make students write reports exactly what the teacher tells them. Hence, 83.2% (41.6 + 41.6) of the teachers replied that they always and often made their students write reports exactly what they tell them. Item 8 was whether teachers made students comment on the laboratory results and discussed how they can be improved. Therefore, the majority (33.3%) of the teachers responded that they often did such an activity.

Regarding the practice of laboratory work, most of the teachers' responses in their interviews (T1, T2, T9, and 13) also showed that it is sometimes practiced in schools. It is difficult to say that it is practiced properly because of the scarcity of laboratory instruments, but they tried to practice with the available materials.

4.2.3. Presentation and Analysis of Data Obtained through Observation. The analysis and presentation of the data collected through observation are presented below. To fulfill the purpose of the observation, two randomly selected lessons were observed. Data were collected based on the requirement of the classroom observation checklist (listed in Table 5). They are analyzed in separate tables. The observation was conducted by the researchers and their coobservers, and the results of observed cases were added up and presented in Table 5.

As depicted in Table 5, the data obtained from classroom observation proved that there was not enough sitting space for all students to implement laboratory work. Accordingly, 100% of the data shows that the seating space was not suitable for laboratory work. In addition to the lack of enough sitting space for all students to implement laboratory work, most (70%) of the observed data showed that the seats were not comfortable for laboratory work. Similarly, most (90%) of the data indicated that the layout of the classroom was not arranged to facilitate laboratory work. Moreover, 100% of the observed data showed that there were no sufficient laboratory types of equipment (chemicals and instruments) in the laboratory classes. However, 100% of the data revealed that there were enough windows of the hoods (air inlet and outlet space) in the laboratory classes.

Teachers are expected to give different activities to students in laboratory work. Therefore, the classroom observation checklist contained some of the possible activities of teachers. Results of the observed data are given in Table 6.

As in Table 6, the classroom observation result indicates that teachers provided some activities for students to do but not others. For instance, for items 1, 5, 7, and 8, majorities of the observed data indicated that the teachers did not do such activities in the laboratory classes. The questions were whether the teachers arrange students for different laboratory activities (item 1), provide activities to the students (item 5), follow the activities and their participation in the laboratory work (item 6), evaluate the cooperation in the laboratory work (item 7), and check and give constructive feedback to the students (item 8). Consequently, 80%, 70%, 60%, 80%, and 50%, respectively, of the teachers did not provide such activities.

However, some activities were done by the teachers. For example, the majority of the observed classes showed that the teachers give directions about the procedures of the laboratory activities (item 2) and how to write reports (item 3). Hence, 100% and 80%, respectively, of the data indicated that the teacher did such activities. The observed data also showed that 100% of the teachers were active in explaining,

Table 4: Teacher's response on the practice of laboratory work.

No.	Items	Always = 5		Often = 4		Sometimes = 3		Rarely = 2		Never = 1	
		F	%	*F*	%	*F*	%	*F*	%	*F*	%
1	Laboratory work is practiced in chemistry classes	—	—	4	33.3	2	16.6	6	50	—	—
2	I had experience in laboratory work	—	—	3	25	6	50	3	25	—	—
3	I participate actively in the laboratory session	7	58.3	4	33.3	1	8.3	—	—	—	—
4	Laboratory work makes students responsible for their own learning	7	58.3	4	33.3	—	—	1	8.3	—	—
5	Laboratory work requires a lot of time	2	16.6	5	41.6	4	33.3	1	8.3	—	—
6	The implementation of laboratory work requires well-trained teachers	9	75	3	25	—	—	—	—	—	—
7	Make the students write a report exactly what the teacher tells them	5	41.6	5	41.6	1	8.3	1	8.3	—	—
8	Encourage students to comment on the results and discuss how it can be improved	2	16.6	4	33.3	2	16.6	1	8.3	3	25

monitoring, and describing activities (item 4) and asked questions to the students (item 4).

As in Table 7, although the classroom observation result indicates that half (50%) of the students were active in participating in the laboratory activities, 100% of the data showed that each student does not play a role in the group discussion. The implementation of laboratory work is affected by different factors. The students and teachers from the sample schools were asked in the questionnaire and interview. Their responses are explained in the following sections.

4.3. Factors Affecting the Practice of Laboratory Work. Different factors can affect the implementation of laboratory work. As discussed in the review of the literature, the factors could be teacher-related, student-related, or materials and facilities related. Therefore, one of the objectives of the research was to identify the factors affecting the implementation of laboratory work. In Table 8, 10 areas are identified and presented for the students to express their ideas on the extent of the influence on the practice of laboratory work. They selected the factors as most serious, serious, undecided, or not serious.

As Table 8 shows, the most serious factors affecting the implementation of laboratory work in chemistry classes include lack of resources (62%), lack of interest in laboratory work (42.6%), lack of time to practice laboratory work (40.3%), lack of participation of students in the laboratory activities (36.6%), and the values given to laboratory reports are not encouraging (36.1%).

In the interview, the students were also asked about the factors affecting the implementation of laboratory work. Some of their responses are presented as follows: one of the students said *lack of laboratory instruments is the main problem.* He adds: *"There are also other problems such as lack of awareness of teachers about how they implement laboratory work and the shortfall of time"* (S4). Another student mentioned factors such as: *"Some teachers do not know about managing the experiment, lack of chairs, and lack of laboratory instruments"* (S250).

4.3.1. Teachers' Response to the Factors Affecting the Practice of Laboratory Work. Teachers were also asked about the factors influencing the implementation of laboratory work in the teaching-learning of chemistry. Hence, 10 areas are identified and presented for the teachers to express their ideas on the extent of the seriousness of the problem as most serious, serious, undecided, or not serious.

Table 9 shows the teachers' responses to the seriousness of the factors affecting the implementation of peer learning. Ten factors were assumed to be affecting factors that affect the implementation of laboratory work. Among these factors, lack of resources (100%), lack of time to practice laboratory work (33.3%), and lack of participation of students in the laboratory activities (25%) were the most serious factors affecting laboratory work.

During the interviews, the participant teachers were also asked: What problems do you experience regarding the implementation of laboratory work? One of the teachers, for example, mentioned: "The main problem is the lack of resources, and some students lack interest, so they are not engaged in laboratory activities" (T14). Similarly, another teacher explained: "For me, it is difficult to practice experiments in contexts where there are not enough resources" (T7).

5. Discussion

5.1. Perception in Laboratory Work. To investigate the relevance of chemistry laboratory work among students and teachers, the two groups (students and teachers) responded via questionnaires or interviews. As a result, questionnaires for students and teachers were created to ascertain their perspectives through the use of various perception questions. Students and teachers responded to the questionnaires by indicating how much they agreed or disagreed with the ideas. According to the study's findings, both students and teachers believe that chemistry practical courses (experiments) are important for students' learning. For example, the majority of respondents agreed on the following items: theories alone are sufficient to develop students' chemistry knowledge (item 1); teaching must prepare students to do laboratory activities (item 3); laboratory work is good in theory but difficult to carry out effectively in practice (item 4).

The responses of teachers validated the students' responses to questions about their perceptions of laboratory work. The teachers' responses tended to agree with the students in general (Table 2). The findings of this study agreed with Legesse and Antehun's [11] finding that a survey of students' opinions on the relevance of chemistry laboratory experiments offered in Jimma University's Chemistry Department revealed that the majority of students believe chemistry laboratory classes are relevant and beneficial to their learning.

5.2. Practices of Laboratory Work. The two groups (students and teachers) responded via questionnaires or interviews to assess the extent to which laboratory work has been practically implemented in the schools. Structured observations were also made to back up the data. To this end, questionnaires for students and teachers determine the frequency with which various laboratory activities were used. Students and teachers marked their questionnaires by ticking a response to each item to indicate how frequently laboratory activities were used in practice. Therefore, the magnitude of laboratory work was addressed. As a result, the data showed that laboratory work is rarely practiced in schools. Furthermore, the majority of activities that demonstrate laboratory work practice were not carried out. For example, teachers did not arrange students for various laboratory activities (item 1), assign activities to students (item 5), monitor students' activities and participation in laboratory work (item 6), evaluate students' cooperation in laboratory work (item 7), and check and provide constructive feedback to students' work (item 8). The responses of the students to

Table 5: Condition of the laboratory room.

No.	Item	Yes		No	
		F	%	*F*	%
1	There are enough sitting spaces for all students			10	100
2	The seats are comfortable to do laboratory activities	3	30	7	70
3	The classroom layout is arranged to facilitate laboratory work	1	10	9	90
4	There is sufficient laboratory equipment (chemicals and instruments) in the laboratory class	—	—	10	100
5	There are sufficient windows of hoods (air inlet and outlet space) in the laboratory class	10	100	—	—

Table 6: Teachers' activities.

No.	Items	Yes		No	
		F	%	*F*	%
1	Arranging students for different laboratory activities	2	20	8	80
2	Giving direction about the procedures of the laboratory activities	10	100		
3	Giving directions about how to write reports	8	80	2	20
4	The teacher is active in explaining, monitoring and describing activities	10	100		
5	The teacher gives activities to the students	3	30	7	70
6	The teacher asks questions to the students	10	100		
7	The teacher follows up students' activities and their participation in the laboratory work	4	40	6	60
8	The teacher evaluates students cooperation in the laboratory work	2	20	8	80
9	The teacher checks and gives constructive feedback on the students' laboratory activities	5	50	5	50

Table 7: Student activities.

No.	Item	Yes		No	
		F	%	*F*	%
1	Students are active in participating in the laboratory activities	5	50	5	50
2	Each student is playing role in the group discussion			10	100

questions about their laboratory work practice were validated by the responses of the teachers. In general, teachers' responses tended to agree with students on the frequency with which laboratory work was implemented (Table 4).

Moreover, the observation data showed that the practice of laboratory work was low. Some of the data that show its practice was as follows: although half (50%) of the students were participating actively in the laboratory activities, 100% of the data showed that each student is not playing role in the group discussion. This is due to the lack of teachers providing activities to each student (80%), following up on student activities (70%), and giving constructive feedback to students (50%).

5.3. Factors Affecting the Implementation of Laboratory Work. Laboratory work, like any other educational issue in the teaching-learning process, may have flaws or limitations during its implementation. Among these constraints, the researcher has identified three of the most serious potential factors influencing the implementation of laboratory work in schools. These factors were chosen based on their frequency of occurrence in the responses of the students and teachers. The factors are a lack of resources, a lack of time to practice laboratory work, and a lack of student participation in laboratory activities.

The first major factor affecting laboratory work implementation is a lack of resources. According to students and teachers, 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. 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 (see Table 9). One of the most important factors is the lack of time. Regarding this issue, both groups of respondents agreed that it was the most serious impediment to the implementation of laboratory work. Consistent with this, many respondents (see Table 9) reported a lack of time to actively engage students in laboratory work.

Teachers, according to Osborne and Collins [17], were dissatisfied with the educational system because there was no time for experimental work. Similarly, in a study conducted by Galea [16], 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 Galea [16], laboratory work was either not presented to students in an appealing manner or students appeared to be more concerned with the grade they would receive.

Table 8: Students' response on factors affecting the implementation of laboratory work.

No.	Factors	Most serious 4		Serious 3		Undecided 2		Not serious 1	
		F	%	*F*	%	*F*	%	*F*	%
1	Teachers' tendency to use the theoretical part	126	32.5	96	24.8	68	17.5	97	25
2	Shortage of time to practice laboratory work	156	40.3	128	33	43	11.1	60	15.5
3	Students' lack of interest in laboratory work	165	42.6	83	21.4	62	16	77	19.9
4	Lack of interest in laboratory work	123	31.7	85	21.9	96	24.8	83	21.4
5	Students' knowledge on laboratory activities	136	35.1	123	31.7	74	19.1	54	13.9
6	Teacher knowledge on laboratory work	111	28.6	92	23.7	87	22.4	97	25
7	Some students' dominance during laboratory work	119	30.7	108	27.9	64	16.5	96	24.8
8	Lack of involvement of students in the laboratory activities	142	36.6	126	32.5	65	16.7	54	13.9
9	The values given to lab reports are not encouraging	140	36.1	127	32.8	64	16.5	56	14.4
10	Lack of resources	240	62	61	15.7	38	9.8	48	12.4

Table 9: Teachers' response to possible factors that affect the practice of laboratory work.

No.	Factors	Most serious 4		Serious 3		Undecided 2		Not serious 1	
		F	%	*F*	%	*F*	%	*F*	%
1	Teachers' tendency to use the theoretical part	3	25	3	25			6	50
2	Shortage of time to practice laboratory work	4	33.3	5	41.6	1	8.3	2	16.6
3	Students' lack of interest in laboratory work	1	8.3	5	41.6	1	8.3	5	41.6
4	Lack of interest in laboratory work	2	16.6			2	16.6	8	66.6
5	Student knowledge of laboratory activities	1	8.3	3	25	6	50	2	16.6
6	Teachers' knowledge of laboratory work			4	33.3	5	41.6	3	25
7	Some students' dominance during laboratory work	2	16.6	6	50	1	8.3	3	25
8	Lack of involvement of students in the laboratory activities	3	25	5	41.6	1	8.3	3	25
9	The values given to lab reports are not encouraging	2	16.6	7	58.3	1	8.3	2	16.6
10	Lack of resources	12	100						

Furthermore, the students' role in 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 this study, 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.

6. Conclusion

The study's findings revealed that both students and teachers believe that chemistry practical courses (experiments) are relevant to students' learning. The study's findings also revealed that, despite its importance, laboratory work is rarely performed. Furthermore, the findings indicated that there was insufficient laboratory equipment (chemicals and instruments) in the laboratory classes, and the classrooms were not comfortable for implementing laboratory activities. Furthermore, a lack of resources (such as laboratory equipment), a lack of time to practice laboratory work, and a lack of engagement in laboratory activities were the major factors affecting laboratory work implementation. Finally, recommendations for improving laboratory work practice were made based on the major findings. As a result, the following conclusions were drawn. 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 this study 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 students' lack of engagement of students in laboratory activities were found to be detrimental.

Data Availability

Data are available upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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