



## Science Practical work and Its Impact on Student's Science Achievement: The case of secondary school

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### ABSTRACT

The main purpose of this study was to investigate the impact of practical work enriching instruction of biology lessons on Ninth grade students' attitudes toward biology lessons and their achievement based on students' success. Attitude pre-test, attitude post-test, achievement pre-test and achievement post - tests are employed for all participants in addition to interviewing four students randomly selected from the total participants. The test was applied to students in two different times. According to the research results, it was found that experimental teaching method was more effective in the attitude and achievement level of students in some biology lessons, attitude and achievement has positive correlation. So the study recommend that high school biology teachers should plan their lessons in more practical way to boost (enhance) learners attitude as well achievement. All stakeholders including curriculum planners should take part in the planning process.

### 1.Introduction

Practical work is an essential part of science education. In science lessons, we are trying to extend students' knowledge of the natural world and develop their understanding of the ideas, theories and models that scientists have found useful in explaining and predicting its behavior. Teaching science naturally involves showing learners things, or putting them into situations where they can see them for themselves (Millar, R., & Abrahams, I. 2009).

It is needless to mention the central role practical work has in the curriculum and its essential nature for science learning. Specifically, practical work has a key role in teaching science subjects such as biology in secondary school. However, practical work faces several challenges, including how to ensure that it is effective in helping learn science. Some research into the teaching and assessment of practical work has been done. For example, projects such as getting practical have shown the importance of analysis in the planning of activities and supporting hands on, mind on approach to teaching (Needham, 2014). But, more research is needed. Most commonly, the challenge of practical work is to find ways to make it more effective as a teaching and learning strategy than it often is at present. The possible measure to make it practical work more productive include identification of learning objectives; informed analysis of the learning demand of tasks; and the design and presentation of tasks to assist students in thinking about their actions and their data in the way it is intended.

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According Millar, R., & Abrahams, I.(2009), improvement is not a matter of doing more practical work, but of doing better practical work.

Most consider practical work as important part of learning biology; an interesting activity during biology lesson; and an easy part of learning biology (Hinne, 2017). The question is does students' attitude about the importance of practical work significantly influence their achievement in biology while their attitude concerning interest and difficulty of practical work do not significantly influence their achievement in biology. It can be concluded that even though students demonstrate some level of positive attitude towards practical work in biology in terms of its importance, the experience students gain from doing practical work in the biology lessons do not motivate them to want to pursue career in biology beyond secondary school. A possible explanation could be the manner in which practical work is carried out in secondary school negatively influences their achievement in the subject.

In other words, students' general attitude towards practical work is positive but would it influence their achievement in biology. There is clearly an overall positive attitude towards practical work and there are some good examples but there are also several messages that need to be addressed. There is well-documented evidence, in secondary schools in general and diaspora secondary school in particular, about the shortcomings of equipment funding, particularly in secondary schools; the need is to ensure that those who make decisions in these matters are well-informed. There are currently no serious threats to practical science from health and safety requirements, but the situation needs to be kept under review. Locally, in some secondary schools,

pupils' behavior and a lack of technical expertise may result in significant reductions in practical science. The current assessment demands are damaging practical science.

According to Dillon, J. (2008), although many teachers are dissatisfied with the amount of time and resources for practical science and some have experienced falls in provision, the time devoted to it is still substantial. Mentoring of inexperienced teachers can build confidence in practical science. Opportunities for training and professional development, particularly for secondary teachers and for technicians, are inadequate. Frequent use of live organism in biology lessons and/or practical works may increase students' interest toward biology (Prokop, P., Tuncer, G., & Chudá, J. 2007)

Attitudes toward science involves the students' affective behaviors; for example preference, acceptance, appreciation and commitment. While students' negative attitudes toward science are related to a traditional approach in science instruction, their positive feelings are associated with constructivist science classrooms (Hacieminoglu, 2016). Teaching science with the past approach and traditional teaching methods can affect students' academic achievement in science education. The central source of the students interest is experiments in science. Traditional teaching and over dependence on textbooks could be responsible for the increasing negative student attitudes about science. Students with positive attitudes towards science tend to have higher scores on the achievement measures. This result showed that students having a more positive attitude towards science preferred to undertake meaningful learning rather than rote learning, resulting in the achievement of higher scores (Hacieminoglu, 2016). As the above research states the findings show quarter of students have no interest on biology. There is no statically significant difference between attitude towards biology and students' biology achievements (Hinnch, 2017).

As the above research shows that students have a positive attitude towards science as well biology in different countries. But, in our country there is no sufficient study on the effect of practical work on students' attitude towards biology lessons on the specific topic of osmosis and diffusion. This is why the study focus on the effect of practical work on enhancing attitude of students towards biology lessons particularly on osmosis and diffusion, On the case of Ethiopia particularly in diaspora secondary school.

Making the teaching learning process more practical help teachers to build positive attitude towards the subject they are

## 2. Literature

### 2.1 Students' attitude towards biology

Biology lessons are interesting, not difficult, but still revealed medium positive attitudes (Prokop, P., Tuncer, G., & Chudá, J. 2007). Nigerian secondary school students have positive attitude towards science lessons (Sakariyau, A. O., Taiwo, M. O., & Ajagbe, O. W. 2016). Slovak students have also a positive attitude toward biology lessons and biology lessons were most popular among younger students and girls (Prokop, P., Tuncer, G., & Chudá, J. 2007). There is a positive relationship between students' attitudes towards learning and their academic performance. When learning is able to provide interesting activities for students and the way those activities are engaged, and even the participation of students in school decisions have influence on how students feel about learning and how they react to school life (Kabunga, A., Habiba, C. M., & Mnjokava, C. E. 2018). While more Greek students carry a negative view about biology 26.4% of secondary school students are not interested in biology, in contrast to 32.8% of them are interested. Due to intrinsic

teaching and to enhance learners' achievement. There are a range of purposes for practical science, indeed there are several purposes for science education as a whole (e.g. science as general education as well as training for future career paths). Ample evidence is available that indicates the existence of positive attitude that teachers and pupils have to practical science. Although the evidence of pupil attitudes is equivocal, more research in the issue would benefit the effectiveness of practical work. Dillon, J. (2008), argues that teachers' and other stakeholders' have positive attitudes based on their answer to the question "how important is practical work in science education". As one head of science put it "it is vital and teaching science without practical work is like swimming without water" (Dillon, J. 2008), So implementing more practical work in science education improve learners attitude as well their achievement in biology.

In majority of Ethiopian secondary and preparatory schools science laboratories are not available or the available ones are not furnished and fully equipped so as to conduct practical activities. Teachers in developing countries do not perform practical activities in the classroom because of different reasons even if they understand the role of practical work to enhance students' attitude towards the subject. In diaspora secondary school learners enthusiasm for science subjects becomes lower and their achievement also, as different scholars saying science teaching is effective when it supported by practical activity. But, as my observation science teachers in diaspora secondary school mostly use traditional teaching methods. That is why the study plan to implement practical work particularly hands on activities (experimental method) to enhance grade 9th students' attitude towards the study of biology lessons.

The aim of this study is to investigate the effects of practical work enriched instruction of biology lessons on 9th grade students' attitudes toward biology lessons and their achievement. This study compared the effectiveness of the practical work enriched instruction related to osmosis and diffusion with 1st principle of designed instruction on 9th grade students' achievement and attitudes toward biology. Specifically, the study is designed to examine how practical work affects learners' attitude towards the study of biology, to improve the implementation of practical work in laboratories and to assess how learners' attitude enhance their achievement.

motivation to learn biology, interest in biology and perceived difficulty of biology and students' views about the way biology is taught (Mavrikaki, E., Koumparou, H., Kyriakoudi, M., Papacharalampous, I., & Trimandili, M. 2012). The status of practical activity in Ethiopia

According to Millar, R., & Abrahams, I. (2009), the status of biology practical activities in secondary and preparatory schools in Ethiopia and the result showed that the frequency of practical activities in all schools. Accordingly, out of the total respondents 70% replied that they were not used practical activities available on their book at all while 8.8% of them responded as they always use practical activities. There was inadequate availability of instructional materials (laboratory equipment's) in majority secondary schools. This result indicated that most laboratories in secondary schools are not performing their laboratory activities based on objectives set on the curriculum (Zengele, A. G., & Alemayehu, B. 2016). Finally, practice-based education is not efficient in almost all of the schools under study.



									or
Attitude pre test	59	5.00	20.00	11.39	2.06	.62	.31	5.33	.61
Attitude post test	59	10.00	22.00	15.05	3.14	.60	.31	-.62	.61
Achievement pre test	59	.00	7.00	4.10	1.61	-.83	.31	.89	.61
Achievement post test	59	4.00	10.00	6.7458	1.39	.55	.31	.40	.61
Valid N (list wise)	59								

Table 1 shows the descriptive statistics of the sampled students. It shows measures of central tendency, variation and shape. Thus, the pre and post treatment scores are presented in terms of minimum, maximum, average, standard deviation, skewness and kurtosis. Looking at the pretest- attitude, the minimum value and the maximum value are 5 and 20 respectively. The average score is 11.39 where as the standard deviation is 2.06. The post- treatment, minimum, maximum, average and standard deviation scores are 10, 22, 15.05 and 3.14 respectively. It is, therefore, possible to conclude that there is an improvement in the attitude of students towards lessons in biology. The variation in the scores of students is relatively small as measured by standard deviation.

Table 2: teaching strategy and effect of practical work

Items	Before intervention		After intervention	
	Practical	Conventional	Practical	Conventional
Preferred teaching strategy	49(83.1%)	10(16.9%)	54(91.5%)	5(8.5%)
How does practical work affect learning	Positively 50(84.7.5%)	Negatively 9(13.7%)	Positively 55(93.2%)	Negatively 4(6.8%)

As it can be clearly observed from the table 2, the students' preferred teaching strategy is found to be practical before and after intervention. Surprisingly enough about 83% of the students' preferred practical work as their learning strategy. This may be due to the fact that practical work is not often used in teaching lessons for various reasons. For this reason students might preferred to have more of practical teaching. But there is also an improvement in their preference even after intervention. About 92% of the respondents preferred practical teaching over conventional teaching strategy. Hence, practical teaching strategy is popular among the students with or without intervention. Moreover, most students believe that practical work affects learning positively. The proportion of students who think that practical work would positively impact learning has increased from 85% before treatment to 93% after intervention.

To what extent the implementation of practical work improve the

students' attitude?

Table 3: paired sample statistics

Paired Samples Test		Paired Differences					T	df	Sig. (2-tailed)
Pair 1	Attitude pre-test attitude post-test	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
		-3.66	2.68	.35	-4.36	-2.96	-10.5	58	.000

The differences between the pre and posttest of attitude and achievement tests following the treatment exposure to practical activities in the experimental research were determined by a series of t-tests for the two measures (repeated measure t- test) samples.

Table 4: paired sample statistics

Paired Samples Test		Paired Differences					T	df	Sig. (2-tailed)
Pair 1	Attitude pre-test attitude post-test	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
		-3.66	2.68	.35	-4.36	-2.96	-10.5	58	.000

Table 4, shows means, standard deviations, and the t-test value for the practical work efficiency and for the importance of perception (the group of students who had been exposed to the use of practical work in the teaching of the substance transportation, osmosis and diffusion)

To test the hypothesis that the pre-attitude test (M=11.39 SD=2.07) and post-attitude test (M=15.05 SD=3.15) were equal at dependent sample t-test was performed. And paired sample t- test shows (M= 3.66 SD= 2.68) and (t(58)= 10.48 P= .00 with DF= 58). The figure shows that extremely statistically significant difference between pre and post attitude results.

Table 5: pre-test correlation

Correlations			
		Attitude pre test	Achievement pre test
Attitude pre test	Pearson Correlation	1	.210
	Sig. (2-tailed)		.111
	N	59	59
Achievement pre test	Pearson Correlation	.210	1
	Sig. (2-tailed)	.111	
	N	59	59

Table 5, shows the means and standard deviations for students' efficiency in the test administered to them before and after the experiment (intervention), and the value of the t test. A significant improvement occurred in the achievement of those students who had been exposed to practical teaching (experimentation). To test the hypothesis that the pre- achievement test (M=4.10 SD=1.61) and post

achievement test ( $M = 6.74$   $SD=1.39$ ) were equal a dependent sample t-test was performed. And paired sample t-test shows ( $M=2.64$   $SD=1.59$ ) and ( $t(58) = 12.78$   $P= .00$ ) this result also shows statistically extremely significant difference between pre and post achievement test results.

Pearson correlation test was conducted to determine the relationship between students' attitude lessons in biology and their achievement. This is done in two different test. One test is done to check the relationship between pre-test attitude and achievement and another test is conducted to determine the relation between post-experiment attitude and achievement. These tests are presented at [table 5](#).

The data in the [table 5](#), shows that there is a weak positive correlation between pre-test attitude and achievement of students. The Pearson correlation coefficient ( $r = 0.21$ ) coupled with  $p=0.11$  indicate that there exists a significant positive relationship between pre-test attitude and achievement of students. However, the correlation is weak as the correlation coefficient is close to zero.

## 5. Discussion of the results

Whether practical activities or laboratory teaching affect the students' attitude towards lessons in biology was one of the questions this study has tried to answer. For this purpose, a questionnaire designed and administered on a sample of 59 students. Attitude towards lessons in biology was measured using such items as interest in biology; future career in biology; importance of biology; possibility of becoming a biology teacher; level of difficulty in learning and use of equipment. The questionnaire was designed in such a way that each of these items are measured using a set of questions.

As can be clearly seen from the presentation of the results in [table 2](#) of chapter four, there is an improvement in all measures of attitude both in number and percentage terms after the experiment. There is an improvement in interest of students towards learning because of the intervention. For example, the liking of biology has increased from 36% before intervention to about 87% liking after intervention. Another indicator of improvement in attitude is the students are found to be interested in taking frequent lessons in biology. Moreover, the students have found that using living organisms in their lessons as interesting as evident from an improvement from pretest percentage of 86% to 92% after-treatment. The students' interest in picking up biology as their future career has also shown improvement. Some 97% of the sampled students have shown interest in taking up biology as their career option. After the treatment, biology is found important in helping to understand other subjects for 93% of the respondents; improve the conceptual skills for 92% and improves the quality of life of another 93% of the students. In addition, there has been an improvement in the liking of biology teachers with the experiment and increasing number of students' perceived their biology teachers as role models. Practical activities has helped about 83% of the students to consider biology as easy subject. This is probably because practical activities have made students to understand the lessons.

The above findings show that the use of practical activities (laboratory teaching) helps to improve the students' attitude towards biology. It helps improve their interest, understanding, motivation and ultimately their achievement. This result is consistent with the findings of ([Daba, T. M., & Anbesaw, M. S. 2016](#); [Ozlem, 2011](#); [Shaheen, M. N. K., & Kayani, M. M. 2017](#)). Exposure to practical work improves students' perceptions of their learning efficiency and the importance of the subject and also enhances the students' achievement and their understanding lesson in biology. For example, ([Ozlem, 2011](#)) found that practical work (laboratory) teaching, if planned properly, and if they are effectively integrated into the learning of concepts, have potential to play an important role in students developing a deep and rich understanding of biological

concepts. Laboratory sessions were found to promote thinking skills and to enable students to think more creatively.

Moreover, students' attitudes toward science subjects; how students learn science best, what students like about science, and how their understanding of science is found to be directly affected by labs and experiments ([Shaheen, M. N. K., & Kayani, M. M. 2017](#)). found that the liking of students improved from 56% before treatment to 77% after treatment and 88% of the students said that what they liked best about science was the labs. [Daba, T. M., & Anbesaw, M. S. \(2016\)](#) in their study in Afar region also found out that lack of interest in science subjects is because of lack of practical activities in teaching them.

Importantly, the students' attitude towards biology was grossly measured pre and post experiment as presented in [table 1](#) in chapter four. The descriptive statistics table clearly shows the improvement in attitude towards biology lessons measured both using average and standard deviation. The average score of pre-test attitude is 11.39 where as it is 15.05 after treatment. The standard deviation before and after treatment are 2.06 and 3.14 respectively. It is, therefore, possible to conclude that there is an improvement in the attitude of students towards lessons in biology. The variation in the scores of students is relatively small as measured by standard deviation. However, the extent of improvement is not significant.

Of course, practical teaching was found to be most preferred by students even before intervention compared to conventional teaching. About 83% of the students preferred practical work as their learning strategy. This may be due to the fact that practical work is not often used in teaching lessons for various reasons and the students wanted to have more of it. Obviously, things that are rare or not easily found are the most sought out. For this reason, students might preferred to have more of practical teaching. Moreover, Practical work develops learners' understanding of ideas, theories and models stimulates creativity, curiosity and critical thinking ([Kang, N. H., & Wallace, C. S. 2005](#)). Absence of any practical activity in science subjects due to laboratory facilities have influence on students score in science and their future study ([Muleta, T., & Seid, M. 2016](#)). In addition to this implementation of instructional congruence in teaching science has the significant effect in improving students' interest towards science, especially in the aspects of practical work of science ([Oladipo, O. F. 2021](#)). Laboratory activities in science fields are paramount relevant to make science learning more practical and observable to internalize the theoretical knowledge about natural processes and phenomena. About 92% of the respondents preferred practical teaching over conventional teaching strategy. Hence, practical teaching strategy is popular among the students with or without intervention. Moreover, most students believe that practical work affects their learning positively. The proportion of students who think that practical work would positively impact learning has increased from 85% before treatment to 93% after intervention.

Another issue of interest to this study was students' achievement. It is possible to speculate that if students have interest in a subject, they are likely to exert more effort in to it and ultimately achieve better results. This research tried to assess the students' achievements both in the descriptive analysis and using correlation study. The analysis revealed that a significant difference exists in achievement of students pre and post intervention. The students achievement has improved after the treatment. The average score of students has increased from 4.10 pre-treatment to 6.74 after treatment. Moreover, the variation in achievement of students is relatively small measured by both range and standard deviation. Accordingly, the minimum and maximum achievement score are 0 and 7 pre-intervention and 4 and 10 after-treatment. The standard deviation of achievement has decreased from a pre-test value of 1.61 to 1.39 after-treatment. The possible generalization from this is the intervention has resulted in to improvement in the achievement of students.

Previous research has reached similar conclusions. Practical work has a significantly positive effect on learners' performance (Kibirige, I., Rebecca, M. M., & Mavhunga, F. 2014). Teaching science without practical activities have effect on student's interest towards science disciplines which result in less student enrolments in science class. (Ozlem, 2011) established that hands on activity, as opposed to traditional instruction, enriched students' achievement and attitude towards. He reported that their experimental group's achievements were statistically significantly better than those of the control groups in understanding environment concepts. Moreover, a statistically significant improvement was found in the achievements and efficiency of those students who were taking the lesson osmosis and diffusion practically. We can explain that by the fact that practical teaching can make the lesson livelier and make teaching and learning of science more enjoyable and interesting, leading to better understanding. Therefore, we suggest extending this strategy to other subjects in biology as well as to other science disciplines.

## 6. Implications of the results

The findings of this study suggest that practical teaching not only positively affects the attitude of students but also found to be the most preferred learning strategy. Practical work, group work or manual activity sessions are found to be useful as follow-up activities after the practical work sessions. Even without manual activity sessions the practical work lessons are superior to regular lessons. Thus, we can conclude that practical work are useful for facilitating and developing learning, since they promote student interest in the lessons and provide teachers with a greater variety of pedagogical tools. Moreover, practical teaching is found to affect the achievement of students. The increased interest is often translated in to effort and effort leading to better achievement.

Practical instructional method has the significant effect in improving students' attitude towards science. Science teaching cannot be effective without students being interested in it. Thus, more practical secession is needed if science teaching has to be effective. Moreover, the way practical teaching is planned and conducted has to be well thought out so that it will boost the students' attitude.

The amount of practical work increases the quality of science subjects, students' view of science and their achievement. If secondary schools have to lay down the foundation for future scientist, doctors, engineers, teachers etc., practical secessions has to be conducted as effectively and efficiently as possible.

Producing required number and kind of manpower for the country's development especially in science heavily depends on the way we teach it in secondary schools. It is at this stage that students will develop their interest in science so that they will pursue it as a career later in their life.

The consequence of ignoring practical teaching is wide and far reaching. With such a little attention to practical teaching and laboratory work, it will be difficult to achieve progress in science and be competitive. This is because laboratory activities in science fields are paramount relevant to make science learning more practical and observable to internalize the theoretical knowledge about natural processes and phenomena

Secondary schools, therefore, must work hard to use more practical activities in teaching science disciplines. Laboratory facilities should fully equip and furnished; all necessary inputs should be made available; training should be given both to teachers and students; laboratory classes should be scheduled and properly conducted. For which the school administration, the concerned government bodies and NGOs must work together to ensure these facilities are available.

## 7. Major Findings of the study

It would be understatement to say that practical work has a pivotal role in science learning. Specifically, practical work has a key role in teaching science subjects such as biology in secondary school. Teaching science naturally involves showing learners things, or putting them into situations where they can see them for themselves. However, practical work need to be fully integrated as a major element of effective pedagogy in science in order to improve learning in science.

Practical teaching is carried out in most secondary schools with whatever facility, input and manpower that is available. However, to what extent such activities affect the attitude of students towards biology lessons and their achievement largely remains an open question. This particular study attempted to assess the impact of practical work on students' attitude towards biology lessons and their achievement in diaspora secondary school. It specifically tried to answer how practical work that affect learners attitude towards the study of biology; how to improve the implementation of practical work in laboratories; and how learners attitude enhance their achievement.

This study is conducted by taking a random sample of 59 students from 482 of the total grade 9th students in diaspora secondary school. The intervention was an experimental teaching method for two weeks for all participants by randomly selecting topic osmosis and diffusion from the text. A questionnaire was designed to collect data about attitude of students before and after the treatment. Two tests were designed and conducted to measure students' achievement. The first test was applied before and the second test was applied after the intervention and general six interview questions was used to asses the students view of the teaching learning process in diasspora seconder school.

## 8. Conclusions

Based on the data analysis and discussion, the following conclusions are drawn.

Practical activities or laboratory teaching is found to positively affect the learners' attitude towards lessons in biology. More and effective practical work has led to a more positive attitude. Particularly it was found to enhance the students' interest in biology; future career in biology; importance of biology; possibility of becoming a biology teacher; level of difficulty in learning and use of equipment.

Practical teaching is found to be the most popular learning strategy compared to conventional teaching. Most students are found to prefer practical teaching more meaningful than the conventional one.

The ways practical activities are conducted directly affect the attitude of students. Well thought out and planned; effectively executed laboratory education with all the relevant equipment and inputs affects students' learning in varying levels and help the students to be engaged in their learning both mentally and physically.

A significant positive relationship was discovered between learners' attitude and their achievement. The results of this study clearly show that students having a more positive attitude towards their lesson are found to be better achievers.

The findings show that the use of effective practical activities (laboratory teaching) helps to improve the students' attitude towards biology. It helped improve their interest, understanding, motivation and ultimately their achievement.

## 9. Recommendations

The way teachers train should be changed, should be make it active in teachers college.

More attention and consideration should be given to practical teaching in secondary schools.

There is an urgent need to re-think and re-focus current state of practical teaching in a way that enables effective teaching

Practical activities should be well planned, effectively conducted and made an integral part of the pedagogy.

Additional resources for fully furnishing the laboratories; buying inputs; training should be made available.

The school administration, teachers, relevant government bodies, NGOs, the community should work closely to make sure practical work is conducted effectively.

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