

# Engagement in Science Practicals: Evidence from Tanzanian Public Secondary Schools.

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## Abstract

This study examines student engagement in science practicals in secondary schools in Nyamagana District, Tanzania, focusing on the roles of laboratory resources, teacher support, and class size across behavioral, emotional, and cognitive dimensions. Despite growing emphasis on practical science learning, empirical evidence from resource-constrained contexts remains limited. A convergent mixed-methods design involving 295 students and 64 teachers from 12 schools was employed. Quantitative data were analyzed using descriptive statistics and multiple regression, complemented by qualitative observations. Results indicate moderate overall engagement, with behavioral engagement exceeding emotional and cognitive dimensions. Laboratory resources and teacher support were positively associated with engagement, while larger class size showed a negative association. Key barriers include inadequate equipment, limited teacher training, and exam-oriented instruction. The findings highlight the importance of structural and instructional conditions and provide evidence-based implications for policy and practice to strengthen practical science learning in developing education systems.

**Keywords:** *Student engagement, practical science work, laboratory resources, teacher support, secondary education.*



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## INTRODUCTION

Education plays a crucial role in every nation since individuals are taught skills and knowledge that can assist them become successful in contemporary society (Seid et al., 2022). This encourages individuals to be economically active and foster social and civic existence resulting in a society that appreciates justice, cleverness and even endurance. Every aspect of traditional education, including the natural sciences, is useful in preparing individuals to solve real-life issues, make wise choices, and develop technology and industry. Consequently, the success of science education has a direct and immediate impact on the development of various spheres, including health, agriculture, the environment, and engineering (Acharya & Subedi, 2023). In the context of the global knowledge economy, science education plays a strategic role in developing human capital and strengthening national competitiveness, particularly in developing countries.

Science education is designed to foster the development of critical thinking, creativity, and an interest in the world, as well as an understanding of how nature works. The most important Aspect of science education is to practice practical work with the help of this model. These science activities provide students with practical experiences of concepts, and classroom strategies are reinforced. In laboratories, simulation, or inquiry-based activities, students can observe scientific events, test ideas, manipulate variables, and analyze hands-on information. Throughout the course of the process, students will update their core knowledge and develop the required skills, including observation, measurement, classification, and inference (Talampas, 2024).

It has been demonstrated that hands-on science learning is good for students. It has been repeatedly demonstrated that students in organized laboratories are more successful in remembering scientific

information, have more positive attitudes toward science, and are encouraged to choose a career in science (Apeadido et al., 2024). Practical science experiments are also linked to improved problem-solving, enhanced teamwork, and increased confidence in solving scientific problems. In essence, practical tasks in science foster active and proactive learning among students, thereby helping them overcome challenges at school and in life. However, the effectiveness of practical science learning is highly context-dependent, and its implementation often varies significantly across educational systems.

Since most countries have promoted learner-centered and competency-based lessons, Tanzania has revised its secondary school curriculum to incorporate more competency-based learning in science subjects. Active practice, conversations, and practice of what students are learning are the main goals of the new curriculum structure. Therefore, students have contributed to the realization of these goals, which aligned with Sustainable Development Goal 4, which targets promoting quality and equal education for all. Despite these policy reforms, a persistent gap remains between curriculum intentions and actual classroom practices.

Policies are heading in the right direction, although a significant gap remains between curriculum implementation and what is taught in schools. Regardless of the type of work done by schools, numerous studies have shown that several impediments within the system and structures prevent schools from leveraging viable scientific work. Some of these issues include problems with laboratory facilities, a lack of required supplies for teaching scientific subjects, and inadequate access to electricity and water in some schools, among others, as well as crowded classrooms (Chala & Walabu, 2019; Mokoro, 2020). The fact that various classes and subjects use the same multipurpose laboratory means that access is limited, and therefore, many schedules may conflict. These systemic constraints not only limit the implementation of practical work but also potentially undermine the quality of student engagement in science learning.

It is commonly stated that science teachers do not receive sufficient training in practical lessons; thus, they often employ methods such as demonstrating experiments or discussing ideas (Sanjito, 2025). The existing methods would minimize the level of interaction between students and materials, thereby decreasing the practical learning that they acquire through the course of activities (Sarah & Kabunga, 2019). In such circumstances, students perceive practical work as a mandatory task that must be completed to meet the requirements or pass the exams, rather than recognizing that it might help improve their knowledge.

Student participation was also an important factor that influenced the effectiveness of practical science learning. Engagement includes behavior, emotional interest, and mental effort to gain more information regarding what occurs in the classroom (Pellegrino et al., 2024). Engaged students are also more curious, more prone to questions, attempt to guess what will occur, and will continue working on complex tasks. Students who are in the classroom but are not paying attention may also hinder the effectiveness of practical work and, in some cases, cause boredom or anxiety about science (Bae and Lai, 2020). Although student engagement has been widely studied, limited research has examined how multiple contextual factors simultaneously influence different dimensions of engagement in practical science settings.

Several interrelated factors influence student participation in practice. One of them is the presence of laboratory materials, as it helps define whether students can participate in activities or continue as observers. When teachers accept, motivate, and interact with students in the classroom, they are better equipped to foster an interest in learning. Practical activities may be influenced by the peculiarities of each class, including their size, the duration of each lesson, and institutional support (Oliveira and Bonito, 2023; Kolil et al., 2023).

In the Tanzanian context, empirical studies that integrate structural factors such as laboratory resources, teacher support, and class size with multidimensional measures of student engagement remain scarce. This lack of integrated evidence limits the development of effective, context-sensitive strategies for improving science learning. These complexities have led to this study to investigate the extent of student involvement in practical science lessons in secondary schools, in the public schools in Tanzania, and especially in the Nyamagana District.

The study aimed at achieving a more precise definition of what factors facilitate or inhibit student involvement in practical work. The approach in this research is to mix data between measurements and observations. This approach allowed studying the level of student engagement in laboratory experiments. This study seeks to establish the extent of student engagement, the factors that influence engagement, and the perceptions of students and teachers towards practical science learning. By integrating quantitative and qualitative evidence, this study provides a more comprehensive understanding of student engagement and offers contextually grounded insights for improving practical science education.

The research findings were supposed to inform policy and school practice that would stimulate science learning in schools across Tanzania. A description of weaknesses in the curriculum as experienced in the classroom, along with successful strategies, can help enhance STEM education at both national and local levels. These findings will likely be utilized by education policymakers, curriculum developers, school administrators, and even teacher training institutions in shaping less biased and more engaging science learning experiences. These contributions are expected to support evidence-based policy formulation and instructional improvement in science education within resource-constrained environments.

### **Research Objectives:**

Science education enables students to acquire the skills and knowledge necessary for national science and innovation. Learning science is more centered on the students who are involved in practical activities that allow them to discover and explore their problems. Nevertheless, science activities on the practical side are rarely practiced in Tanzanian public secondary schools due to a lack of equipment, overcrowded classes, and, in most cases, teachers take the lead in the activities (Sanjito,2025). They do not allow students to achieve what the curriculum is intended to accomplish, thereby lowering their involvement and performance in science. Based on the above context, this study sought to respond to the following research objectives:

1. To assess the level of student engagement in science practical work in public secondary schools.
2. To examine the relationship between student engagement and factors such as laboratory resources, teacher support, and classroom environment.
3. To explore student and teacher perceptions regarding the value and implementation of science practical work.

### **LITERATURE REVIEW**

Recent studies in the field of education have given considerable focus to student engagement in order to improve student learning and participation in classroom activities. This is because being involved in science education allows students to excel academically and develop an interest in science (El Masri et al., 2023). Science learning requires active participation, critical thinking, and engagement with information by learners to be effective. In applied science lessons, students tend to touch, inquire, and interact with objects and reach conclusions at the end of the experiment (Akimi Engku Ismail and Mohd Matore, 2024). Meanwhile, some students are unable to engage in science-related activities, specifically in science classes, mainly due to the structural and educational issues that most secondary schools face, such as resource deficiency. This paper investigated student engagement in science education in terms of responsibilities, significant aspects, and performance in real-life activities. It also examines factors that may influence student participation, including the availability of resources, the teacher's role, and the learning environment.

#### **The role of student engagement in science learning**

Participation in lessons is a crucial source of academic performance and high-quality learning, particularly in science. Engagement refers to the active interest, motivation, and mental effort that learners invest in any schoolwork (Ingulfsen et al., 2023). Since science is a practical activity and research area, its role in this area is considerable. Science students are expected to observe phenomena, conduct experiments, analyze the data obtained, and draw well-grounded conclusions, all of which require effort. Students who are engaged in studying can advance in their education and become interested in science (Apeadido et al., 2024).

Additionally, the science of learning is not concerned with memorizing facts and mathematical equations. This involves stimulating interest and educating individuals on how to discern information, as well as thinking critically about facts and questions. Through engagement, students will be able to move away from the passive reception of knowledge and actively construct it. The student is interested in learning and tends to ask questions, explore theories, and contemplate their learning, which leads to improved results (Fru Vitalis Akumaa & Ronel Callaghana, 2019). Practical work is now the most effective way to involve students in science. Participating in laboratory practice, conducting field experiments, and engaging in hands-on activities provide students with a genuine understanding of science, helping them learn while enjoying and believing in their abilities in the field.

### **Types of engagement (behavioral, emotional, cognitive)**

Three important aspects comprise the concept of student engagement: behavioral, emotional, and cognitive (Pellegrino et al., 2024). This enabled us to gain a broad view of how students respond to learning tasks, particularly when conducting science experiments. It is measured based on what students do, for example, by participating in tasks, adhering to the instructions given, and using laboratory equipment with care. Lab students achieve this by conducting prompt, cooperative, and diligent experiments.

Emotional engagement reflects how students feel about the tasks they are completing in their learning, for example, whether they are interested, happy, eager, or nervous. Students who have a positive connection to what they are doing in the science lab tend to show interest, wonder, and curiosity and become motivated by their questions. Negative feelings, such as fear of failure, frustration, or boredom, can make it unlikely for a person to continue learning (Kolil et al., 2023).

The fact that the minds of students are involved can be taken as evidence of their willingness to work hard and listen to the concepts of science. This interaction can manifest itself through the ability of students to come up with ideas of how experiments can be conducted, comment on the outcomes, compare them with the information previously acquired and dwell on the consequences of their input (Oliveira and Bonito, 2023). All these dimensions interrelate to the effect that they have in guiding how students engage and take advantage of hands-on work in science. Once the teachers integrate the three types of engagement, learning becomes more inclusive and engaging to the students, creating a more in-depth perception of science.

### **Practical Work and Active Learning in Science Education**

Most teachers believe that practical work is a significant part of science education because it gives the learner a chance to acquire practical experience in the science discipline. Such activities allow the students to experiment with scientific hypotheses and learn to ask questions and think scientifically in practical conditions (Ingulfsen et al., 2023). Using this model, students will be with the model not as consumers of knowledge, but as producers of knowledge. It is founded on constructivist theories, which, in turn, state that learning develops when students interact with the ideas, formulate questions, and solve real-life problems (Efgivia et al., 2021).

Practical work enhances critical thinking, stimulates curiosity, and improves skills in handling various tools and techniques used in science. Scientific studies enable students to identify patterns, gather information,

and formulate explanations of Brownian motion using evidence, all of which are key aspects of scientific learning. Although projects are helpful for learning, many teachers use them poorly, especially in schools with limited resources (Chala & Walabu, 2019). Sometimes, these lessons take the form of teacher-guided presentations instead of hands-on activities, so students have less opportunity to take an active part.

For practical work to be educational, it should be planned with a purpose, well-equipped, and related to what students are meant to learn. Teachers must link every activity to clear learning goals and provide sufficient support during the activity. If applied effectively, practical work reinforces the key concepts you learn, as well as the habits and mindsets necessary for learning science (Sarah & Kabunga, 2019).

### **Factors influencing students' engagement (resources, teacher support, classroom environment)**

In practical science work, many different factors influence students' interest, engagement in activities, and success. Quality and quantity of laboratory resources are important in attaining success. Effective scientific learning requires provision of scientists with adequate equipment, reagents, and well-equipped laboratories. Without these resources, which are available, or are in a wrong condition, the students might not have a chance to carry out experiments. They are more likely to watch things happen without participating in them and this reduces their interest, and this affects the real world of studying science (Mokoro, 2020).

Teacher support has a huge role to play in defining the level of student engagement. In most cases, an enthusiastic teacher who supports his/her students with a strong passion towards science and offers all possible help in the form of instructions, testing, and other types of resources may make the classroom atmosphere lively and inviting to all (Tuyishime & Tukahabwa, 2022). In this way, such teachers have an opportunity to plan relevant work that would meet the requirements of the curriculum, providing more students with a learning opportunity and an opportunity to participate. Also, classroom environment has an enormous influence on student engagement. One of the factors that affect performance of students in science includes student relationship with teachers, classes size, timing of science lessons and the school. The high workload of teachers and the number of students often presuppose that not many hands-on meetings are possible, which makes the process of communicating with students in a significant way more complicated (AbiDoye et al., 2022). A school that focuses on investigation and research, on the other hand, stands a higher level of motivation and interest among students in science. Overall, existing studies highlight the importance of practical work and student engagement; however, they often examine these elements in isolation. There remains limited integrative evidence that simultaneously considers structural, instructional, and contextual factors influencing multidimensional student engagement, particularly in resource-constrained secondary school settings.

## **RESEARCH METHOD**

### **Research Design**

The study employed mixed-methods research design, the quantitative and qualitative data were collected and analyzed concurrently. This approach combines objective measures with real-life information to have the comprehensive picture of the student engagement in practical activities in science. Quantitative data was used to analyze the levels and trends of engagement, whereas direct observation was used to analyze the perceptions, difficulties and real-life experience of the teachers and students. This approach improved and added more nuance to the results, as it analyzes each type of data individually and interprets the results (Creswell and Plano Clark, 2018).

## Population and Sampling

The target population of this study was identified to be science students and teachers at public secondary schools of Nyamagana district in Tanzania. Sample selection was done using a sampling procedure which involves several steps. The schools were first organized according to their location, and 12 schools were selected in a random manner on the stratified list. All schools were stratified randomly with emphasis being made on science students in various grades as well as teachers of science. After the selection process was done, 359 respondents were involved in the study with 295 science students and 64 science subject teachers.

## Data Collection Tools

Two critical tools, questionnaires and laboratory observations were used to collect data. The structured questionnaires offered to students and teachers of science were aimed at measuring their involvement in science work, the materials which were available in the science lab, the support, which was provided to students by their teachers, and the personal attitude of teachers to the significance of practical work. Most of the items were rated on a five-point Likert and they were checked with the help of a sample of schools to prove the fact that the measurements are reliable.

A checklist was used to make laboratory observations. The behaviors of the students, kind of communication between the teacher and students, and use of resources were given special attention as a component of the lab observations. It was done by observing issues like questioning, collaborating with the students and manipulating the material supplied. This data collection method assisted in developing an insightful idea about the study subject.

## Data Analysis Techniques

SPSS Version 25 was used to analyze the questionnaire data. Descriptive statistics were reported in terms of means, standard deviations, and frequencies. Multiple linear regression was conducted to examine the relationship between student engagement and key variables, namely laboratory resources, teacher support, and class size. Qualitative data were analyzed using thematic analysis, with observations and textual responses coded to identify patterns related to practical work, classroom interaction, and school context. The integration of quantitative and qualitative findings enabled a more comprehensive interpretation of student engagement (Islam, 2020). These analytical approaches were selected to ensure robustness in identifying both statistical relationships and contextual insights. Ethical approval for this study was obtained from the relevant institutional authority, and informed consent was secured from all participants prior to data collection.

## FINDING AND DISCUSSION

The study's findings are presented and discussed in this section in accordance with the stated research objectives.

### Student Engagement in Science Practical Work

The assessment of students' participation in science practicals was conducted by evaluating their behaviours, emotions, and cognitive responses using a Likert scale. The table below summarizes the descriptive statistics for these three dimensions, derived from the responses of 295 students.

Table 1. Mean scores for dimensions of student engagement (N = 295)

Engagement Dimension	Mean	SD	Interpretation
Behavioral	3.1	0.82	Moderate
Emotional	2.85	0.76	Low to Moderate

Cognitive	2.98	0.88	Moderate
Overall Engagement	2.98	0.82	Moderate

Table 2. Key for Interpretation (Adapted from Boone & Boone, 2012)

Mean Score Range	Interpretation
1.00 – 1.80	Very Low Engagement
1.81 – 2.60	Low Engagement
2.61 – 3.40	Moderate Engagement
3.41 – 4.20	High Engagement
4.21 – 5.00	Very High Engagement

Table 1 reveals that the students were moderately engaged in the practice-based science work as the overall score is 2.98 (SD = 0.82). According to Boone and Boone (2012), scores of moderate ranges were between 2.61 and 3.40. Interaction is present yet not as high as it would be to offer the students an optimal learning experience and a deeper interest in science. The participation of students in behavioral activities (average of 3.10) was observed to be the best meaning that students attended laboratories on a regular basis, followed instructions, and performed practical work. Nevertheless, the emotional engagement (M = 2.85) was rather low because it was in the lower half of the moderate range. Therefore, the students may not be eager or interested in practical activities. Respondents' cognitive participation was mild, so they invested time, but not enough to conduct a thorough analysis or generate scientific ideas.

Studies from other areas in sub-Saharan Africa have shown that these findings are related to main barriers, such as teacher-directing classes, limited laboratory resources, and the minimal use of inquiry-based approaches (Olajide et al., 2017; Seid et al., 2022). They believe that authentic learning, which involves practical work, only occurs when students use their judgment and relate what they do to broader and more significant ideas.

Even if students seem interested, they do not regularly think creatively or emotionally, which may diminish the educational impact of practical work. If teachers want students to become more engaged, they can use approaches that involve students, including hands-on experiments, and link practical work to the theory they learn. These techniques can increase people's interest, encourage them to think more deeply and make routine jobs more fulfilling for their minds.

### **The relationship between student engagement and factors such as laboratory resources, teacher support, and classroom environment**

To identify the factors affecting student engagement, such as laboratory resources, teacher support, and class size, multiple linear regression analysis was employed. The findings are detailed in Table 3.

Table 3. Multiple Regression Analysis Predicting Student Engagement

Predictor Variable	B	SE	$\beta$	p-value
Laboratory Resources	0.39	0.05	0.41	< .001
Teacher Support	0.28	0.07	0.27	< .001
Class Size	-0.14	0.06	-0.13	0.018
$R^2 = .46, F(3, 295)$				

The multiple linear regression test was conducted to analyze the effects of the laboratory facilities, teacher support, and class sizes on the student participation in practical science activities. The model yielded significant statistics ( $F(3, 295) = 83.29, p = .001$ ) and explained a large percentage of variation in student engagement ( $R^2 = .46$ ).

The largest positive variable according to the regression coefficients entailed laboratory resources ( $B = 0.39$ ,  $\beta = 0.41$ ,  $p = .001$ ), which implies that availability of appropriate equipment and space in the laboratory can have massive influence on engagement and motivation of the students. Teacher support affected the participation of the students positively ( $B = 0.28$ ,  $\beta = 0.27$ ,  $p < .001$ ). The findings also established that the higher the size of the classroom the less the engagement with the students ( $B = -0.14$ ,  $\beta = -0.13$ ,  $p = .018$ ).

The findings showed that certain aspects of teaching can significantly influence students' participation in practical science work. Since laboratory resources play a significant role in enhancing educational outcomes, laboratories should be well-equipped to enable students to engage in productive activities. This supports Mokoro's (2020) argument that, due to the scarcity of resources in laboratories, students spend most of their time observing but not learning.

As in other works, teacher support proved to be a crucial factor in determining whether students were engaged or not. When teachers scaffold the learning process, use encouraging words, and teach in different ways, they ease the practical work and make students feel like valued group members (Fadzil & Saat, 2020). Constructivist concepts also emphasize that it is the teacher's role to promote meaningful learning in partnership with the students.

Nevertheless, Kolil et al. (2023) observed that a large class size harms students because it reduces the time that can be allocated to each individual and limits the possibilities for each student to engage in the teaching process. When classrooms are overcrowded, teachers often resort to classroom discipline, spending less time attending to students individually.

In general, these results suggest that the decision to make practical science more widespread will depend on effective curriculum planning and addressing the broader issue within schools. Investment in laboratories, promotion of scientific professionalism among teachers, and reducing the number of students in classes will be beneficial to policymakers and administrators. Besides, given that the  $R^2$  of the model is 0.46, it can be concluded that the three predictors are significant; however, other variables, including student attitude, the role of school leaders, and evaluation plans, may also influence engagement, which should be investigated.

### Student and Teacher Perceptions Regarding the Value and Implementation of Science Practical Work

The views regarding the practical science work in both the teacher and student case were addressed based on the scale and more information on the same was acquired in the questionnaires through open questions. The study found out that out of 295 respondents, the average 3.42 (SD 0.66) was the result of their attitude towards educational experience. On the other hand, the teachers ( $N = 64$ ) considered their perception to be positive, and the mean was 3.58 out of five (SD = 0.71).

Table 4. Perception scores of students and teachers regarding practical work

Group	N	Mean Score	SD	Interpretation
Students	295	3.42	0.66	Generally Positive
Teachers	64	3.58	0.71	Positive

Four significant themes were identified during the analysis of qualitative data. Both the parties remarked that scientific activities assisted them in comprehending these concepts more. The other problem was that the officials were afraid of the scarcity of available resources since they perceived that this had been a setback in making this implementation successful. It further came out that practical lessons tend to fit the demands of exams, and as such, they are not assisting students to build their skills and understand more. Also, some of these teachers were observed to be unprepared and unsure about how to make and present practical experiments

that were completed successfully. These results confirm the importance of practical science work but also show that a big challenge lies in the attempt made by the teachers to implement such a practice.

Fadzil and Saat (2020) and Oliveira and Bonito (2023) note that students and teachers acknowledge the fact that science practicals are a crucial source of education. However, the implementation of these precious strategies has been done occasionally because of various problems. Even though it is generally positive, the teachers are not properly prepared, which might be related to the statement made by Sarah and Kabunga (2019) about the significance of teacher skills in the creation of practical activities. There should be constant instruction and assistance in classes since the intentions and what teachers teach are different, which facilitates effective learning. These findings are consistent with constructivist perspectives on learning, which emphasize the importance of active participation and contextual support in fostering meaningful engagement.

## **CONCLUSION**

This research was designed to investigate the levels of student participation in science practice as well as the elements that affect their interest in this activity in the public secondary schools in the Nyamagana District of Tanzania. The study employed a convergent parallel mixed methodology to gather the data involving science students and teachers through quantitative and qualitative designs to examine the practicability of science learning in government high schools in Tanzania.

The results found that there was moderate engagement of students in practical science activities with majority of them engaging in behavioral activities compared to emotional and cognitive activities. This means that even when the students are involved in school activities, they might not be motivated and engaged enough to have to learn. The results of the regression model showed that the laboratory resources and teacher support are important variables that may positively influence the level of engagement of the learners. But large classes will probably undermine such levels. Based on these results, it is agreeable that school design and methodologies of learning have immense impact on the learning of students.

Another thing that was rather evident was that students and teachers were sure that hands-on work in science was an essential part of the study of new material and the enhancement of their scientific abilities. However, there are some present problems such as the lack of laboratory resources, training of teachers, and excessive focus on exams preparation, which decreased the performance and the results of the practical work. Given that what is taught in classrooms does not necessarily correlate with the concept of competence, it would not be easy to encourage students to be proactive and curious in science.

Finally, the unavailability of materials, inadequate teacher training, and poor organization of the classroom can be solved to enhance motivation in science. The recommendations of this paper are that investing in laboratories, training teachers of science, and changing policies like having reduced classes and methods of instruction that can consider the needs of the students will improve the interest of Tanzanian students in STEM. The changes assist the students in developing interest in science, developing science education skills and preparing them to complete tasks associated with science. This study extends current understanding by demonstrating how structural and instructional factors interact to shape multidimensional student engagement in real classroom contexts.

## **LIMITATION & FURTHER RESEARCH**

The research provides valuable insights into how students can engage in science experiments in Tanzanian public secondary schools, but it also has its limitations. This research was done in a single district, and Nyamagana was unable to capture a national scale. Therefore, the findings may not be applicable to areas or schools with high disparities in social and educational cut-off points.

Additionally, the research was based on student and teacher feedback, as gathered through questionnaires and laboratory observations. Nonetheless, it may have impacted the results, particularly in assessing the level of involvement among students and their perception of practical science. Therefore, caution is needed in generalizing these findings beyond similar educational contexts.

Additionally, due to the mixed methods being used, the research was enriched; however, the observation sessions were limited in duration and frequency because of scheduling problems at the school. In turn, there is a risk of overlooking the various dimensions of the interaction between students and teachers, as well as their involvement in practical classes. By using long-term ethnography, the behavior and action in the classroom can be observed at a deeper level.

Nevertheless, several areas of future study require exploration. At the beginning of the process, it would be useful to implement studies that track student engagement over a long period to analyze the impact of efforts, including changes to the laboratory environment or modifications to teacher preparation. Comparative studies across multiple regions should be done in future research to explore the extent to which geographic and institutional variations determine the use of science in schools. Additionally, there is a need to investigate the impact of inquiry-based instructional skills on student engagement and performance. Researchers can explore the use of virtual or remote labs in the future to determine whether their inclusion in schools with limited resources enhances student interest. When these areas are addressed, future work may apply the available findings to enhance science teaching across all populations in Tanzania and other similar environments.

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