International Journal of Science, Technology and Society
2024; 12(1): 44-62
http://www.sciencepublishinggroup.com/j/ijsts
doi: 10.11648/j.ijsts.20241201.15
ISSN: 2330-7412 (Print); ISSN: 2330-7420 (Online)

Investigation for Availability of Laboratory Technicians and Laboratory Facilities for Public Secondary Schools in Dar es Salaam Region, Tanzania

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To cite this article:

Wema Wekwe, Rose Mina, Juliana Masaulwa, Awiria Mafie, Kaiza Mnahuva et al. (2024). Investigation for Availability of Laboratory Technicians and Laboratory Facilities for Public Secondary Schools in Dar es Salaam Region, Tanzania. *International Journal of Science, Technology and Societyl*, *12*(1), 44-62. https://doi.org/10.11648/j.ijsts.20241201.15

Received: October 7, 2023; **Accepted**: October 28, 2023; **Published**: January 18, 2024

Abstract: A science laboratory technician has an essential role to play in the current and future science education. This study investigated availability of qualified laboratory technicians and laboratory facilities in 10 public secondary schools at Ubungo municipal. The study used quantitative and qualitative descriptive survey design where quantitative data from a sample of 10 head of schools, 30 science teachers, 2 laboratory technicians and 150 students from ten schools were drawn using random sampling technique. The data was collected by using structured questionnaire, and conducted focusing group discussion. Analysis were done by using Microsoft Excel had revealed that over 80% of ten schools had no qualified laboratory technicians only 20% had qualified laboratory technicians. Also, the study found that 70% among ten schools were found to have sufficient laboratory facilities with the necessary basic laboratory equipment but 30% were identified to have insufficient laboratory facilities. However, the study found that students' accessibility to practical sessions in their school is very limited to the schools with no qualified laboratory technicians but to the schools with qualified laboratory technicians had more privilege of attending more regularly into practical sessions. According to the head of schools and science teachers commented that absence of qualified laboratory technicians affects implementation of science subjects and practical learning to students, hence hinder performance in science subjects. Appropriate conclusion and recommendation are suggested based on the findings and experience from the schools.

Keywords: Laboratory Facilities, Laboratory Technicians, Dar Es Salaam Region, Tanzania, Survey 2023

1. Introduction

1.1. Background of the Study

Officially speaking, laboratory technicians frequently help with laboratory tasks. They complement the instruction given, particularly during actual practice. They also communicate and work together to exchange information regarding laboratory experiments and demonstrations with the teaching team. The details include the activity type (experiment or demonstration), the number of students, the prerequisites for the experiment, the chemicals or materials required, the preparation that the laboratory personnel must make, etc.

Qualified laboratory technicians perform routine and semi-skilled work in the collection, preparation and distribution of field samples, maintenance of laboratory equipment and glassware. Other activities carried out regularly by laboratory technicians, instructing and assisting teachers with practical skills.

Instructors have a really difficult job since running labs in institutions. The vast majority of educators don't typically have the necessary abilities, and someone with no training cannot perform this job in an appropriate and secure way [6]. Thus, a laboratory's employee, attendant, or technicians has a crucial function to play in today's and tomorrow's teaching of science. They possess a wide range of abilities and

knowledge that scientists and educators are unlikely to have. Laboratories staff members, crew members, and technologists with expertise and training have in-depth understanding of practical procedures and frequently have higher skill (than scientific professors) in topics pertaining to approaches, security, reliability, and equipment economies. An experienced and knowledgeable laboratories support personnel can provide immediate help with practical responsibilities, providing technical guidance to pupils as well as employees and fixing issues. They might have an impact on the department's utilization of resources by guaranteeing a variety of resources and equipment are accessible, properly looked after, and stored efficiently. Materials support the laboratory's efficient operations and security while also allowing faculty to present engaging and distinct scientific classes.

When it comes to helping learners enhance their awareness regarding scientific methodology, hands-on involvement is crucial. According to Lunetta [8] as well hands-on learning refers to educational experiences in where learners work with objects or additional sources of information to study and comprehend how things work (for instance, using spectrum for studying the makeup of stars along with atmospheric pressures or sunspot pictures to investigate physiological organizations). According to Gangoli [5], among others hands-on instruction assists pupils create memory that is permanent, increases their understanding of the moral aspects of science and believed that fosters a spirit of cooperation and engaged engagement between pupils, and demonstrates students to technological knowledge that they may ultimately aid them in establishing philosophical beliefs and abilities. According to [1] work Enriching Laboratory Practices in Education institutions, laboratory experiments encourage students to improve combined mechanical as well as analytical abilities. Researchers observed that most classroom laboratory assignments prevent students from doing inquiries that include organizing investigations, generating discoveries, gathering and evaluating the information, and thinking through and evolving solutions to problems. According to Bajah (1984), there have been a wealth of studies to back up the idea that technology is best taught using practical activity since it promotes engaging education. Whenever the material to be retrieved was originally given using a method that is feasible, memory was discovered to be smoother.

Ughamadu (1992) stated that creative use of equipment in teaching science increases the probability that students will learn and improve their performance. Abimbade (1999) attested that instructional or laboratory materials when appropriately used, enhance learning, improve the competence of teachers and make learning more meaningful to learners. He added that, on the other hand, when these materials are misused, sequel to lack of knowledge on how to use them, science teaching and learning process may be adversely affected. According to Jatau (2008) additionally whenever educational tools are used properly, they increase the efficiency of the educational process, but ultimately is dependent upon an instructor's proficiency in doing so. According to Edet & Inyang (2008) additionally pupils who were taught in an environmental landscaping (an outside lab) outperformed those who were not. This is the case since through the use of environmentally friendly machinery, pupils received instruction by examining things that are natural.

It is evident that hands-on learning helps learners enhance their comprehension of scientific findings, fosters their passion in the subject, and helps them do better on tests. Professionals contribute a crucial role in helping teachers to deliver engaging and diverse lessons that are practical in a productive and secure setting. According to Sir Roberts, who was mentioned in Claps [3] “Pupils’ learning experiences are influenced not just by the teacher but also by the environment in which the subjects are taught. He identified three factors that are responsible and important to include: The quality of the laboratory and associated scientific and technical equipment, the support provided by laboratory technicians and, lastly, the support and guidance that pupils have in carrying out practical work (with particular reference to the adverse effect of high pupil-to-teacher ratios)”. His voice claims that technologists help with every single one of these criteria by supplying and servicing labs and technology as well as by advising and guiding learners and instructors. As a result, laboratory professionals play a crucial part in carrying out competent real-world tasks.

1.2. Statement of the Problem

The availability of qualified laboratory technicians and adequate laboratory facilities is crucial for the effective delivery of science education in secondary schools. However, there is a growing concern regarding the scarcity of qualified laboratory technicians and the lack of properly equipped laboratories in secondary schools. Insufficient resources and expertise in the laboratory setting may hinder the quality of practical science education, limiting students' learning experiences and overall educational outcomes. Therefore, this study aims to identify and address the problem of inadequate availability of qualified laboratory technicians and laboratory facilities in secondary schools.

1.3. Objectives

1.3.1. General Objectives

To determine availability of qualified laboratory technicians and appropriate laboratory facilities in public secondary schools in Dar-es-salaam Region.

1.3.2. Specific Objectives

1) To assess the qualifications and experience of laboratory technicians in public secondary schools.
2) To identify the number of qualified laboratory technicians available in each public secondary school.
3) To evaluate the adequacy of laboratory facilities in public secondary schools.
4) To determine the availability and functionality of essential laboratory equipment and resources in public

secondary schools.

5) To examine the accessibility and utilization of laboratory facilities by students and teachers in public secondary schools.

1.4. Hypothesis

Based on the identified problem, the following hypothesis is proposed for this study:

1) H0 (Null Hypothesis): There is no significant shortage of qualified laboratory technicians and laboratory facilities in secondary schools.
2) H1 (Alternative Hypothesis): There is a significant shortage of qualified laboratory technicians and laboratory facilities in secondary school.

1.5. Scope of the Study

Ubungo is a district north west of Dar es Salaam central business district, Tanzania. It is located in the western part of the province. Coordinates 60C 47’20"S 390C 12’20"E. Ubungo district was selected as case study of the project. The aim of the study was to investigate the current state of availability of qualified laboratory technicians and laboratory facilities in secondary schools. It aims to assess the adequacy of laboratory resources in secondary schools, determine the qualifications and competencies of laboratory technicians, and identify potential challenges and opportunities for improvement in laboratory infrastructure and staffing. The study will be conducted in Ubungo district, by considering a representative sample of five secondary schools within Ubungo district.

1.6. Expected Outcome

1) Increased availability of qualified laboratory technicians by implementing effective recruitment and retention strategies, we anticipate a significant increase in the number of qualified laboratory technicians willing to work in secondary schools.
2) Enhanced skill sets and competencies: strengthened training and certification programs will equip laboratory technicians with up-to-date knowledge, skills, and competences, enabling them to deliver high quality practical education.
3) Improved students learning experiences: students will benefit from enhanced laboratory facilities and the expertise of qualified laboratory technicians, resulting in improved learning outcomes and a greater interest in scientific disciplines.
4) Sustainable partnerships: embellishing partnerships with local industries, research institutions, and universities with create sustainable ecosystem for continuous professional development and collaboration.

1.7. Limitations of the Study

The study was restricted only to Dar es Salaam region zone, in one district Ubungo municipal was sampled for the study. The study was only done to ten public secondary schools. Period of observation was short. The little time that was available to researchers was well planned and full utilized to gathered as much relevant data as possible. The study involved only one district and only ten schools, thus findings from such a small sample may not generalizable to all secondary schools in Tanzania.

1.8. Significance of the Study

The project will help sciences teachers and students through recruiting and retaining qualified laboratory technicians who are used in providing and assisting teachers with practical skills.

Also, to researchers the project will highlight recommendations and challenges of availability of qualified laboratory technicians in secondary schools for more investigations.

To policy makers, qualified laboratory technicians play essential role to assure safety and accuracy of experiments since they have detailed knowledge of practical techniques and often, greater expertise than do the science teachers.

To ministry of education; the availability of competent and skilled laboratory technicians is essential for creating a conducive learning environmental and ensuring the effective implementation of science curricula.

More ever availability of laboratory facilities and qualified technicians in secondary schools prepares students for higher education and gain the necessary practical experience and familiarity with laboratory procedures, increasing their changes of pursuing science related careers.

2. Literature Review

The content of this section includes a review of the available research on the subject of the availability of trained technicians for labs & lab space in public high schools in the Tanzanian town of Ubungo. It discusses the idea and justification behind the teaching of science, the idea of community-based secondary schools, the methods of teaching and absorbing science, hands-on experiences, the significance of hands-on experiences in instructing and understanding scientific topics, real-life science throughout the classroom, and understanding shortages.

2.1. The Aim & Justification of Education Science

There are numerous approaches that researchers have spoken about science. Sciences is the understanding of exactly how things work in nature is a result of thorough, impartial investigation and measurement. Sciences is a way of learning about everything in existence via careful observation and planned experimentation. As more facts are gathered, ideas are developed to explain what has been seen. Physics is being researched not only according to what people are aware, its information, as well as as to how we have access to it, or method. Additionally, the goal of studying science is to create citizens who are proficient in science and capable of blending with the technologically

advanced contemporary society, instead of just academics.

Although not all students choose to pursue professions in science, science is increasingly seen as a subject that should be studied throughout their whole academic lives. People who are more knowledgeable about science are thought to be more capable of promoting social welfare and sustainable economic growth. Any country's development depends greatly on science. With this in mind, UNESCO advised all nations, including Tanzania, to improve the teaching of science in order to hasten the social and economic development of poor nations (UNESCO, 1966). Since exists a clear correlation between scientific advancement as well as a nation's level of economic progress, science is crucial for the nation in question to succeed.

When striving to raise learners' scientific accomplishment and there are numerous aspects to take into account. These factors include the accessibility of trained laboratory personnel, scientific equipment in the lab, and the caliber of the science instructors. Students are meant to be prepared for solving challenges within their own community through science practical tasks in school, particularly the application of science towards farming and effective utilization of energy. If science is not taught in middle and high schools, the Tanzanian Developmental Vision 2025's national development goals cannot be realized. For instance, one of the objectives in the Vision 2025 plan is to ensure that all Tanzanians have access to high-quality livelihoods that will enable them to employ technological and scientific discoveries in their daily lives (URT, 2001).

2.2. The Ideas Behind Community Secondary High School

The community High institutions were created in collaboration with local governments and households in the populations, with the federal government in charge of providing human and financial assets to these institutions. According to the literature, there were no community schools in Tanzania until 1984, when two schools were created (Chediel, Sekwao, & Kirumba, the year 2000). Approximately 350 The community secondary education institutions in 1999. These higher education institutions were insufficient to meet the enormous demand created by the large output of pupils from elementary schools as a result of the PEDP to the mixture from 2002 through 2007 [2]. In 2004, government officials developed the Secondary Educational Development Plan (SEDP) within the Ministry of Environment and Vocational Education (MoEVT), having the goal of expanding enrollment as well as access of primary school graduates to higher education. Each ward was required by the government to have at least one Community Secondary School. One of the goals of founding these types of institutions was to boost learning about science including the number of scientists who graduated.

2.3. Learning and Teaching Science Approaches

When various kinds of instructional approaches are applied, the most engaging aspects of education and instruction can occur. For educating about science subjects, collaborative or shared learning approaches, inquiry, project lecture-demonstration approaches and experiments, and problem-solving ways have been advocated. Inquiry-based learning allows youngsters to build their reasoning skills while also providing experiences that benefit at the earliest stages of mental development. For optimal interactive and cooperative education, pupils are given the opportunity to collaborate in pairs or trios (URT, 2010a).

Given pupils firsthand experience with scientific studies helps in preparing them for life in an increasingly complicated scientific and technical world. Students grasp the natural world better when they're interacting hands-on with natural phenomena, building up their understanding as they go, rather than encountering it simply through print sources. Students that participate in inquiry-based programs develop more creativity, have more positive views toward science courses, and have higher reasoning development, interpersonal ability, and reading preparation. Those who are exposed to the inquiry method for studying science have a more positive attitude about learning in all areas, enjoy school more, and have higher skill mastery in numerous domains, particularly independent thinking ability, than those who are exposed to the conventional method of teaching.

2.4. Teaching with Science in Practice

In the past few decades, real-world work in technology has progressed through a number of stages. In the words of Gott and Duggan (2007), most practical works are illustrated in nature, with a teacher illustrating a concept or law or encouraging learners to uncover concepts or laws on their own [4]. Later, practical work included more open-ended inquiries that were still laboratory-based jobs. Although the context was more manufactured, learners had the opportunity to develop their own research, gather, and interpret their results.

Practical activities make studying more concrete than abstract, more pleasurable than tedious, and, most importantly, skills, concepts, understanding, and attitudes are quickly acquired and immediately applied. Furthermore, according to Watson (2000), in spite of changes in the type of practical work performed over time, the aims of all studies stay increasingly common: to encourage precise reporting and mindful recording, to make phenomenon immensely real; to arouse and maintain interest; and to promote a logical and reasoning method [7].

2.5. The Value for Active Work in Science Teaching and Learning

Evaluations, categorization, measurements, forecasting, issue recognition, collecting data, analyzing it, and interpretation, generating conclusions, and experimentation distinguish scientific from other disciplines. Practical practice is essential in the teaching and learning of science. Aside from assisting students in gaining understanding of scientific concepts, it also assists them in acquiring a variety

of scientific abilities, especially cognitive and manipulative, not to mention the motivational aspects it fosters in the learner. The achievement of these objectives, however, is dependent on how practical labor is organized. According to Mafumiko (2006), hands-on instruction is an important component of science teaching in Tanzanian secondary colleges. Ideally (according to the official syllabus), every O-level and high school class should perform practical assignments [11].

According to Abrahams and Millar (2008), practical work with real things and materials not only helps us transmit knowledge and concepts about the environment, but it also provides opportunity for students to deepen their understanding or scientific method of inquiry. According to Millar (2004), the role of practical activity in science content teaching and learning is also to help students draw connections between two domains of understanding: the world of things and observable properties while events on the one hand, and the domain of concepts on the other. The success of any practical exercise is determined by the learning objectives. As a result, the teacher must ensure that what he or she performs in the testing facility during the hands-on activity is linked.

According to Mustapha (2002), the benefit of practical in science courses is that it allows students to use laboratory supplies to develop basic manipulative skills, practice investigative or inquiry activities, and develop problem-solving attitudes necessary for future work in science. According to Omosewo (2006), laboratory activities can help students gain a better grasp of the scientific and technology processes by encouraging active engagement and developing critical thinking skills. It also provides tangible experiences to back up the theoretical concepts presented.

Usmani (2011) thinks that pupils with extensive practical experience outperform those with less practical experience. This implies that there is an essential connection between theories and practice, which means that student performance in one can be utilized to determine success in the other. Students also regard practical activities as beneficial to their science learning and enjoyment. One cannot envision science being presented without experimental effort; nonetheless, such work, while necessary, is insufficient (Petty, 2009).

2.6. School Practical Sciences

According to research, laboratory-based learning and instruction (practical work) is a more learner-centered educational strategy. According to Motswiri (2004), the goal of instructing science should be to offer practical knowledge and ways to help students confront their misunderstandings, supply possibilities for data manipulation by means of the application of misconceptions, provide possibilities for creating abilities in logical thinking as well organization, particularly with dealing with science, technology, and societal challenges, and provide opportunities for building values, particularly those related to science, technology, and societal issues [12]. These activity-based science teaching objectives apply to all subjects in science.

Practical instruction fosters the development of cognitive talents such as problem solving, analysis, generalization, evaluating, decision making, and creativity (Tilya 2003; Mafumiko, 2006). Practical instruction and learning are vital for the development of a variety of skills, including manipulation, inquisitive, investigative, organizational, and communicative abilities. Practical teaching and learning assist students in better understanding the ideas underpinning scientific research such as definitions of a biological problem, hypothesis, assumption, prediction, and conclusion. Further study has demonstrated that in order to be successful, science training must include direct direct handling of goods, equipment, and materials (Haury & Rillero, 1994). In the words of Kitta and Mafumiko (2009), successful scientific educational instruction in schools requires well-trained teachers who have completed pre-service and in-service programs.

2.7. Empirical Studies on Laboratory Practical Teaching

2.7.1. Science Laboratory Practical Teaching a Global Perspective

Several studies have emphasized the significance of laboratory technicians in facilitating effective science instruction and practical learning experiences (Liu et al., 2018; Smith and Cardella, 2019). Qualified laboratory technicians possess the necessary expertise to set up and maintain equipment, prepare materials, and assist teachers in conducting experiments (Khemmani et al., 2020). However, the literature indicates that public secondary schools often face challenges in attracting and retaining skilled laboratory technicians due to various factors.

One of the primary challenges identified in the literature is the shortage of qualified laboratory technicians in the education system (Braga et al., 2017). Many public secondary schools struggle to recruit individuals with the appropriate educational background and experience in laboratory procedures. This shortage is often exacerbated by low salaries, limited career advancement opportunities, and a lack of recognition for the contributions of laboratory technicians (Braga et al., 2017; Wu et al., 2019). As a result, schools may have to compromise on the qualifications and expertise of their laboratory staff, impacting the overall quality of science education.

In addition to the shortage of qualified technicians, the availability and adequacy of laboratory facilities are also critical factors affecting science education in public secondary schools. Research indicates that many schools lack sufficient laboratory space, equipment, and resources to support hands-on learning experiences (Khemmani et al., 2020; Liu et al., 2018). Insufficient funding and limited resources allocated to laboratory infrastructure contribute to this problem (Smith and Cardella, 2019). Inadequate laboratory facilities can hinder practical demonstrations, limit students' opportunities for experimentation, and undermine the effectiveness of science instruction.

Furthermore, studies have highlighted the importance of laboratory technicians' ongoing professional development

and training (Wu et al., 2019). Continuous training programs enhance technicians' skills and knowledge, enabling them to adapt to new technologies and teaching methods (Liu et al., 2018). However, the literature suggests that professional development opportunities for laboratory technicians in public secondary schools are often limited or non-existent, further impeding their ability to provide high-quality support to science teachers and students.

2.7.2. Teaching Science Laboratory in Developing Countries

The investigation of scientific education and development for SSA countries discovered that reading and duplicating from text books were the primary teaching methods, and pupils learned through rote memorization. Because of the absence of equipment and facilities, practical work requires less than 20% of the time required for scientific research (AHDD, 2007). Wachanga overall Mwangwi (2004) discovered in Kenya that teaching approaches which encourage students to use their hands, eyes, ears, and minds when studying science subjects improve effective understanding and student accomplishment more than teacher-centered methods.

In the nation of Nigeria, Ogunbiyi (1986) discovered that a majority of secondary school pupils are acquainted with more than one laboratory instrument and are unable to identify the experiment in which they are utilized. Similarly, Malawi has a severe scarcity of technicians for laboratories and equipment [13]. Teachers theoretically showed half of what they taught in practical assignments (Zeymelman, 1990). According to Botswana Motswiri (2004), the goal of teaching the scientific community ought to incorporate the objectives that follow: provide practical knowledge and ways that assist learners confront their presumptions, provide possibilities for data modifications through the application of misunderstandings, offer possibilities over developing skills in reasoning and organization, particularly with regard to science, technology, and societal issues, and deliver opportunities for developing values, particularly with respect towards science, technology, and societal issues.

2.7.3. The Nation of Tanzania Sciences Laboratory Teaching

According to Tanzanian studies, the decline of education quality has been a major cause of curriculum modifications in teacher education, although techniques for teaching science topics across higher education institutions and schools are ineffective (Mosha, 2000). The debut of competence-based education represents a paradigm shift from content-based curriculum, which aims to equip students to use knowledge from science outside of the classroom. According to the Directive, scientific teaching ought to be student-centered, competence-based, activity-oriented, and connect students to real-life experiences (URT, 2011). As a result, implementing science instruction in schools has been difficult due to numerous challenges such as the use of non-interactive methods of instruction, theoretical instruction in that learners are not involved in conducting experiments, a lack about instructional and educational materials, and an insufficient supply of science educators and laboratory technicians. All of these are significant barriers to implementing scientific procedures (Kibga, 2004, as well as Anney, 2007; Kabuje, 2009; and Kalolo, 2010).

Most Tanzanian secondary schools lack instructional facilities that could be used to teach and learn science courses for the development of expertise and abilities (Kibga, 2004; Mafumiko, 2006, as amended). These influence instructional approaches, attitudes toward both teachers and students, and even the outcomes of the process of learning and instruction (Kibga, 2004). Good performance as part of interest development is only possible if there are supportive inputs such as positive peer and societal pressure toward the area of study, enabling conditions, a positive schooling climate, as well as appropriate learning and instruction interaction along with instructional approaches.

According to Osaki (2007), science teaching that was experimental in nature encountered problems, one of which was the cost of equipment. Among the obstacles of teaching sciences include a lack of experienced laboratory personnel, assets such as laboratory furnishings, laboratory space, and a paucity of chemicals and apparatus. Knowing the difficulties with implementing the science educational program, the MoEVT tried to obtain financial assistance from the African development Bank (ADB) in 2002 to improve the teaching of mathematics and science by purchasing relevant textbooks, building school laboratories, and designing science in-service training (INSET) courses as well as supplies (Osaki, 2007). Furthermore, Kibga discovered that little preliminary preparation was done during practical lessons, therefore students wasted a lot of precious time collecting equipment from science classrooms followed with conducting experiments.

Kibga (2004) demonstrated that the number of streams for the particular format and the number of pupils enrolled in one stream might influence teaching and learning approaches. This is backed the Magennis and Farell (2004) and Rusbult (2001), who state that crowded laboratories make it difficult for teachers to teach a hard subject to pupils through collaborative, problem-solving, and activity-based learning. School and classroom atmosphere appear to have an impact on student success and participation in various learning contexts. The growing enrolment rates of secondary school students, as well as the high number of students, make it challenging for teachers to teach science courses by demonstration, trial and error, hands-on activities, and other methods of instruction and learning that necessitate close monitoring of pupils.

3. Methodology

3.1. Introduction

The study design, which is study site, study population size, methodology for sampling, sample size, and research tools are all presented in this section of the paper.

3.2. Research Design

A design of descriptive surveys was used in the course of the research. The term "descriptive questionnaire" refers to the process of gathering information to address inquiries about the state of the investigation at the moment. Descriptive research has been selected given that it provides a wealth of factual knowledge that is ideal for determining the truth in education. Additionally, it helps the investigator to acquire information at a specific period and use it to define the specific characteristics for those circumstances that are in place (Colen, 2000, as amended).

Figure 1. *Courtesy. Maphil.*

3.3. Location of the Study

Ubungo is a district north west of Dar es Salaam central business district, Tanzania. It is located in the western part of the province. Coordinates 60C 47’20"S 390C 12’20"E. Ubungo district was selected as case study of the project. The aim of the study was to investigate the current state of availability of qualified laboratory technicians and significance of laboratory technicians. It aims to determine the qualifications and competencies of laboratory technicians, and identify potential challenges and opportunities for improvement in laboratory infrastructure and staffing. The study will be conducted in Ubungo district, by considering a representative sample of ten secondary schools within Ubungo district.

3.4. Target Population

The population of this study will be comprised with 10 public secondary schools out 26 public secondary schools from Ubungo district. These included community secondary schools. The population will include 50 girls’ students, 100 boys’ students who taking science subjects, 30 science teacher's, 30 laboratory technicians and 10 head of school. The target population will be 10 head of the schools, 60 science Teachers and 150 science students and 30 laboratory technicians. According to Bart and Gall (1989) define the target population as the population to which the researcher wants to generalize the results of the study.

3.5. Sample

Kothari, (2004) define a sample as a representative part of a population. The project will select ten (10) secondary schools out 26 of the whole population in Ubungo district by using random sampling techniques. The population will include 30 science teacher's which is 18%, 10 head of schools which is 100%, 30 laboratory technicians which is 100% and 15 science students from each school which is 22.5%.

3.6. Instrumentation

The instrument will be used in this study is Questionnaire and interview. These two instruments were designed for science teacher's, head of schools, laboratory technicians and students. The instrument's goal was to determine the availability of technicians for laboratories and laboratory facilities in secondary schools. The instrument is divided into two parts: A and B. Part A asked for general information about the respondents, such as credentials and years of experience as technicians at a certain school. Part B included twelve questions about the availability of skilled technicians for laboratories and laboratory equipment in secondary schools.

4. Results and Discussions

4.1. Results

4.1.1. Availability of Qualified Laboratory Technicians

We conducted a comprehensive survey across ten schools to assess the presence of qualified laboratory technicians and the utilization of subject teachers as laboratory instructors. The objective was to understand how schools manage their laboratory resources and ensure effective practical education for students. Our finding was Out of the ten schools surveyed, only two schools (20%) were found to have qualified laboratory technicians as tabulated in Table 1.

Table 1. *Proportion of schools with qualified laboratory technicians.*

Variables	Number	Percentage (%)
Yes	02	20
No	08	80
Total	10	100

Information from Table 1 above shows that out of the Ten (10) schools surveyed, two (2) schools have qualified laboratory Technicians and eight (8) schools have no qualified laboratory technicians. This revealed that 20% have qualified laboratory technician and 80% have unqualified laboratory technician.

The remaining eight schools (80%) did not have qualified laboratory technicians available. In the schools without qualified laboratory technicians, it was observed that respective qualified subject teachers of Physics, Chemistry, and Biology played the role of laboratory instructors as tabulated in Table 2.

Table 2. *Proportion of public schools with laboratory instructors.*

Variable	Number	Percentage (%)
Yes	08	80
No	02	20
Total	10	100

Information from Table 2 above shows that eight schools (80%) had respective science subject teachers who work as laboratory instructors and two schools (20%) used qualified laboratory technician.

4.1.2. Availability of Appropriate Laboratory Facilities

In our study, we conducted an assessment to determine the appropriateness of laboratory facilities based on the availability of a suitable building and necessary laboratory equipment. The categorization of labs was done by analyzing whether they had sufficient or insufficient basic laboratory equipment (as defined below).

DEFINITION OF TERMS

1) SUFFICIENT LABORATORY EQUIPMENT: Labs that possess all the necessary basic laboratory equipment required for conducting experiments effectively.
2) INSUFFICIENT LABORATORY EQUIPMENT: Labs that lack some or all of the necessary basic laboratory equipment, hindering the ability to conduct experiments adequately.

Our finding was, out of the ten schools surveyed: 7 schools (70%) were found to have sufficient laboratory facilities with all the necessary basic laboratory equipment available. 3 schools (30%) were identified to have insufficient laboratory facilities, lacking some necessary basic laboratory equipment as presented in Figure 2.

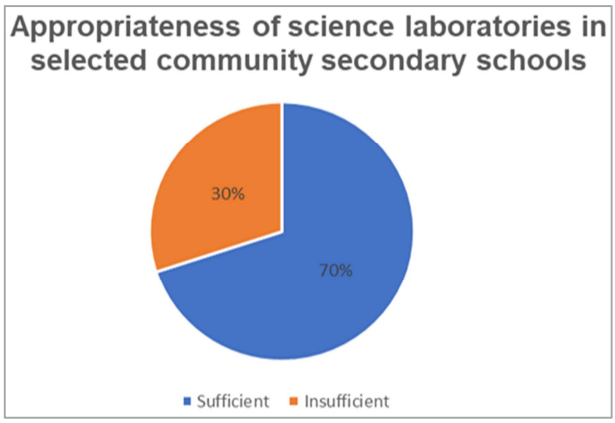

Figure 2. *Presents the results of our assessment, showing the distribution of schools with sufficient and insufficient laboratory facilities among the ten schools surveyed.*

Notably, all the ten schools had a building designated for use as a laboratory. However, it was evident that having a dedicated laboratory building did not guarantee sufficient laboratory equipment. Only 70% of the surveyed schools managed to provide their laboratories with the required equipment, while the remaining 30% faced limitations in this regard.

4.1.3. Students Accessibilities to Laboratory

In this study, we adopted a qualitative approach, conducting focused group discussions with 15 students from each school. The primary objective was to understand how students utilized laboratory facilities during practical learning sessions. Based on their responses, we categorized accessibility to laboratories into three groups: Regularly, Oftenly, and Rarely (as defined below).

Definition of Accessibility Categories

1) Regularly: Students who have consistent and frequent access to laboratory facilities for conducting practical experiments as part of their learning activities.
2) Oftenly: Students who have frequent but not consistent access to laboratory facilities, utilizing them for practical learning purposes on a fairly regular basis.
3) Rarely: Students who have limited and infrequent access to laboratory facilities, restricting their opportunities for practical learning experiences.

Upon conducting the focused group discussions, we obtained valuable insights into the students' accessibility to laboratory facilities across the schools. The results are as follows: 50% of the students reported Oftenly accessing laboratory facilities, indicating that they had frequent opportunities to conduct practical experiments as part of their learning journey. 30% of the students mentioned that they

had Regular access to laboratory facilities, suggesting that they consistently and frequently engaged in practical learning experiences. 20% of the students expressed that they had rare access to laboratory facilities, highlighting limited opportunities for hands-on practical learning. As shown in figure 3.

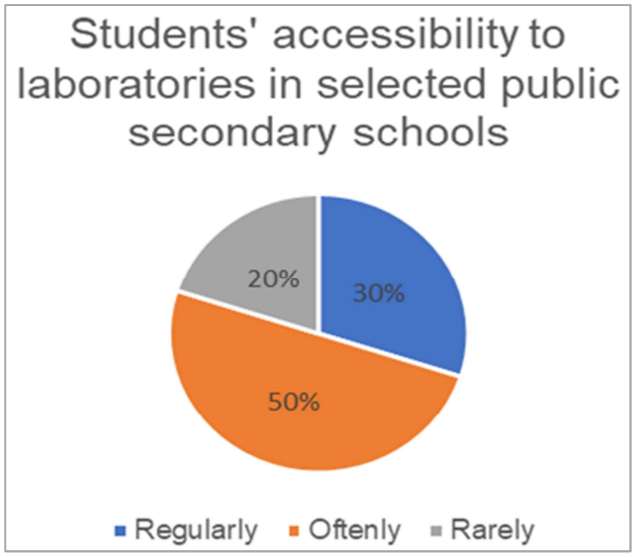

Figure 3. *Students Accessibilities to Laboratories in selected public secondary schools.*

Information from figure 2 above shows that out of the 10 schools surveyed, three schools (30%) had regularly accessibility to laboratories, five schools (50%) had Oftenly accessibility to laboratories, and Two schools (20%) had rarely accessibility to laboratories.

4.2. Discussion

In this study we found that only 20% of schools had qualified laboratory technicians. The remaining 80% of schools despite not having qualified technicians they utilize qualified science teachers to act as lab instructors during practical sessions. This improvision is commendable however the ministry of education (MoE) recommend that all schools should have qualified lab personnel to facilitate lab training. Similarly, (Braga et al., 2017; Wu et al., 2019) found that without proper expertise and guidance from laboratory technicians, the effectiveness of laboratory activities and practical learning experiences may be compromised to student.

The availability of subject teachers to conduct laboratory activities, despite the lack of qualified technicians, reflects the schools' efforts to maintain some level of practical education. However, the literature warns that subject teachers may not possess specialized training in laboratory management, leading to potential safety risks and reduced educational impact refer to (Liu et al., 2018; Smith & Cardella, 2019). The need for ongoing professional development and training for laboratory technicians, as highlighted in the literature, is further reinforced by the absence of such programs in public secondary schools (Wu et al., 2019). Implementing continuous training can improve technicians' skills and adaptability to modern technologies, benefiting both teachers and students.

Regarding laboratory facilities: 7 schools (70%) were found to have sufficient laboratory facilities with all the necessary basic laboratory equipment available. 3 schools (30%) were identified to have insufficient laboratory facilities, lacking some necessary basic laboratory equipment the research findings are consistent with the literature, which indicates that a substantial number of schools lack sufficient resources to support hands-on learning experiences (Liu et al., 2018; Khemmani et al., 2020). The presence of insufficient facilities in three (3) out of 10 schools suggests that likely inadequate funding and limited resources for laboratory infrastructure are prevalent challenges, similarly (Smith and Cardella, 2019) found that Insufficient laboratory facilities can hinder students' exposure to practical demonstrations and limit their opportunities for experimentation, impacting their overall learning outcomes.

Regarding the utilization of laboratories in schools, despite most institutions reporting that they have access to laboratory facilities, there remains a significant challenge in ensuring consistent and frequent practical sessions for students. Out of 100% of schools surveyed, only 30% have the privilege of conducting practical learning consistently, while the remaining 70% of schools conduct practical sessions frequently but not consistently – often limited to once every three months. This infrequency is not recommended for achieving a thorough understanding of science subjects through practical learning.

The importance of practical work for fostering a better understanding of science cannot be overstated, as it plays a vital role in the development of scientific process skills among students. According to Lunetta, Hofstein, and Clough (2007) [8], practical work refers to learning experiences in which students directly interact with materials or secondary sources of data to observe and comprehend the natural world. Gangoli (1995) [5] also asserts that practical work promotes long-term memory retention in students, enhances the ethical dimensions of science, fosters collaboration and active participation among learners, and exposes them to scientific experiences that help develop scientific attitudes and skills.

As highlighted by Shaibu and Mari (2008) [10], schools must prioritize and make improvements to enhance students' accessibility to laboratory facilities. By doing so, students can reap the full benefits of practical learning, leading to a more profound grasp of scientific concepts and principles.

5. Conclusions and Recommendations

5.1. Conclusion

This chapter presents the major findings of the study and giving conclusions which attempt to give answers to specific questions that were investigated. It also presents recommendations for possible actions and suggestions for future research.

Conclusion of the Study

The conclusions of the study were based on the themes derived from the study objectives.

1) QUALIFIED LABORATORY TECHNICIANS: The study revealed that a mere 20% of the surveyed schools had qualified laboratory technicians. This deficiency underscores the need for greater attention to personnel with specialized expertise to ensure the effectiveness of laboratory activities and practical learning experiences.
2) IMPROVISATION WITH SCIENCE TEACHERS: While 80% of schools lacked qualified technicians, they utilized qualified science teachers as lab instructors during practical sessions. While this effort is commendable, it's essential to heed the Ministry of Education's recommendation for having qualified lab personnel, as their expertise contributes significantly to facilitating lab training and enhancing the quality of instruction.
3) SUBJECT TEACHERS' EFFORTS: The involvement of subject teachers in conducting laboratory activities reflects schools' determination to provide practical education. However, it's important to acknowledge that these teachers may lack specialized training in laboratory management, potentially leading to safety risks and reduced educational impact.
4) PROFESSIONAL DEVELOPMENT FOR TECHNICIANS: The absence of ongoing professional development programs for laboratory technicians, as observed in public secondary schools, underlines the necessity for continuous training. Implementing such training initiatives can improve technicians' skills and adaptability to modern technologies, thereby benefiting both educators and students.
5) LABORATORY FACILITIES: The study found that 70% of schools possessed sufficient laboratory facilities, while 30% lacked some necessary basic equipment. This disparity is consistent with existing literature, indicating that many schools struggle to provide the necessary resources for hands-on learning experiences.

5.2. Recommendations

Based on our research work the following recommendations are proposed to address the identified gaps and improve the quality of science education in public secondary schools:

1) RECRUITMENT AND RETENTION OF QUALIFIED LABORATORY TECHNICIANS: Education authorities should devise strategies to attract and retain qualified laboratory technicians. This may involve offering competitive salaries, providing career advancement opportunities, and recognizing the contributions of laboratory staff.
2) PROFESSIONAL DEVELOPMENT FOR LABORATORY TECHNICIANS: Implementing regular professional development programs for laboratory technicians is essential to enhance their skills, knowledge, and adaptability to new technologies. Collaborations with academic institutions and industry partners can facilitate access to relevant training resources.
3) UPGRADE OF LABORATORY FACILITIES: Schools with insufficient facilities should be prioritized for infrastructure upgrades. Adequate funding should be allocated to procure modern equipment and materials, creating a conducive environment for hands-on learning experiences.
4) COLLABORATIVE EFFORTS: Schools with sufficient facilities and qualified technicians should collaborate with schools facing challenges. Knowledge sharing, mentoring, and resource pooling can promote best practices and improve overall science education outcomes.
5) RESEARCH AND POLICY ADVOCACY: Policymakers should invest in comprehensive research on the state of laboratory facilities and technician availability in the education system. Data-driven policies can address the identified issues and drive positive changes in science education.
6) CONDUCTION OF FURTHER STUDY: the research was conducted only at Ubungo municipal by considering of ten (10) school out of twenty-six (26) this doesn’t generally.

Challenges of Inadequate Facilities: The presence of insufficient facilities in 30% of school’s likely stems from challenges such as inadequate funding and limited resources for laboratory infrastructure. Insufficient facilities can hinder students' exposure to practical demonstrations and limit opportunities for experimentation.

UTILIZATION OF LABORATORIES: Although most schools reported having access to laboratory facilities, there remains a significant challenge in ensuring consistent and frequent practical sessions for students. The infrequency of practical sessions, particularly in 70% of schools conducting them only occasionally, hampers the depth of understanding attainable through practical learning.

Based on the discussions and findings presented in this study, the evidence strongly supports the rejection of the null hypothesis (H0) and the acceptance of the alternative hypothesis (H1). The study's results clearly demonstrate a significant shortage of qualified laboratory technicians and laboratory facilities in secondary schools. The lack of qualified technicians, the utilization of science teachers as lab instructors, and the insufficient laboratory equipment in a considerable portion of schools all align with the conditions described in the alternative hypothesis. These findings underscore the need for attention and intervention to address the shortage of resources and expertise in secondary school laboratories.

List of Symbols and Abbreviations

Dr: Doctor
ARPE: Academic Research in Public Engagement
HO: Null hypothesis

H1: Alternative hypothesis
°C: Centigrade
E: East
S: South
%: Percentage
UNESCO: United Nations Educational, Scientific and Cultural Organization
URT: United Republic of Tanzania
PEDP: Primary Education Development Program
MoEVT: Ministry of Education and Vocational Training
SEDP: Secondary Education Development Plane
MoE: Ministry of Education
UK: United Kingdom
NESTA: National Earth Science Teachers Association
USA: United states of America
SSA: Sub-Saharan Africa
ADB: African Development Bank
INSET: In-Service Education and Training
N: Number

Appendix

Appendix I: Head of School Questionnaire

Head of school questionnaire on the availability of qualified laboratory technicians and laboratory facilities for public secondary school in Dar es salaam.

Introduction:

Thank you for taking the time to complete this questionnaire. The purpose of this survey is to assess the availability and accessibility of laboratory technicians and facilities in public secondary schools in Dar es Salaam. Your responses will help us understand the current status and identify areas for improvement. Please answer the following questions to the best of your knowledge and provide any additional comments or suggestions you may have.

SECTION 1: General Information

A: Age
1: 21- 30 [ ]
2: 31-40 [ ]
3: 41-50 [ ]
4: 51-above [ ]
B: Sex
1: Male [ ]
2: Female [ ]
C: Name of the School…….
D: School Location……
E: School Type…….
1: Government [ ]
2: Private [ ]
3: Specialized [ ]
F: Number of Students Enrolled…….
1: 10-30 [ ]
2: 31-60 [ ]
3: 61-90 [ ]
4: 91-above [ ]
G: Number of Laboratory Technicians Currently Employed……...
1: 1-3 [ ]
2: 4-6 [ ]
3: 7-above [ ]
4: absent [ ]

SECTION 2: Laboratory Technicians

The information collected in this questionnaire will be used solely for the intended purpose and therefore any responses or information given will be treated with utmost confidence.

Respond to all items by ticking (√) the correct option or providing the accurate information.

A. How would you rate the availability of laboratory technicians in your school?
1: Excellent [ ]
2: Good []
3: Average [ ]
4: Poor [ ]
5: Not Applicable [ ]

B. Do laboratory technicians have the necessary qualifications and training for their roles?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
C. Are laboratory technicians adequately trained to handle and maintain laboratory equipment?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
Are laboratory technicians regularly updated on new developments in their field?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
D. Are laboratory technicians responsible for the safety and security of laboratory equipment?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
SECTION 3: Laboratory Facilities
A. How would you rate the availability of laboratory facilities in your school?
1: Excellent [ ]
2: Good [ ]
3: Average [ ]
4: Poor [ ]
5: Not Applicable [ ]
B. Which types of laboratories does your school have?
1: Physics [ ]
2: Chemistry [ ]
3: Biology [ ]
4: Computer Science [ ]
5: Other (please specify)……
C. Are laboratory facilities adequately equipped with the necessary tools and materials?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
D. Are laboratory facilities regularly maintained and kept in good condition?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
E. Are laboratory facilities accessible to students during regular school hours?
1: Yes [ ]
2: No [ ]
3: Not Sure [ ]
F. How many laboratories does the school have? 1: Biology
2: Chemistry
3: Physics
4: Other (please specify)
G. Are there dedicated laboratory technicians assigned to each laboratory?
1: Yes
2: No
H. If yes, how many laboratory technicians are assigned to each laboratory? (Please specify for each subject)
I. Are the laboratory technicians qualified and trained in their respective subjects?
1: Yes, they are highly qualified
2: Yes, but additional training may be required
3: No, they are not qualified
J. How often do the laboratory technicians receive professional development or training opportunities?
K. Are the laboratory technicians able to effectively assist teachers and students in conducting experiments and practical activities?
1: Yes, they are very competent

2: They have some level of competence but require improvement 3: No, they are not able to provide adequate assistance

L. Do the laboratory technicians actively participate in curriculum planning and development?

1: Yes, they are involved in curriculum planning

2: No, they are not involved in curriculum planning

M. Is there a process in place to regularly assess and update the skills and knowledge of laboratory technicians?

1: Yes, there is a formal assessment and development process

2: No, there is no formal process in place

N. Are there any challenges in recruiting and retaining qualified laboratory technicians in the school?

O. What resources and support are available to laboratory technicians in terms of equipment, materials, and infrastructure?

P. Are there any suggestions or improvements you would recommend for enhancing the role of laboratory technicians in the school?

SECTION 4: Challenges and Suggestions

A. What are the major challenges faced in maintaining laboratory technicians and facilities?

1: Lack of funding [ ]

2: Inadequate training opportunities [ ]

3: Insufficient staffing [ ]

4: Lack of equipment and materials [ ]

5: Poor infrastructure [ ]

6: Safety concerns [ ]

7: No major challenges [ ]

8: Other (please specify)……...

B. Are there any additional comments or suggestions you would like to provide regarding laboratory technicians and facilities in your school?

Appendix II: Science Teacher Questionnaire

Science teacher questionnaire on the availability of qualified laboratory technicians and laboratory facilities for public secondary school in Dar es salaam.

Introduction:

Thank you for taking the time to complete this questionnaire. The purpose of this survey is to assess the availability and accessibility of laboratory technicians and facilities in public secondary schools in Dar es Salaam. Your responses will help us understand the current status and identify areas for improvement. Please answer the following questions to the best of your knowledge and provide any additional comments or suggestions you may have.

Instruction

The information collected in this questionnaire will be used solely for the intended purpose and therefore any responses or information given will be treated with utmost confidence.

Respond to all items by choose the correct option or providing the accurate information

Personal Information:

A. School name…….

B. Sex

1) male

2) female

C. age

1) 20-25

2) 26-31

3) 32-37

4) 38-43

5) above

D. How long have you been teaching science at your current school/institution?

1) 1-3 years

2) 4-6years

3) 7-9years

4) above 10

E. Do you currently have a qualified laboratory technician available in your science department?

1) Yes

2) No

F. If you answered "Yes" to the previous question, please rate the competency and effectiveness of the laboratory technician on a scale of 1 to 5, with 1 being poor and 5 being excellent.

……

G. If you answered "No" to question 3, please provide the reason(s) why a qualified laboratory technician is not available in your science department.

……

H. How would you describe the impact of not having a qualified laboratory technician on the quality of science education at your school/institution?

……

Other information

Please indicate the availability and condition of the following facilities/equipment in your science department:

A. Laboratory benches and workstations

1) Available and in good condition
2) Available but in poor condition
3) Insufficient number of benches
4) Not available

B. Safety equipment (e.g., goggles, gloves, fire extinguishers)

1) Available and in good condition
2) Available but in poor condition
3) Insufficient quantity
4) Not available

C. Microscopes and other optical instruments

1) Available and in good condition
2) Available but in poor condition
3) Insufficient quantity
4) Not available

D. Chemicals and reagents

1) Sufficient quantity and variety
2) Insufficient quantity or variety
3) Not available

E. Glassware and lab supplies

1) Sufficient quantity and variety
2) Insufficient quantity or variety
3) Not available

F. What challenges or limitations do you face as a science teacher due to the unavailability or poor condition of laboratory facilities/equipment?

……

G. Have you communicated the need for a qualified laboratory technician and improvements to the facilities/equipment to the relevant authorities at your school/institution?

1) Yes, and they have taken appropriate action
2) Yes, but no action has been taken
3) No, I have not communicated the need

H. What is your subject specialization? (e.g., Biology, Chemistry, Physics)

……..

I. How often do you conduct practical experiments or activities in your science classes?

……..

J. Are there dedicated laboratory technicians assigned to support science teachers?

1). Yes
2) No

K. If yes, how would you rate the availability of laboratory technicians in terms of their availability during your scheduled practical classes?

1) Always available
2) Mostly available
3) Sometimes available
4) Rarely available
5) Not available at all

L. Are the laboratory technicians qualified and trained in their respective subjects?

1) Yes, they are highly qualified
2) Yes, but additional training may be required

3) No, they are not qualified

M. Do the laboratory technicians possess the necessary skills and knowledge to assist you and the students during practical sessions?

1) Yes, they are very competent
2) They have some level of competence but require improvement
3) No, they are not able to provide adequate assistance

N. Are there sufficient resources, equipment, and materials available in the science laboratories to conduct experiments effectively?

1) Yes, we have all the necessary resources
2) We have some resources, but there are limitations
3) No, we lack essential resources

O. Are there any challenges or limitations you face in accessing or utilizing laboratory facilities for practical sessions? If yes, please specify.

P. How would you rate the overall condition and maintenance of the science laboratories?

1) Excellent
2) Good
3) Fair
4) Poor

Q. Are there any suggestions or improvements you would recommend to enhance the availability of qualified laboratory technicians and facilities in the secondary school?

……

R. Is there anything else you would like to share regarding the availability of laboratory technicians and facilities in the school?

……

S. What steps, if any, have been taken to address the current situation regarding laboratory facilities and technician availability?

……

T. In your opinion, what are the ideal qualifications and skills required for a laboratory technician in a science department?

……

U. Is there any additional information or comments you would like to provide regarding the availability of a qualified laboratory technician and facilities in your science…….

Thank you for taking the time to complete this questionnaire. Your input is greatly appreciated and will contribute to our understanding of the challenges faced in science education.

Appendix III: Laboratory Technician Questionnaire

Laboratory technician questionnaire on the availability of qualified laboratory technicians and laboratory facilities for public secondary school in Dar es salaam.

Introduction:

Thank you for taking the time to complete this questionnaire. The purpose of this survey is to assess the availability and accessibility of laboratory technicians and facilities in public secondary schools in Dar es Salaam. Your responses will help us understand the current status and identify areas for improvement. Please answer the following questions to the best of your knowledge and provide any additional comments or suggestions you may have.

Instruction

The information collected in this questionnaire will be used solely for the intended purpose and therefore any responses or information given will be treated with utmost confidence.

Respond to all items by choose the correct option or providing the accurate information

SECTION 1: General information

A. School name…….

B. Sex

1) Male
2) Female

C. Age

1) 20-25
2) 26-30
3) 31-35
4) 36-40
5) above 40

Marital status.
1) married
2) unmarried
Number of children's
1) none
2) 0-3
3) 4-6
4) 7-10
5) above 10
D. Occupation
1) lab technician only
2) Lab technician and other activities, please specify …….
SECTION 2: Other information
A. How long have you been working as a laboratory technician in this secondary school?
……
B. Are you a qualified laboratory technician with relevant certifications/training?
1) Yes
2) No
C. How would you rate the availability of laboratory equipment and facilities in your school on a scale of 1 to 5, with 1 being "Not Available" and 5 being "Fully Available"?
1) Microscopes
2) Bunsen burners
3) Test tubes and beakers
4) Chemical reagents
5) Safety equipment (gloves, goggles, lab coats, etc.)
6) Other (please specify):
D. How long have you been working as a laboratory technician in the secondary school?
……
E. Which subject areas do you specialize in as a laboratory technician? (e.g., Biology, Chemistry, Physics)
……
F. How would you rate the availability of qualified laboratory technicians in the school?
Sufficient number of qualified technicians
Insufficient number of qualified technicians
G. Are the laboratory technicians adequately trained and qualified in their respective subject areas?
1) Yes, they are highly qualified and trained
2) Yes, but additional training may be required
3) No, they are not qualified or trained adequately
H. How often do you collaborate or work with other laboratory technicians in the school?
1) Regularly
2) Occasionally
3) Rarely
I. Are there sufficient resources, equipment, and materials available in the science laboratories to support practical sessions?
1) Yes, we have all the necessary resources
2) We have some resources, but there are limitations
3) No, we lack essential resources
J. How would you rate the condition and maintenance of the science laboratories?
1) Excellent
2) Good
3) Fair
4) Poor
K. Do you receive adequate support and guidance from the school administration in your role as a laboratory technician?
1) Yes, I receive sufficient support
2) I receive some support, but there is room for improvement
3) No, I lack support and guidance
L. Are there any challenges or limitations you face while performing your duties as a laboratory technician? If yes, please specify.
……

M. Do you feel that having more qualified laboratory technicians would enhance the overall effectiveness of the science laboratories in the school?

1) Yes, it would significantly enhance the effectiveness
2) It would somewhat enhance the effectiveness
3) No, it would not make a significant difference

N. Do you feel adequately supported by the school administration in terms of maintaining and upgrading laboratory equipment and facilities?

……

O. Are there any specific challenges or limitations you face in carrying out your duties as a laboratory technician? If yes, please describe:

……

P. How often do you conduct practical experiments or laboratory sessions with the students?

……

Q. Are there any restrictions or limitations on the number of students participating in laboratory sessions?

……

R. In your opinion, how important are well-equipped laboratories and qualified laboratory technicians in enhancing the quality of science education?

……

S. Have you received any professional development opportunities or training programs to enhance your skills as a laboratory technician?

……

T. Are there any areas where you feel additional training or support would be beneficial to improve your effectiveness in your role?

……

U. Are there any plans or discussions within the school administration to improve or expand laboratory facilities in the near future?

V. Do you have any suggestions or recommendations for improving the availability of qualified laboratory technicians and laboratory facilities in secondary schools in Dar es Salaam?

……

Thank you for taking the time to complete this questionnaire. Your feedback is highly valued and will contribute to our assessment of the current situation and potential improvements in secondary school science education in Dar es Salaam.

Appendix IV: Student Questionnaire

Student questionnaire on the availability of qualified laboratory technicians and laboratory facilities for public secondary school in Dar es salaam.

Introduction:

Thank you for taking the time to complete this questionnaire. The purpose of this survey is to assess the availability and accessibility of laboratory technicians and facilities in public secondary schools in Dar es Salaam. Your responses will help us understand the current status and identify areas for improvement. Please answer the following questions to the best of your knowledge and provide any additional comments or suggestions you may have.

Instructions

The information collected in this questionnaire will be used solely for the intended purpose and therefore any responses or information given will be treated with utmost confidence.

Respond to all items by choose the correct option or providing the accurate information

SECTION 1: GENERAL INFORMATION

A. Name of the secondary school you attend……

B. Class ……

1) Form 1
2) Form 2
3) Form 3
4) Form 4

C. Sex……

1) Male
2) Female

D. age……...

1) 12-14
2) 15-17

3) 18-20
4) Above 20
SECTION 2: OTHER INFORMATION
A. Are there laboratory facilities available at your school? (Please select one) a) Yes, fully equipped
1) Yes, but inadequately equipped
2) No, there are no laboratory facilities
B. If your school has laboratory facilities, please rate the condition of the equipment and resources available. (Please select one)
1) Excellent
2) Good
3) Fair
4) Poor
C. Are there qualified laboratory technicians present at your school? (Please select one)
1) Yes, we have qualified laboratory technicians
2) Yes, but they are inadequately qualified
3) No, we do not have qualified laboratory technicians
D. If your school has qualified laboratory technicians, please rate their competence and knowledge. (Please select one)
1) Highly competent and knowledgeable
2) Moderately competent and knowledgeable
3) Inadequately competent and knowledgeable
E. How often do you have access to laboratory sessions? (Please select one)
1) Regularly, at least once a week
2) Occasionally, once or twice a month
3) Rarely, only a few times a year
4) Never, we do not have laboratory sessions
F. Have you participated in any practical experiments or activities in your science classes?
1) Yes, regularly
2) Yes, occasionally
3) No, never
G. How would you rate the availability of laboratory technicians during your practical classes?
1) Always available
2) Mostly available
3) Sometimes available
4) Rarely available
5) Not available at all
H. Do you feel that the laboratory technicians possess the necessary skills and knowledge to assist you during practical sessions?
1) Yes, they are very competent
2) They have some level of competence but require improvement
3) No, they are not able to provide adequate assistance
I. Are there sufficient resources, equipment, and materials available in the science laboratories for conducting experiments effectively?
1) Yes, we have all the necessary resources
2) We have some resources, but there are limitations
3) No, we lack essential resources
J. Are the science laboratories well-maintained and equipped with modern facilities?
1) Yes, they are in excellent condition
2) Yes, but there are some maintenance issues
3) No, they are not well-maintained or lack modern facilities
K. Do you feel that the science laboratories provide a conducive environment for learning and conducting experiments?
1) Yes, they are highly conducive
2) They are somewhat conducive but could be improved
3) No, they are not conducive to effective learning and experimentation
L. Do you believe that having qualified laboratory technicians would enhance your learning experience in science classes?
1) Yes, it would significantly enhance my learning experience
2) It would somewhat enhance my learning experience
3) No, it would not make a significant difference

In your opinion, how important are laboratory facilities and qualified technicians for effective science education……

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