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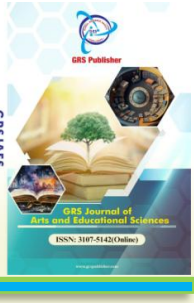

The Effect of Inadequate Equipment in Physics Lab and the Students Performance in G.S Bukomero (Ruhango)

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Abstract: ***Background:*** The integration of lab methods into science education has its roots in early scientists, especially during the 17th century. Taylor (1963) points out that around 1590, experimental science began to take shape as scientists conducted intentional experiments. ***Objective:*** The study aimed at exploring the effects of inadequate equipment in physics lab and the students' performance. ***Materials and Methods:*** A combination of qualitative and quantitative data was gathered through the use of surveys, interviews, and observations. The study focused on three key groups: teachers, students, and staff members of G.S. Bukomero. Among them, 89 participants were selected for the sample population. ***Results*****:** The research findings showed that 84.3% of the respondents faced challenges during the teaching and learning of physics due to inadequate lab equipment. These challenges included limited opportunities for social interaction, inadequate practical laboratory activities, reduced motivation among both learners and educators, and poor performance in the physics subject. The research results also indicated that 60.7% of the participants believed that the availability of laboratory facilities had a substantial effect on students' performance in science subjects. ***Recommendations:*** It is advised that school administrators collaborate closely with science teachers to alleviate the challenges stemming from limited resources. Moreover, the Ministry of Education should organize regular professional development programs for science educators, focusing on effective utilization of locally accessible materials to enhance laboratory experiences for students.

Keywords: *Inadequate equipment, Physics lab, the students' performance.*

Cite this Article

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Introduction

The integration of lab methods into science education has its roots in early scientists, especially during the 17th century. Taylor points out that around 1590, experimental science began to take shape as scientists conducted intentional experiments (Taylor, 2008). Galileo Galilei was credited by Taylor as the first to extensively use the modern scientific method in physics and astronomy (Mason, 2002). The 17th century marked a heightened emphasis on the scientific method, leading to a transformative shift in science. Kalinga highlighted the lack of labs and equipment in many schools for practical science subjects like chemistry, biology, and physics (Msoka, 2015). This shortage leads new educational institutions to prioritize arts over science, resulting in fewer science graduates and lower performance. Ross, K., Lakin, L., and Callaghan, P. (2004) noted that practical work helps educators connect theoretical concepts to real-world applications, boosting student motivation (Ross, 2010). However, inadequate lab equipment hinders interaction between students and teachers during practical sessions, making it hard for students to bridge the gap between theory and application, ultimately reducing motivation. Mboto, F. A., and Udo, N. N demonstrated that many schools rely on neighboring institutions for practical sessions, leaving students with incomplete practical skills (KIZITO, 2016). Wiley observed that teachers use practical demonstrations when schools have labs, equipment, and chemicals (DeMeo, 2001). In the absence of these resources, educators often depend on lectures. Furthermore, the active learning enhances understanding and critical thinking (Mugabe, 2021).

Materials and Methods

ETHICAL CONSIDERATION

Ethical approval was sought and received from G.S Bukomero (Ruhango) Ethical Review Board. The ethical approval letter was

provided. Informed consent was obtained from the parent before collecting oral swab samples from study participants. Data were handled confidentially coupled with coding to identify practical Equipments' from which the data were obtained.

STUDY AREA

This study was conducted from January, 2023 at G.S Bukomero (Ruhango), Southern province.

STUDY DESIGN

The study used a combination of qualitative and quantitative data gathered through the use of surveys, interviews, and observations.

STUDY POPULATION AND SAMPLE SIZE

The study focused on three key groups: teachers, students, and staff members of G.S. Bukomero. Among them, 89 participants were selected for the sample population.

Data Analysis

As the main study aim was to explore the effects of inadequate equipment in physics lab and the students' performance with the relevant specific objectives; the study investigated how the lack of adequate equipment in physics lab affects students' academic performance. To assess this scenario, questionnaires and surveys were shared to the respondents as indicated in table *1*.

Table 1 Number of respondents

Categories	Number	Percentage
Students	60	67.50%
Teachers	28	31.40%
Head teacher	1	1.10%
Total	89	100%

Source: primary data, 2023

As indicated in the above table, table *1*, a total of 89 individuals participated in the survey. Among them, 60 were students, 28 were teachers, and 1 was the Head teacher. Students accounted for 67.5% of the respondents, teachers constituted 31.4% of the respondents, and the Head teacher made up 1.1% of the respondents. A substantial number of students were included in the study due to its focus on investigating the effect of inadequate equipment in physics laboratory on students' academic performance. This topic is of greater relevance to learners compared to other groups, as they are the ones likely to experience the most significant consequences. Again, for the results not to be biased, sex of the respondents was considered to learn more.

Table 2 Sex of respondents

Sex	Frequency	Percentages
Male	49	55%
Female	40	45%
Total	89	100%

Source: primary data, 2023

The table 2 above presents the data about the sex of respondents. Male respondents occupy 55% of the total respondents while female represents 45%. This shows that the research has used both male and female sexes. The results are not based on one sex.

Table 3: Age of respondents

Age range	Frequency	Percentages
At most 12years old	**2**	**2.2%**
]12-18] years old	**58**	**65.2%**
]18-25] years old	**10**	**11.2%**
]25-35] years old	**15**	**16.9%**
Above 35 years old	**4**	**4.5%**
Total	**89**	**100%**

Source: primary data, 2023

The data presented in the table3 illustrates the findings gathered concerning the age distribution of the participants. The data indicate that 2.2% of the respondents are aged 12 years or younger, 65.2% fall within the age range of over 12 but not exceeding 18 years old, 11.2% are above 18 but not surpassing 25 years old, and 16.9% are above 25 but under 35 years old. Additionally, 4.5% of the respondents are aged above 35 years. These findings demonstrate that the research encompasses a diverse range of ages, implying that the conclusions drawn from the study are not limited to a single age bracket. The higher concentration of individuals between 12 and 18 years old can be attributed to the prevalence of students among the respondents.

Table 4: Educational level of respondents

Level of education	Frequency	Percentages
Ordinary level	40	45%
Advanced level	21	23.6%
A1 Certificate	5	5.6%
A0 degree	22	24.7%
Master's degree	1	1.1%
Total	89	100%

Source: primary data, 2023

The table 4 presents the data about the educational level of respondents. 45% are in ordinary level, 23.6% of them are in advanced level, 24.7% have A0 degree, 5.6% have A1 certificate while 1.1% have master's degree. This shows that the research has been participated by all levels of education in this school.

Findings Related To the Topic

The difficulties encountered by the students and teachers during teaching and learning physics subject with inadequate physics' lab equipment.

Table 5: Availability of physics lab equipment

Q: **Do you have enough physics lab equipment?**		
Responses	**Frequency**	**Percentages (%)**

Yes	20	22.5
No	69	77.5
Total	89	100

Source: primary data, 2023

From all respondents, 22.5% affirmed that there is enough physics lab equipment, while 77.5% denied.

Table 6: How often physics lab equipment are used in teaching/learning process

Q: How often do you use physics lab equipment in teaching/learning process?		
Responses	**Frequency**	**Percentage (%)**
Always	**2**	**2.3**
Often	**10**	**11.2**
Sometimes	**35**	**39.3**
Rarely	**42**	**47.2**
Total	**89**	**100**

Source: primary data, 2023

From the respondents, only 2.3% said that they always use physics lab equipment in teaching/learning process, 11.2% said they often use physics lab equipment in teaching/learning process, 39.3% said that they sometimes use physics lab equipment in teaching/learning process while 47.2% said that they rare use them.

Table 7. Students and teacher's responses concerning with difficulties during teaching and learning physics subject with inadequate lab equipment

Q: Do you have the difficulty during teaching and learning physics subject with inadequate lab equipment?		
Responses	**Frequency**	**Percentage**
Yes	75	84.3
No	14	15.7
Total	89	100

Source: primary data, 2023

The findings indicated that 84.3% of participants encountered difficulties while teaching or learning physics due to a lack of proper laboratory equipment. The majority of educators faced various issues when conducting hands-on activities with inadequate lab resources:

They encountered hurdles in promoting inquiry-based learning, a method that helps students develop scientific concepts. This is because inquiry learning requires identifying assumptions, applying critical and logical thinking, and considering alternative explanations. It is widely agreed that the discovery method (guided or unguided inquiry) or experimental approach is more effective for teaching science. For example, Piaget encouraged children to learn through exploring their surroundings ***(Simatwa, 2010)***.

They struggled with assessing specific learning goals. Many teachers noted that the methods used to assess student understanding and performance in practical work did not align with the precise objectives of the activities. This misalignment arises because students do not directly engage with materials and phenomena, which hampers their ability to comprehend and construct knowledge through scientific practice ***(Powietrzynska, 2015)***. However, only 15.7% of students disagreed with the idea of facing challenges in learning physics, especially in practical work with inadequate lab equipment. According to the obtained results, most respondents identified the following difficulties when learning physics in a classroom rather than a well-equipped physics laboratory:

Limited social interaction: Physics labs provide a unique learning environment where students can collaborate in small groups to explore scientific phenomena and connections. These lab exercises foster collaborative social interactions, positive attitudes towards science, and cognitive development ***(Hofstein, 2004)***.

Lower physics performance: Fisher argued that increased time spent on academic work enhances student performance ***(Fisher, 2012)***. Therefore, it is crucial to allocate sufficient time for students to engage with subject content, facilitating effective learning. Conversely, science educators noticed that students who learned physics in small cooperative groups outperformed those in large group settings in terms of achievement and inquiry skills.

Proficiency in Understanding Physics Concepts with Limited Practical Work

The study uncovered that most physics students found mastering physics concepts challenging without proper practical work. Similarly, most physics teachers indicated that students struggle to grasp physics concepts when science subjects are taught without enough practical work. Osborn and Collins and suggested that certain activities should be demonstrated, while others should be led by students, although there might be some overlap depending on factors like time and equipment availability ***(Bennett, 2009)*.**

Table 7 Can you master physics concepts with inadequate practical work?

Responses	**Frequency**	**Percentages**
Yes	14	15.7%
No	75	84.3%
Total	89	100%

Source: primary data, 2023

It can be seen from the findings of this study that 84.3% of the respondents claimed that without enough practical work they cannot master physics concepts, however 15.7% of the respondents agreed that possibly they can master physics concepts without enough practical work.

How inadequate physics lab equipment can affect students' performance in physics

Table 9: Relationship between Laboratory Facilities and Academic Performance

Respondents were asked to indicate the extent to which availability of laboratory facilities affect performance of students in physics subjects. Responses are summarized and presented in table below.

Responses	**Frequency**	**Percentage**

Very great extent	54	60.7
Great extent	23	25.8
Moderate extent	10	11.2
Little extent	2	2.3
Total	89	100

Source: primary data, 2023

Findings in table 9 show that 60.7% of the respondents indicated that availability of laboratory facilities affect performance of students in science subjects to a very great extent. This implies that schools with well-equipped laboratories have better results in the school certificate science examinations than those that are ill-equipped. The finding concurs with Soyibo and Nyong that schools with well-equipped laboratories have better results in the school certificate science examinations than those that are ill-equipped and lack of adequate exposure to practical work is one of the contributing factors to dismal performance in examinations ***(MASIME, 2016)***. Laboratory work stimulates learners' interests as they are made to personally engage in useful scientific activities and experimentation which promotes that science is not only product or process but also affords the learner the basic skills and scientific methods of problem solving and knowledge obtained and promotes long term memory.

Table 10: The measures that can be put in place to overcome the challenges caused by inadequate physics lab equipment

Responses	**Frequency**	**Percentage (%)**
Teaching physics using locally available materials	32	35.9
Teaching physics through demonstration	25	28.1
Teaching physics using postures and simulations	20	22.5
Having partnership with schools which are well equipped with Physics lab materials	12	13.5
Total	**89**	**100**

Source: primary data, 2023

Findings from Table 10 illustrate the strategies that can be implemented to address the challenges arising from inadequate equipment in the physics laboratory:

- Teaching physics using locally available materials
- Employing demonstration-based teaching for physics
- Incorporating postures and simulations in physics instruction
- Establishing partnerships with well-equipped schools that have physics lab resources

Information Gathered From Interview

The head teacher's responses align with the questionnaire results. She highlighted difficulties faced by both students and teachers when dealing with inadequate physics lab equipment, such as students struggling to grasp physics concepts. The head teacher also noted that inadequate equipment can lead to poor student performance in class and national examinations. She suggested solutions like improvisation, consistent requests for new materials from the government, and forming partnerships with well-equipped neighboring schools.

Discussion of Findings

The research focused on exploring the effect of inadequate equipment in the physics lab on student performance at G.S. Bukomero in Ruhango district. The analysis addressed the identification of challenges faced by students and teachers due to inadequate lab equipment, the effect of such equipment on student performance, and recommendations to overcome related challenges. The findings, summarized in tables, indicate that a considerable percentage of respondents encountered difficulties due to inadequate lab equipment and that such deficiencies can notably influence students' performance in science subjects. It concludes that inadequate physics lab equipment can adversely affect students' performance, leading to issues like limited social interaction, inadequate practical activities, low motivation, and subpar physics performance.

Conclusion

The study aimed to explore the effect of inadequate physics lab equipment on student performance. It unveiled that teachers encounter challenges when teaching science due to a lack of laboratory resources, leading to issues like limited social interaction, motivation gaps, inadequate practical activities, and lower performance in the physics subject. The research also indicated that schools with well-equipped labs tend to achieve better results in science examinations. Potential solutions, such as teaching through demonstrations, utilizing locally available materials, employing simulations, and forming partnerships with well-equipped schools, were identified. Despite teachers' use of group work and demonstrations to navigate the limitations, overcrowded classrooms and inadequate resources impede optimal teaching practices. The study concludes that further exploration in this domain could provide valuable insights.

Recommendations

Based on the study's findings, the following recommendations are proposed:

To the School

To mitigate the effect of limited resources, school administrators should collaborate closely with science teachers. Promoting the use of locally available materials and organizing in-house professional development sessions for teachers can help address the challenge. Establishing partnerships with neighboring well-equipped schools to share resources and experiences is also suggested.

To the Ministry of Education

The Ministry of Education should prioritize teacher training, focusing on the use of locally available materials to facilitate laboratory activities. Employing laboratory technicians to assist teachers in creating improvised materials and supporting classroom activities is advisable. Additionally, utilizing science students on

internships for assistance could be beneficial. Ensuring equitable distribution of resources across schools is crucial.

To Teacher Educators

Through robust professional development, teacher educators should enhance their understanding of the benefits of using locally available materials. Equipping student-teachers with skills for teaching with limited resources and managing large class sizes is recommended. Effective instruction in educational media is vital to prepare future educators for designing and using improvised materials.

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