
FACULTY OF SCIENCE AND EDUCATION

NAGONGERA CAMPUS

**EFFECTS OF AVAILABILITY AND UTILIZATION OF PHYSICS LABORATORY
EQUIPMENT ON STUDENTS' ACADEMIC ACHIEVEMENT IN SECONDARY
SCHOOLS OF KAPCHORWA DISTRICT.**

BY

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FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF
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DECLARATION

I, Cherop Daisy Mwanga declare that this research report is my original work and has not been submitted anywhere for the award of the degree, where other people's work was used has been acknowledged and cited according to the University policy.

Signature.....Date...../November/2023

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APPROVAL

This research project has been submitted for examination with my approval as her university supervisor.

Signature.....*[Signature]*.....Date.....*12/11/2023*.....

-DR. RICHARD CLIFFE SSENUNZI

DEDICATION

This work is dedicated to my beloved parents Mr. Sikorya Simon Mwanga and Mrs. Sandra Mwanga who saw me through school and to my beloved sisters and brothers Deborah Chemutai M, Enos M, Sarah Chebet M, Samantha Yeko M, Jesse Chekwech B, Faith Chesuro M and Elizabeth Edith C.

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ABSTRACT

The study conducted in Kapchorwa district, Eastern Uganda, assessed the availability and utilization of Physics Laboratory Equipment (PLE) in secondary schools. The research involved 70 students and 30 Physics teachers from 10 out of 16 schools, selected randomly and purposively respectively. Data was gathered through a questionnaire, an equipment checklist, and a Physics Achievement Test (PAT). The results indicated that the effective use of PLE significantly improves Physics teaching. Private schools, which had a good amount of PLE and utilization, scored well in achievement tests. However, public schools with the least equipment and utilization had the lowest scores. The study concluded that a well-equipped science laboratory is essential for high-quality Physics education in Kapchorwa secondary schools.

CHAPTER ONE: INTRODUCTION

1.1. BACKGROUND

Historically, the use of laboratory equipment in teaching is as old as the early 1900s when the use of laboratory equipment took an upper stage in the teaching-learning process to enable educators to deliver their instructional content. However, by then the technology was less developed so local equipment such as Paschen type galvanometer (1919-1924), induced current demo piece (19th century), reversing switch (19th century) and so many others (Olufunke, 2012). It was during this time that educators recognized that using laboratory equipment could improve learning outcomes by making lessons more engaging in the mid-20th century, with the advancement of technology, there was the introduction of more laboratory equipment such as a thermal expansion ring, Demonstration conductor for electrostatics and then Micrometer reading manometer in the mid-late 20th century, which further expanded the use of laboratory equipment in the classrooms(Vaidya & Clifton, 2003). This support was found to improve learners' retention of information and it also fostered greater student engagement. Here in Uganda, the Ministry of Education and Sports has been emphasizing the importance of laboratory materials in secondary schools to improve the quality of education. Despite this recognition, some of the schools in rural areas might have limited access to laboratory equipment like those that require electricity to run the equipment, which might affect the academic performance of learners(Olufunke, 2012). In this case, this study sought to contribute to the ongoing scholarly conversation about the effect of the availability and utilization of physics laboratory equipment on students' academic achievement in secondary schools of the Kapchorwa district.

Using instructional materials in primary schools is grounded in several key concepts such as Instructional materials being resources that aid teaching and learning by providing learners with visual representations, audio-visual aids, and other supplementary materials. Effective use of instructional materials could enhance learning outcomes by improving learner engagement, motivation, and retention of information as well as the availability and quality of instructional materials could affect the academic performance of learners (Zhao et al., 2002b). All learners ought to have equal access to instructional materials to ensure that they receive a quality and equal education. However, schools in rural areas may have limited access to instructional materials, which could negatively impact the academic performance of learners. On the other hand, the advances in technology have led to the development of digital instructional materials,

which now offer greater flexibility and accessibility of knowledge for both teachers and learners. Hence instructional design principles have been used to design materials that are aligned with learning objectives, can cater to the diverse learners' needs, and promote academic performance(Ho & Boo, 2007).

The context in which secondary schools of Kapchorwa District in Uganda, is an area of this study is where secondary education as a critical aspect of the country's education system is meeting challenges. The Uganda Bureau of Statistics (UBOS) claims primary school enrolment has been steadily increasing over the years, with a net enrollment rate of 89.4% in 2019(Petronella, 2018). The quality and academic performance of secondary education may face issues in some regions, despite these advancements, since some rural schools may have inadequate access to laboratory equipment, which can impact students' academic performance(Wenham et al.). Among these are inadequate teacher training and support that can also hinder the effective use of laboratory equipment in teaching and learning. The Ugandan Ministry of Education and Sports has acknowledged the value of laboratory equipment in secondary schools, but more has to be done to increase their accessibility, effectiveness, and quality(Petronella, 2018). The Ugandan Ministry of Education and Sports has acknowledged the value of laboratory equipment in secondary schools, but more has to be done to increase their accessibility, effectiveness, and quality. Otherwise, various organizations have provided support for the development and distribution of laboratory equipment in Uganda. For instance, The Forum for Education NGOs in Uganda (FENU), Uganda Digital Learning Hub (Mityana), Solar Lamps, and GGP Grant (Japan) established a science laboratory in the Adjumani area to illuminate the future of refugee students in Uganda. Unfortunately, the COVID-19 outbreak significantly raised the requirement for laboratory equipment to support online teaching and learning(Ibembe, 2007). The Kapchorwa district in Uganda suffered significantly from the pandemic-induced school closings, which forced instructors to transition to alternative teaching tactics including online learning that did not entail the use of laboratory equipment.

In secondary school education, the study of both the availability and use of laboratory equipment education generally is grounded in several theoretical frameworks. Among these is constructivism, which suggests that learners construct their understanding of concepts based on their experiences and interactions with the environment(Aduda, 2003). Here therefore laboratory

equipment can facilitate this process by providing learners with numerous representations of concepts and allowing them to actively engage with the laboratory equipment. Also, the social learning theory posits that learners can benefit from observing and interacting with others and laboratory equipment can facilitate social learning by providing opportunities for collaboration and interaction among learners themselves; it forms the foundation for this study of laboratory equipment

1.2. STATEMENT OF THE PROBLEM

Although the government of Uganda and various organizations are concerned about the availability and utilization of laboratory equipment in secondary education in the country, it remains a concern to improve it in the Kapchorwa district. The critical aspect here is the use of laboratory equipment in both teaching and learning. Some secondary schools in Uganda's rural areas might have limited access to laboratories, which might affect the academic performance of their learners. This coupled with inadequate teacher training and support might hinder the teachers and learners from the effective use of laboratory equipment in both teaching and learning. To this end, there is a need to understand the relationship between laboratory equipment availability, utilization, and academic performance. Academic performance remains an essential aspect of improving the quality of secondary education in the Kapchorwa district. The findings of this study might provide insights into the factors that influence the effective utilization of available laboratory equipment in teaching and learning in secondary schools, particularly in the Kapchorwa district and other rural areas. Its urgency might also inform policy practice in the development, distribution, and use of laboratory equipment to improve learners' academic performance in Uganda as a whole.

1.3. OBJECTIVES OF THE STUDY

1.3.1. General Objectives

To provide a deeper understanding of the effects of the availability and utilization of laboratory equipment on the student's academic performance in secondary schools of the Kapchorwa district.

1.3.2. Specific Objectives

- i. To assess the availability and quality of laboratory equipment in secondary schools of the Kapchorwa district.
- ii. To determine the extent to which the use of laboratory equipment influences academic performance in secondary schools of the Kapchorwa district.
- iii. To make recommendations for strategies to increase the accessibility and use of laboratory equipment in the secondary schools in the Kapchorwa district.

1.4. RESEARCH QUESTIONS

This study was guided by the following research questions:

- i) What are the available Physics laboratory Equipment (PLE) used in secondary schools of Kapchorwa District?
- ii) To what extent does the use of laboratory equipment influence the academic performance of secondary school learners in Kapchorwa District?
- iii) What strategies can be implemented to improve the availability, and utilization of laboratory equipment in secondary schools of Kapchorwa district?

1.5. SCOPE OF THE STUDY

1.5.1. Geographical scope

This study focused on the secondary schools in Kapchorwa District, Uganda. The study examined the effects of the availability and utilization of laboratory equipment on the student's academic performance in this specific geographical location.

1.5.2. Population scope

The study involved secondary school learners and teachers in Kapchorwa District, Uganda. The sample size was determined through stratified random sampling, to ensure that the sample was representative of the population of secondary school learners and teachers in the study area.

1.5.3. Content scope

The study focused on the effects of availability and utilization of laboratory equipment in secondary education, with specific emphasis on experimentations and other hands-on activities. The study also examined the role of teachers' competence, experience, and attitudes towards laboratory equipment in their effective use in teaching and learning.

Temporal Boundaries: The study was conducted over four months, from July and October 2023. The study focused on the current academic year, 2023, and examined the use of laboratory equipment during this period.

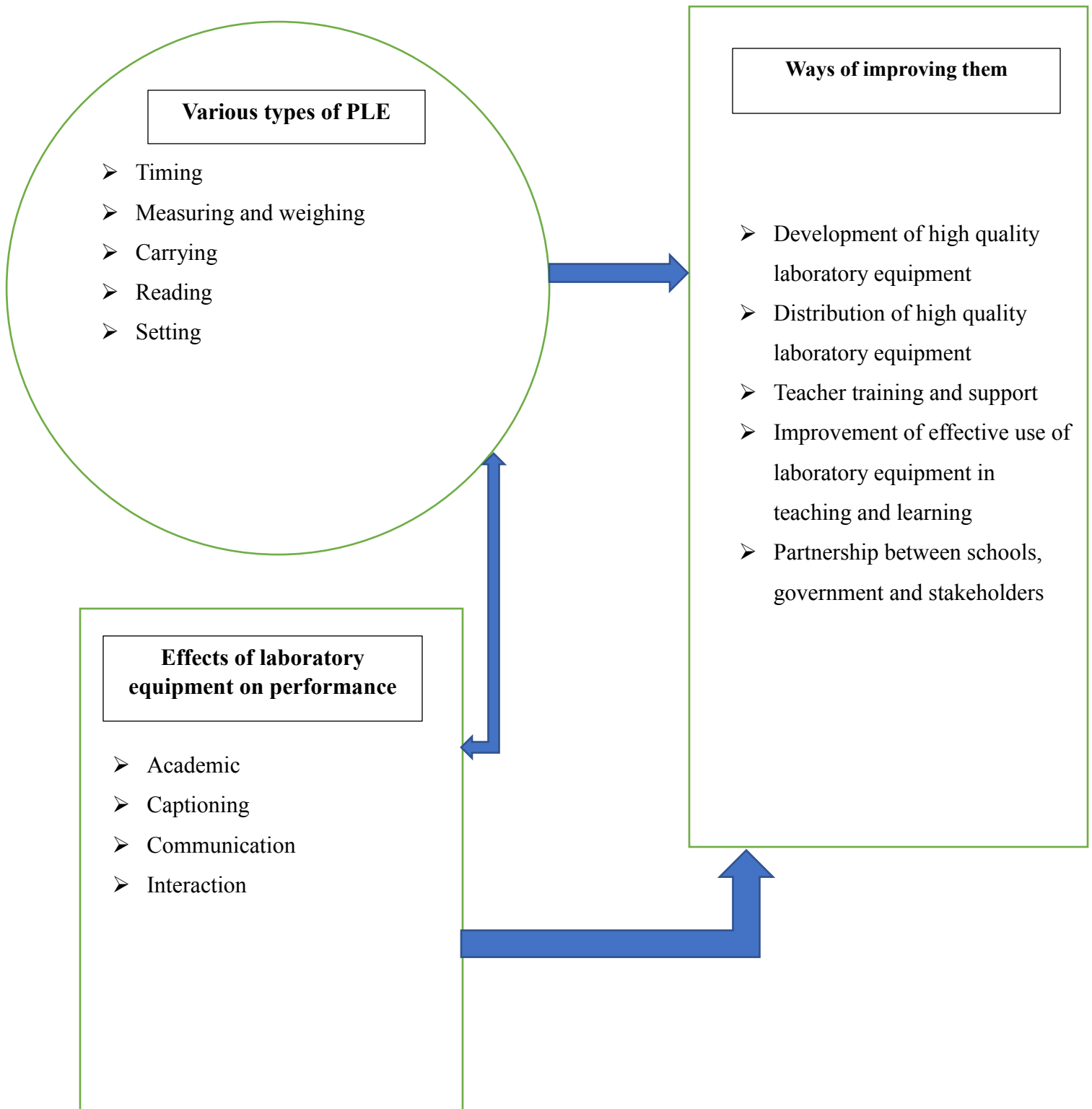
1.6. SIGNIFICANCE OF THE STUDY

This study is found significant in such a manner that in the first instance, it might contribute to the existing literature on the relationship between laboratory equipment and learners' academic performance in secondary education, particularly in the context of Kapchorwa District, Uganda. The study might then provide insights into the availability, quality, and effective use of laboratory equipment and their impact on learners' academic performance, which can inform policy and practice in secondary education. In the second instance, the study might provide a better understanding of the role of teachers' competence, experience, and attitudes towards laboratory equipment in their effective use in teaching and learning. This study might inform the design and implementation of teacher training programs and support systems to improve the use of laboratory equipment in secondary education. In addition, the findings of this study might inform the development and distribution of high-quality and relevant laboratory equipment that meet the specific needs of learners in Kapchorwa District, and other similar contexts in Uganda. This might improve the overall quality of secondary education in the country and as well as contributing to achieving the Sustainable Development Goal of ensuring inclusive and quality Education For All (EFA).

1.7. CONCEPTUAL FRAMEWORK

This illustration has aided in identifying the link between secondary school students in the Kapchorwa District's academic performance and the availability and use of laboratory equipment. Academic Performance was considered the dependent variable in this study, whereas laboratory equipment was considered the independent variable (IV) (DV). Laboratory equipment was measured in terms of its types, characteristics, impacts, availability, and utilization on performance, as well as its relationships to academic, captioning, communication, and interaction

aspects while Academic performance was measured as ways to use laboratory equipment to enhance academic performance, with its variables including the creation of high-quality laboratory equipment, the distribution of high-quality laboratory equipment, teacher training and support, increasing the effectiveness of using laboratory equipment in teaching and learning; and partnerships between educational institutions, the government, and other stakeholders, as shown in the conceptual framework.



1.8. Figure: 1.1

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Science has been of great importance internationally for sustainable and socio-economic development as well as for the technological advancement of nations. Knowledge of science and technology is therefore a requirement in all countries and needed by all people globally due to numerous challenges that are facing them. These challenges include the emergence of new drug-resistant diseases, the effects of genetic experimentation and engineering, the ecological impact of modern technology, the dangers of nuclear war and explosions, and global warming among others (Olufunke, 2012). This resulted in rapid changes taking place in medicine, industry, communication, and agriculture. Science as an agent of development plays an important role in bringing about these changes through technological advancement, national wealth enhancement, health improvement, and industrialization (Kantarcıoglu et al., 2003) this is why scientific and technological breakthrough is usually the goal of any developing nation like Uganda. According to (Wenham et al.) pinned that Physics is and will remain the fundamental science. Physics is the bedrock of science and technology because many of the tools on which scientific and technological advancement depends are the direct products of Physics. As a result, physics is a foundational subject in science and technology since it examines the essence of natural events and aids in understanding a society that is rapidly changing due to technology (Zhao et al., 2002a). The laws of physics have been extensively applied to several economic, scientific, and technical advancements, including information technology, which has utilized computers and satellites to turn the world into a small town. Additionally, the understanding of physics has facilitated sustainable manufacturing for the advancement of materials beneficial to the survival of the human species. In addition, learning about physics helps students develop the decision-making and problem-solving abilities necessary for critical thinking and inquiry, which may enable them to respond to widespread and drastic changes in many parts of life. Despite the significance of Physics to the scientific and technical advancement of our country, knowledge of the subject had deteriorated over time, and student performance had not been particularly encouraging. (Ho & Boo, 2007) examined how there has been a fall in the number of students who want to pursue physics in many different nations. Students' performance in science classes was subpar (Ali, 1990). Furthermore, prior research has demonstrated that students who have negative stereotypes of scientists, science, and technology in society are easily deterred from

pursuing scientific fields and typically perform badly in science courses (Changeiywo, 2000). This circumstance does not support Uganda's efforts to become a more technologically advanced country. Additionally, when given the choice, students avoid the sciences, particularly physics, and this is especially true for girls (Aduda, 2003). This suggests that if given the option, a student would choose another science subject over Physics. The importance of the instructor in the classroom necessitates a lot of teacher input to improve physics learning and accomplishment. The resources a teacher uses and the method of instruction they use can both have an impact on the success of their students (Jones Jr et al., 1991). As a result, effective physics teaching and learning depend on the employment of the right tools and instructional techniques. According to (Bello, 2011), adopting small group cooperative teaching approaches increased students' learning in Physics despite research having been completed looking at various teaching strategies used in Physics classes, for instance. Additionally, this method raised students' motivation to learn, and it was discovered that even kids who were below average were able to outperform their peers using the traditional teaching approach. The cooperative idea mapping method improved the delivery of science instruction in secondary schools (Olufunke, 2012). Additionally, according to (Kibett & Kathuri, 2005) students who were taught utilizing a project-based learning approach outperformed those who received standard instruction. In terms of making the best use of the instructional resources at our disposal, there is still much work to be done. Therefore, the purpose of this study was to determine how the Physics laboratory equipment was used and available, as well as how this affected the student's performance in the subject. More often than not, low performance is attributed to issues like teacher competency, teaching methodology, and student attitude toward the subject, as well as the absence or inadequateness of relevant instructional facilities (Sabri & Emuas, 1999). The academic performance of students will be improved if secondary schools use enough and appropriate laboratory equipment to teach Physics. There hasn't been any research on the effectiveness of appropriate Physics laboratory equipment (PLE) in senior secondary school Physics in Uganda, according to the literature that is currently available. Therefore, it was the goal of this research investigation to close this information gap. The research was offered empirically. In senior secondary schools in the Kapchorwa District, the study offered empirical evidence on the use of appropriate and available PLE and its impact on students' achievement.

CHAPTER THREE: MATERIALS AND METHODS

3.1. Methodology

This study employs the descriptive survey design. Ten senior secondary schools are comprised of six public, and four private and will be randomly selected from the whole of Kapchorwa district. The sample for the study consists of the Physics teacher(s) of each secondary school and Physics students that will randomly be chosen from each school.

3.2. Research instruments

The data gathering for this project utilized three instruments. The Physics Laboratory Equipment Questionnaire (PLEQ), a 13-item self-designed validated, and reliability-established questionnaire, was the first instrument. The Physics Laboratory Equipment Checklist (PLEC) was the second instrument, and the "Physics Achievement Test" was the third (PAT). There were two sections in the questionnaire. Section A asked general questions and comprised of general statements about the school, the physics teacher, and practical activities that occur in physics class; Section B asked general questions and comprised of general statements about the teachers' opinions of the PLE that are available, the impact of using PLE on students' academic achievements in Physics, and the relevance of the PLE that are available to the teaching of Physics. The checklist was made up of predicted PLE on several physics' practical topics. Six major areas of physics were covered by the lists: mechanics, heat and energy, current electricity, light and optics, waves and sound, and magnetism. These areas all call for practical effort. The checklist must list both the used and available PLE. The Physics Achievement Test (PAT), the third tool, comprised of 3 structured questions assessing the grades of students in physics from S.1 to S.6 and it is administered once a year. This is produced to understand the connection between student academic achievement and the use of PLE.

3.3. Data collection and analysis

The researcher gave copies of the questionnaire to the physics instructors and students at each institution. With the assistance of the physics teacher and the lab assistant, the checklist was used to verify the equipment that is present in each school's lab. Students will take the PAT, which was scored by the researcher, who then produced quantitative data for analysis.

Assessment of each PLE distribution and PAT has a maximum score of 10% totaling up to 100%. The chi-square value to determine correlation between PLE usage and students' performance for each class was expected to be 40%. The chi-square for each class using PAT results and a total was taken. The value was determined at 0.01 level of significance.

chi-square value using the formula: $X^2 = \sum_{s=1}^{s=6} \frac{(O-Es)^2}{E}$, where Es was the observed frequency (PAT grade for each class) and E was the expected outcome for each class graded as 40%. With the aid of descriptive statistics and percentages, all the data that was gathered was revised and examined.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 RESULTS

The results of the analysis of the data obtained for each of the research questions are presented as follows:

Objective one: To assess the availability and quality of laboratory equipment in secondary schools of the Kapchorwa district

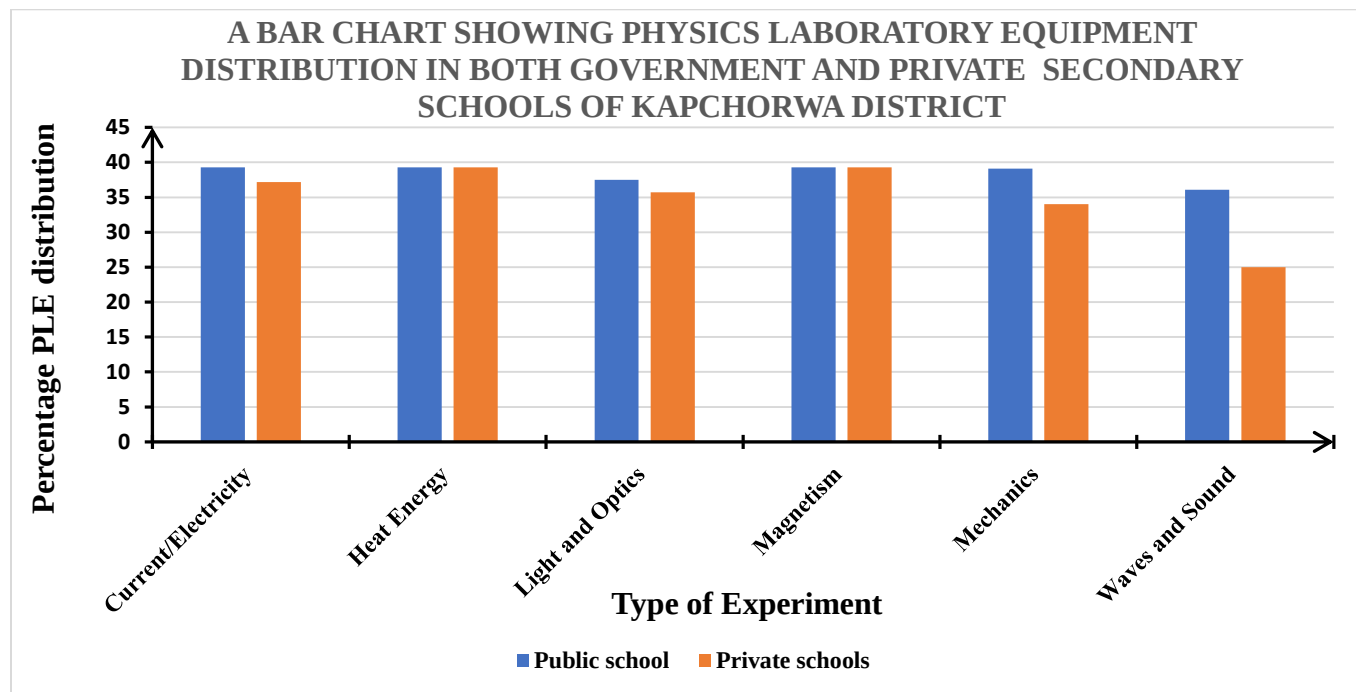
Research question one: Are there Physics Laboratory Equipment (PLE) for the teaching of Physics in Kapchorwa Senior Secondary Schools?

Table 1: Percentage distribution of Physics Laboratory Equipment (PLE) available in senior secondary schools

Type of experiment	Public school	Private schools	Total
Current/Electricity	39.3	37.2	76.5
Heat Energy	39.3	39.3	78.6
Light and Optics	37.5	35.7	73.2
Magnetism	39.3	39.3	78.6
Mechanics	39.1	34.0	73.1
Waves and Sound	36.1	25.0	61.1
Total	69.1	30.9	100

From the table above, the results indicate that there is a difference in the availability of Physics Laboratory Equipment (PLE) between public and private schools in Kapchorwa district. Public schools have a higher percentage of PLE available across all types of experiments. The availability ranges from 36.1% for Waves and Sound to 39.3% for Current/Electricity, Heat Energy, and Magnetism experiments. This suggests that public schools have a more diverse range of PLE, potentially due to better funding or resources. Private schools have a slightly

lower percentage of PLE available across all types of experiments. The availability ranges from 25.0% for Waves and Sound to 39.3% for Heat Energy and Magnetism experiments. This could be due to a variety of factors such as funding, resources, or curriculum focus. In general, both types of schools have a strong focus on Current/Electricity, Heat Energy, and Magnetism experiments, indicating these are key areas in the physics curriculum. However, Waves and Sound experiments are less common, especially in private schools.



Objective two: To determine the extent to which the use of laboratory equipment influences academic performance in secondary schools of the Kapchorwa district

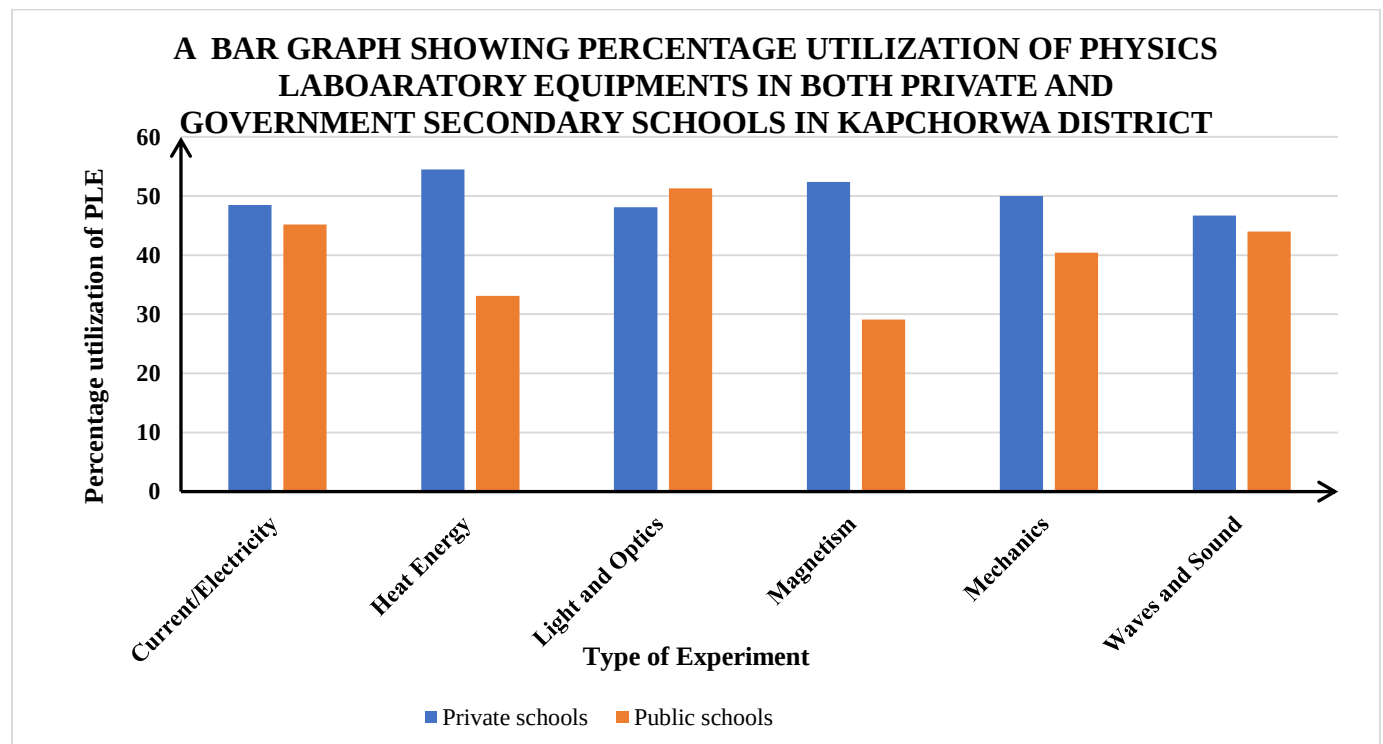
Research Questions Two: Are the available Physics Laboratory Equipment (PLE) utilized by teachers in the teaching and learning of Physics?

Table 2: Percentage distribution of the utilization of Physics Laboratory Equipment (PLE) in Kapchorwa Secondary Schools.

Type of experiment	Private schools	Public schools	Total
Current/Electricity	48.5	45.2	93.7
Heat Energy	54.5	33.1	87.6
Light and Optics	48.1	51.3	99.4
Magnetism	52.4	29.1	81.5
Mechanics	50.0	40.4	90.4
Waves and Sound	46.7	44.0	90.7
Total	69.4	30.6	100.0

Table 2 indicates that the use of PLE in teaching varies based on the type of experiment and the type of school. In other words, both the experiment being conducted and the nature of the school (whether it's private or public) influence the extent to which PLE are utilized. Private schools have a higher percentage (50.0%) of utilization of PLE in teaching mechanics compared to public schools (40.4%). This suggests that private schools may have more resources or place more emphasis on this area. Similarly, private schools lead in the utilization of PLE for teaching heat energy with a percentage of 54.5%, while public schools stand at 33.1%. This could indicate a stronger focus on this type of experiment in the private sector. The utilization of PLE for teaching current/electricity is fairly balanced between private (48.5%) and public schools

(45.2%). This shows that both types of schools recognize the importance of this topic. Public schools (51.3%) slightly outperform private schools (48.1%) in the utilization of PLE for teaching light and optics. This could be due to specific curriculum requirements or available resources. Both private (46.7%) and public schools (44.0%) have similar percentages for the utilization of PLE in teaching waves and sound, indicating a comparable emphasis on this topic. Private schools have a significantly higher percentage (52.4%) compared to public schools (29.1%) in the utilization of PLE for teaching magnetism. This suggests that private schools may have more resources or a different teaching approach for this subject. Therefore, private schools tend to have higher utilization of PLE across most types of experiments, with the exception of light and optics where public schools slightly lead. This could be attributed to various factors such as resource availability, curriculum focus, or teaching methodologies.



Research Questions Three: Does the utilization of Physics Laboratory Equipment (PLE) have any influence on the academic achievement of students in Physics?

Table 3: Chi-square statistics showing the influence of utilization of PLE on the academic achievement of students in Physics

	Value	Df	Significance
Chi-Square Calculated	24.35	6	0.01
Chi-Square Table	16.812		

The Chi-Square calculated value is 24.35, which is larger than the Chi-Square table value of 16.812 for 6 degrees of freedom at a significance level of 0.01. Therefore, there is a significant association between the utilization of PLE and the academic achievement of students in Physics. This suggests that the use of PLE does have an influence on student performance in Physics.

Table 4: Statistical mean of the student's score in PAT for public and private schools

Schools	Number of students	Mean score	Standard Deviation (SD)
Private	220	62.0	9.0
Public	260	57.0	10.0

Private schools have a higher mean score compared to public schools. The number of students in public schools is higher than in Private schools and the standard deviation, which measures the amount of variation or dispersion in the scores, is slightly higher in public schools.

4.2 DISCUSSION OF RESULTS

The study revealed that the presence and use of Physical Laboratory Equipment (PLE) for teaching Physics in Kapchorwa secondary schools varies depending on the type of school and its ownership. Private schools were found to have a higher percentage of PLE for teaching and learning processes compared to public schools, which are primarily owned by state governments and communities. This is attributed to the fact that private school owners often ensure their schools are well-equipped before seeking approval. The study also found that PLE are being effectively utilized for teaching and learning processes. The extent of utilization also varies among different types of schools, with private schools having a higher average utilization capacity compared to public schools. This aligns with the view of (Lorton & Walley, 1979), who suggested that learning experiences are enriched when environments equipped with physical laboratory equipment meet students' needs through adequacy and effective utilization. In terms of the impact of PLE utilization on students' academic achievement, the study found a significant relationship between effective utilization of PLE and students' academic performance. Students from schools with a high percentage of available and well-utilized PLE had the highest mean score. This suggests that optimal availability and utilization of PLE is effective in teaching and learning Physics. This supports the findings of (Adesoji & Olatunbosun, 2008), who found that laboratory adequacy affects students' performance, as students tend to understand and recall what they see more than what they hear. However, it's important to note that while laboratory instruction may play a crucial role in achieving some science teaching goals, it may not necessarily achieve all stated goals of science education. Many teachers have not incorporated laboratory goals into their instruction and evaluation systems (Hofstein & Lunetta, 2004). According to (Thijs & Bosch, 1995), the study found no significant difference in learning outcomes between lab-based and demonstration methods, suggesting that the alignment of lab instruction, experiments, and textbooks with science teaching goals should be examined. This indicates that lab work in Physics can demystify abstract concepts, enhancing students' academic performance. It also accommodates diverse learning styles, promoting idea exchange and teamwork. Hence, there's a strong positive correlation between the availability of lab equipment and academic achievement.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The availability and utilization of Physical Laboratory Equipment (PLE) significantly impact the teaching and learning processes in Physics, particularly in Kapchorwa secondary schools. Private schools tend to have better-equipped laboratories and higher utilization rates compared to public schools, leading to improved student performance. Therefore, this study confirms that effective use of PLE enriches the learning experience and positively correlates with students' academic achievement.

5.2 Recommendations

Investment in PLE: Both public and private schools should invest more in acquiring and maintaining PLE to enhance the teaching and learning processes.

Training for Teachers: Teachers should be trained on how to effectively incorporate laboratory goals into their instruction and evaluation systems.

Alignment of Instructional Materials: There should be a concerted effort to align lab instruction, experiments, and textbooks with science teaching goals.

Regular Assessment: Regular assessment of laboratory adequacy and utilization should be conducted to ensure optimal learning outcomes.

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