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Original Article

Laboratory Materials Usage and Physics Practical Skills Acquisition among S.3 Students of Isingiro North County, Isingiro District

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Keywords: Laboratory Materials, Usage, Physics Practical Skills, Acquisition, S.3 Students, Isingiro North County, Isingiro District.

This study examined the relationship between laboratory material usage and physics practical skills acquisition among Senior Three (S.3) students in Isingiro North County, Isingiro District, Uganda. The main objective was to evaluate the practical effect of laboratory material usage skills acquisition. The specific objective was to assess the extent of laboratory material usage among Senior Three (S.3) students in Isingiro North County, Isingiro District. A descriptive cross-sectional design was used, targeting 480 S.3 students, 12 physics teachers, and 6 laboratory attendants from six secondary schools. A sample of 162 participants was selected using stratified random and purposive sampling. Data were collected using questionnaires, interviews, and observational checklists, and analysed using SPSS for quantitative and thematic analysis for qualitative. Key findings revealed inconsistent laboratory material adequacy, with 40.3% of students reporting sufficient apparatus, but 86.8% lacked access to ICT tools. The study concluded that while basic laboratory resources were available, their inadequacy and the near-total absence of ICT tools hindered effective practical learning. Although students possessed basic skills, they struggled with advanced competencies like error analysis and independent experimentation. The study recommends increasing laboratory material quantities, investing in ICT infrastructure, and training teachers in resource utilisation. Policymakers should allocate targeted funding to rural schools to reduce resource gaps and improve physics practical learning outcomes.

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INTRODUCTION

The integration of practical skills in physics education dates back to the scientific revolution of the 17th century, where pioneers like Galileo Galilei emphasized the importance of experimentation in validating physical theories. His hands-on approach laid the foundation for the modern scientific method and influenced subsequent scientists such as Sir Isaac Newton, whose laws of motion and gravitation were validated through empirical observations. Over time, the role of laboratory work in physics evolved, becoming central to fostering scientific inquiry, critical thinking, and conceptual understanding.

Educational literature strongly supports laboratory-based learning for enhancing students' attitudes, interest, and engagement in physics. Practical activities allow learners to develop investigative skills such as measurement, classification, and data interpretation. Studies by Achor et al. (2010) and Foulds et al. (2018) show that students who regularly perform experiments retain knowledge better and perform more effectively than those exposed only to theory. However, in many developing countries, including Uganda, challenges such as inadequate equipment, poor infrastructure, and teacher shortages hinder effective laboratory instruction (Eze & Obike, 2015).

The theoretical foundation of this study lies in experiential and constructivist learning theories, particularly those proposed by Piaget (1970) and Vygotsky (1978). Practical physics work enables students to construct knowledge actively through interaction with materials and peer collaboration. Vygotsky's concept of the “zone of proximal development” highlights the role of guided practice,

where structured laboratory activities act as scaffolds, helping students move from dependence to independent mastery of practical skills.

Globally, countries like the U.S., Germany, and Japan have invested heavily in school laboratories, leading to improved student performance in STEM subjects (OECD, 2020; Asian Development Bank, 2018). In contrast, UNESCO (2021) reports that less than 30% of secondary schools in sub-Saharan Africa have functional laboratories. Uganda mirrors this trend, with the Ministry of Education and Sports (2022) revealing that over 60% of rural schools, including those in Isingiro District, lack essential laboratory resources, directly impacting students' ability to acquire physics practical skills.

In Isingiro North County, the situation is especially dire. The Uganda National Examinations Board (UNEB, 2022) reported that only 32% of rural students earned credit passes in physics compared to 54% in urban schools. Over 70% of schools in the district lack well-equipped physics laboratories (MoES, 2020), and only 45% have trained physics teachers (Isingiro District Education Office, 2021). This has resulted in poor student performance, particularly in practical exams. UNEB (2021) data shows that 58% of students scored below average. These challenges, compounded by large class sizes, inadequate funding, and safety concerns, necessitate urgent intervention. Thus, this study investigates how laboratory material usage influences practical skill acquisition among S.3 students in Isingiro North County.

Problem Statement

Physics education at the Senior Three (S.3) level is expected to equip students with essential practical skills, including planning experiments, handling

apparatus effectively, recording and analyzing data, estimating uncertainties, and applying theoretical knowledge to real-life experiences. According to the New Lower Secondary Curriculum (NLSC, 2020), these competencies are vital for understanding physics concepts and fostering innovation. However, students in Isingiro North County, like many other rural areas in Uganda, often receive theoretical instruction with limited opportunities for hands-on learning due to inadequate laboratory materials. This shortage fails to meet the needs of the growing student population, as highlighted in the Isingiro Inspector of Schools Report (2022).

The Ministry of Education and Sports (MoES, 2018) has implemented various measures to address science education challenges, including increasing salaries for science teachers and constructing new laboratory, classroom, and library facilities. These efforts are complemented by equipping schools with the necessary resources to enhance the performance of students in science subjects, including physics. Despite these interventions, the Uganda National Examinations Board (UNEB, 2019) reported persistently poor performance in physics across several districts, including Isingiro. This challenge is compounded by the inadequate laboratory material-to-student ratio, which directly hinders students' ability to acquire practical skills crucial for academic success and career readiness in science, technology, engineering, and mathematics (STEM) fields.

The repercussions of poor physics performance are far-reaching. For instance, during the 2020–2021 academic year, only 4% of students applying for engineering courses at Kyambogo University were denied admission due to failing to secure a credit in physics (Daily Monitor, 2021). Without addressing this issue, students may face significant barriers in contributing to the nation's scientific and technological advancement. This study, therefore, aimed to examine the relationship between laboratory material usage and the acquisition of

practical skills among S.3 students in Isingiro North County.

Objectives of the Study

The general objective of the study was to evaluate the effect of laboratory material usage on physics practical skills acquisition among S.3 students of Isingiro North County, Isingiro District.

Specific Objectives

To assess the extent of laboratory material usage in studying physics by S.3 students of Isingiro North County, Isingiro District.

Research Question

What is the extent of laboratory material use in the study of physics practicals by S.3 students of Isingiro North County, Isingiro District?

Significance of the Study

The study is hoped to help schools identify gaps in laboratory resources and guide resource allocation to improve physics practical skills acquisition.

The study will empower the community with knowledge about the importance of practical physics education in fostering innovation and solving local challenges.

The findings will provide evidence-based recommendations for policy formulation and implementation to improve science education infrastructure and performance.

The study is hoped to highlight effective strategies for utilizing laboratory materials, enhancing teaching methods, and fostering students' interest in physics.

The findings guide policymakers in allocating resources effectively to improve laboratory facilities and promote STEM education across rural areas.

The study will serve as a reference for future research on the relationship between laboratory

resources and students' performance in science education.

LITERATURE REVIEW

Theoretical Review

This study was grounded on the Constructivist theory that provided a foundation for understanding the relationship between laboratory material usage and the acquisition of physics practical skills among Senior Three (S.3) students.

Constructivist theory, including those of Piaget (1970) and Vygotsky (1978), is central to this, underpins the study. The theory emphasizes active engagement and interaction in learning, with students constructing their understanding through exploration and collaboration. Laboratory practicals in physics serve as an ideal environment for this, allowing students to manipulate apparatus, test hypotheses, and observe phenomena. Vygotsky's concept of the Zone of Proximal Development (ZPD) is particularly relevant, highlighting the role of guidance from teachers and peers in helping students master complex tasks. This scaffolding is essential in bridging the gap between theoretical knowledge and practical application.

The theory collectively provides a robust framework for analysing the dynamics of laboratory material usage and its impact on physics practical skill acquisition. It highlights the importance of interactive, hands-on, and scaffolded learning experiences in fostering deeper understanding and practical competence. Applying this theoretical perspective, this study investigates how the availability and effective use of laboratory materials contribute to students' ability to acquire, retain, and apply practical physics skills, addressing the challenges observed in rural schools such as those in Isingiro North County.

Laboratory Material Usage in Studying Physics by S.3 Students

The Asian Development Bank (2018) conducted a comparative analysis of laboratory facilities in

South Korea and Japan, where advanced equipment is integrated into secondary school physics curricula. The study revealed that schools with modern laboratories experienced a 30% increase in students' problem-solving and analytical skills. It also highlighted that students in such schools performed significantly better in international physics competitions. These findings suggest that investment in laboratory facilities not only enhances students' practical skills but also prepares them for global STEM opportunities.

Foulds and Bekoe (2018) conducted a study in Ghana exploring the relationship between laboratory resource availability and student performance in physics. The study revealed that schools with adequately equipped laboratories experienced a 35% higher pass rate in physics examinations than those without sufficient resources. The researchers emphasised the importance of laboratory materials in enabling students to relate theoretical physics concepts to real-world applications through experimentation. Their findings underscored that hands-on learning using laboratory apparatus enhances students' ability to observe phenomena, analyse data, and interpret outcomes accurately. The study further identified that laboratory resources significantly motivated students by fostering curiosity and encouraging active participation during physics lessons.

Eze and Obike (2015) examined the role of laboratory materials in fostering practical skills among secondary school students in rural Nigeria. They found that only 40% of the surveyed schools had basic laboratory equipment, resulting in poor skill acquisition among students. Students who lacked access to these resources often struggled with setting up experiments, measuring variables, and interpreting data. Conversely, students in schools with adequate resources displayed a higher mastery of physics concepts and performed 25% better in practical examinations. The study concluded that laboratory resources are

indispensable in providing students with opportunities to develop essential manipulative skills and bridge the gap between theoretical learning and practical application.

Achor and Orji (2010) examined the motivational effects of laboratory materials on secondary school students in Nigeria. Their study revealed that 75% of students who engaged in laboratory-based instruction reported a higher interest in physics compared to those who relied solely on theoretical teaching. The researchers noted that access to laboratory resources helped students develop a deeper appreciation of physics concepts and improved their ability to analyse and interpret experimental results.

UNESCO (2021) reported on the state of laboratory facilities in secondary schools across sub-Saharan Africa. The report revealed that only 30% of schools in the region have access to functional physics laboratories. This lack of resources was highlighted as a significant barrier to achieving educational outcomes, particularly in rural areas. Students in schools with well-equipped laboratories were found to have a 40% higher retention rate of physics concepts compared to those in under-resourced institutions. The study stressed the need for investment in laboratory infrastructure to address educational disparities and improve students' readiness for STEM-related careers.

West and Ndubuisi (2020) explored the impact of teacher preparedness on the effective use of laboratory materials in Kenya. They found that teachers in schools with adequate laboratory facilities demonstrated higher confidence in conducting practical lessons, resulting in a 20% improvement in student performance in physics practicals. The study highlighted that well-equipped laboratories allowed teachers to employ diverse instructional methods, enabling students to actively engage with experimental processes and develop critical thinking skills. The authors concluded that equipping schools with laboratory materials not

only benefits students but also empowers teachers to deliver high-quality science education.

A survey by the Ministry of Education and Sports (2020) investigated the availability of laboratory materials in Ugandan secondary schools. The findings showed that only 30% of rural schools, including those in Isingiro District, had adequately equipped laboratories. This deficiency correlated with low physics practical examination pass rates, with rural schools recording a 32% success rate compared to 54% in urban schools. The study also revealed that schools with functional laboratories observed a 20% improvement in students' engagement and understanding of complex physics concepts, emphasising the critical role of laboratory materials in enhancing academic performance.

The Uganda National Examinations Board (2022) reported that 60% of schools in Isingiro District lacked essential laboratory materials, significantly hindering effective physics education. The study noted that students in these schools often relied on outdated or improvised materials, resulting in poor practical skills acquisition. The report also highlighted that schools with better laboratory resources achieved 25% higher scores in physics practical examinations. This finding underscored the urgent need to address resource gaps in rural schools to improve educational outcomes and bridge the urban-rural performance divide.

METHODOLOGY

Research Design

This study adopted a descriptive cross-sectional design, enabling data collection at one point in time to analyse laboratory material usage and its influence on physics practical skills acquisition (Onen & Oso, 2008). This design efficiently explores relationships between variables within a defined population without requiring longitudinal data.

The cross-sectional approach focused on Senior Three (S.3) students in Isingiro North County,

allowing detailed examination of current laboratory practices and their outcomes. It helped identify patterns critical for addressing research objectives. The design's relevance was validated by similar studies like Eze and Obike (2015).

Study Area

The research was conducted in Isingiro North County, Isingiro District, Uganda. The study targeted Laboratory Materials Usage and Physics Practical Skills Acquisition among S.3 students, justified by poor physics performance in rural schools, often due to limited laboratory resources. The district was chosen because over 70% of schools reportedly lacked adequately equipped laboratories (Ministry of Education & Sports, 2020). Isingiro North provided a relevant setting to explore how resource availability affects practical skills in physics, especially within rural Ugandan education systems.

Study Population

The study targeted Senior Three (S.3) students enrolled in 12 private and government-aided schools in Isingiro North County. These students are at a critical point in physics education where practical skills are emphasised. The population also included teachers and physics laboratory attendants from these schools. S.3 students were selected in alignment with National Learning Standards Council (2020) guidelines, identifying this level as foundational for building physics competencies.

Sample Size and Determination

The study selected 6 schools from 12 private and government-aided schools in Isingiro North. With a total population of 240 S.3 students, a sample of 144 students was selected using the Krejcie and Morgan (1970) formula. Each school contributed 24 students, 2 teachers, and 1 laboratory attendant. This resulted in a total sample of 162 participants. The sample was balanced to ensure broad representation and feasibility in data collection.

Table 1: Sample Size Distribution Among Study Participants

School	Students (Target)	Students (Sample)	Teachers	Lab Attendant	Total Sample
School A	40	24	2	1	27
School B	40	24	2	1	27
School C	40	24	2	1	27
School D	40	24	2	1	27
School E	40	24	2	1	27
School F	40	24	2	1	27
Total	240	144	12	6	162

Sampling Techniques and Procedure

Stratified random sampling and purposive sampling were used. Schools were stratified into private and government-aided, and 3 from each stratum were randomly selected. Students were randomly selected from physics learners. Teachers and laboratory attendants were purposively selected. These techniques minimised bias and ensured varied representation from eligible schools and stakeholders.

Both quantitative and qualitative data collection methods were used. Structured questionnaires gathered data from students; semi-structured interviews were used with teachers and lab attendants. An observational checklist assessed the availability and condition of lab materials. This triangulated approach provided a more complete view of laboratory use and physics practical instruction.

Questionnaire Method

Data Collection Methods

A questionnaire involves a set of structured questions completed by respondents (Mugenda & Mugenda, 2004). It included both closed and open-ended questions based on the study objectives. Closed questions enabled simple, quick responses, while open-ended ones allowed students to freely express their thoughts. The structure was designed for clarity and relevance to the study.

Interview Method

As Kathari (2004) explains, interviews present oral stimuli and collect oral responses. Face-to-face interviews with teachers and laboratory attendants offered immediate feedback and deeper exploration of study themes. This method also enabled probing, clarification, and rapport building, leading to high response rates and better understanding of responses from teachers and lab attendants.

Observation Method

The researcher systematically observed and recorded laboratory materials' availability and use in the selected schools. A checklist adapted from UNESCO standards was used. Observations provided first-hand evidence of how materials were used, student involvement, and environmental factors. This method helped reveal conditions that impact skill acquisition during practical physics sessions.

Research Instruments

The study used three main instruments: questionnaires, interview guides, and observation checklists. Each was designed to suit the type of respondent and nature of the data being collected.

Questionnaire

The questionnaire measured student perceptions of lab material usage and skills acquisition. It included three sections: demographics, 5 Likert scale questions on lab usage, and 5 on physics practical skills. The structure followed Mugenda & Mugenda (2004), with clear and concise questions focused on

capturing data relevant to the study's objectives and hypotheses.

Interview Guide

The interview guide consisted of open-ended questions used to collect data directly from teachers and lab attendants (Monk, 2010). It allowed in-depth exploration of participants' views and provided non-verbal cues. Face-to-face interviews enabled clarification of ideas, probing for detailed information, and flexibility in guiding conversations, which enriched the qualitative findings of the study.

Observation Checklist

The observational checklist followed UNESCO (2021) guidelines for assessing laboratory materials and infrastructure. It was pre-tested to ensure clarity, relevance, and alignment with the study variables and objectives. This tool evaluated equipment, manuals, ICT tools, and record books, offering objective data on availability, usability, and overall physical conditions during lab sessions.

Study Procedure

The researcher first visited schools to explain the study, its benefits, and the voluntary nature of participation. Those who consented were included in the study sample. Data were collected using questionnaires from students, interviews from teachers and attendants, and an observation checklist for lab conditions. The entire process was followed by data cleaning and analysis.

Data Analysis

The researcher recorded, translated, sorted, edited, coded, and accessed the data that was collected. All the data collected was checked for completeness, accuracy, and uniformity.

Assessing the Extent of Laboratory Material Usage in Studying Physics by S.3 Students; Quantitative data from student questionnaires were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to

measure the extent of laboratory material usage. A Likert scale was used to assess students' perceptions of laboratory resources, and results were presented in tables with frequencies and percentages. Qualitative data from teacher and laboratory attendant interviews underwent thematic analysis, identifying recurring themes regarding resource availability, usage frequency, and challenges in laboratory work. Observational data on laboratory materials were analyzed through frequency counts and categorized based on adequacy, functionality, and accessibility.

Ethical Considerations

Ethical approval for the study was obtained from Bishop Stuart University Research and Ethics Committee (BSU-REC) before data collection. Additionally, clearance from school headteachers was secured. Participants were assured of confidentiality, anonymity, and voluntary participation, with the right to withdraw at any time without any penalties.

Parental consent was obtained by distributing informed consent forms through students,

accompanied by translated explanatory letters (English/local language). Schools facilitated follow-ups via staff to ensure timely returns. For accessibility, community meetings were organized at schools to address queries and collect consents directly. Collaboration with school authorities and local leaders ensured effective communication, enabling parents to provide voluntary consent while adhering to ethical standards.

Informed consent was obtained from all participants through a written consent form detailing the purpose, procedures, potential risks, and benefits of the study. To protect participants' privacy, all collected data was anonymised, securely stored, and used solely for academic purposes. The researcher ensured a safe environment for data collection by adhering to ethical guidelines, including respecting respondents' autonomy, maintaining objectivity, and avoiding any form of coercion or harm.

FINDINGS OF THE STUDY

Demographic Characteristics of Respondents

The demographic characteristics of participants included gender, age and school type.

Table 2: Gender Distribution of Study Participants

Gender	Students		Laboratory attendants		Teachers		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Male	30	20.8	3	50	7	58.3	40	24.7
Female	114	79.2	3	50	5	41.7	122	75.3
Total	144	100.0	6	100	12	100	162	100

The study utilised 162 participants, including 144 students (88.9%), 6 laboratory attendants (3.7%), and 12 teachers (7.4%). Gender distribution revealed a significant disparity among students, with females (79.2%, $n = 114$) outnumbering males (20.8%, $n = 30$). Laboratory attendants exhibited an

equal gender split (50.0% each, $n = 3$), while male teachers (58.3%, $n = 7$) slightly outnumbered female teachers (41.7%, $n = 5$). Overall, females constituted 75.3% of the total study participants, while 24.7% were males.

Table 3: Age Distribution of Students

Age	Frequency	Percent
14	1	0.7
15	4	2.8
16	51	35.4
17	45	31.3
18	31	21.5
19	7	4.9
20	3	2.1
21	2	1.4
Total	144	100.0

Results in Table 3 indicate that the majority of students (66.7%) were aged 16–17 years, with peak frequencies at 16 (n = 51, 35.4%) and 17 (n = 45, 31.3%). Less than a quarter 31(21.5%) were 18 years old, while older students (19–21 years) constituted only 12(8.4%). Younger students (14–15 years) were markedly underrepresented (n = 5, 3.5%).

Table 4: Type of School

Type of School	Frequency	Percent
Government-Aided	49	34.0
Private	95	66.0
Total	144	100.0

The data in Table 4 reveal that the majority of study participants were from private schools 95(66.0%), while 49(34.0%) were in government-aided schools.

The Extent of Laboratory Material Usage in Studying Physics by S.3 Students

Table 5: The Extent of Laboratory Material Usage in Studying Physics by S.3 Students

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std Dev.
The laboratory apparatus available are adequate for practical physics lessons	28 (19.4%)	20 (13.9%)	38 (26.4%)	33 (22.9%)	25 (17.4%)	3.05	1.36
Practical guides provided are sufficient to aid experiments	4 (2.8%)	24 (16.7%)	18 (12.5%)	34 (23.6%)	64 (44.4%)	3.90	1.22
Students regularly use records books to log experimental results	10 (6.9%)	17 (11.8%)	20 (13.9%)	33 (22.9%)	64 (44.4%)	3.86	1.29
ICT tools (e.g., computers, simulations) are accessible during physics practicals	90 (62.5%)	35 (24.3%)	8 (5.6%)	5 (3.5%)	6 (4.2%)	1.63	1.03

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std Dev.
The apparatus provided are well-maintained and functional	4 (2.8%)	4 (2.8%)	23 (16.0%)	52 (36.1%)	61 (42.4%)	4.13	0.97
Teachers ensure the guides align with the syllabus objectives	3 (2.1%)	3 (2.1%)	10 (6.9%)	48 (33.3%)	80 (55.6%)	4.38	0.87
Physics experiments are consistently documented in records books	38 (26.4%)	34 (23.6%)	25 (17.4%)	19 (13.2%)	28 (19.4%)	2.76	1.47
Online resources and ICT tools enhance the learning of practical physics skills	34 (23.6%)	35 (24.3%)	14 (9.7%)	30 (20.8%)	31 (21.5%)	2.92	1.51
Total						3.33	1.22

Students' Perceptions on Laboratory Material Use in Physics

The findings in Table 5 reveal that most students strongly believe practical guides are aligned with syllabus objectives. A total of 128 students (88.9%) supported this claim, while only 6 (4.2%) disagreed, and 10 (6.9%) remained neutral. These findings suggest a generally positive view of how teachers integrate curriculum standards into practical instruction.

A majority (78.5%) also affirmed that laboratory equipment is well-maintained, whereas a mere 5.6% reported dissatisfaction. The neutrality of 16.0% suggests some variability in equipment condition, possibly due to differences in resource management among schools.

The sufficiency of practical guides was confirmed by 68.0% of students, though 19.5% disagreed. The neutral 12.5% reflects a moderate level of uncertainty. Overall, most learners appear to benefit from the guides, although enhancements could be made for clarity or accessibility.

Record-keeping practices drew mixed reactions. While 67.3% of respondents confirmed consistent use of record books, 18.7% denied this, and 13.9% remained neutral. This reflects a positive culture of documentation, albeit inconsistently applied.

Apparatus Availability and Use of ICT Tools

Students expressed concerns regarding apparatus adequacy. Only 40.3% agreed that the apparatus was sufficiently available, while 33.3% disagreed, and 26.4% were neutral. This disparity suggests unequal access to tools, possibly related to school funding or infrastructure. Experimental documentation was reported inconsistently. Half of the students (50.0%) stated that experiments were not always recorded, outnumbering the 32.6% who affirmed consistent documentation. Neutral respondents made up 17.4%, highlighting a weak area in practical implementation.

Student perceptions of ICT integration were polarised. While 42.3% agreed that ICT tools enhanced learning, 47.9% disagreed, and 9.7% remained neutral. This indicates a deep divide in exposure or access to digital tools in physics learning environments.

The deficiency in ICT infrastructure was further emphasised as 86.8% of students reported no access to digital tools. Only 7.7% noted availability, and 5.6% were neutral. This marks a significant gap in implementing modern, technology-enhanced instruction for science education. Supporting these perceptions, the mean score for resource adequacy was moderate ($M = 3.05$, $SD = 1.36$). Practical guides were highly rated ($M = 3.90$, $SD = 1.22$), but

ICT accessibility was notably poor ($M = 1.63$, $SD = 1.03$), underscoring a digital divide in practical science delivery.

Responses from Physics Teachers

Teachers across schools consistently reported the availability of basic apparatus. *“Mechanics, optics and electricity/heat related experiments”* (Participant A), *“Lenses, ammeters, meter rules, masses hangers and slotted masses ...”* (Participant B), and *“All basic apparatus are available”* (Participants C and F) reflected a shared belief that essential tools are generally provided.

However, there was agreement on material inadequacy during lessons. *“No, they put in groups”* (Participant A), *“No, group work is encouraged”* (Participant C), and *“No, most of the time group work is emphasised”* (Participant D) indicated reliance on group-based learning due to insufficient equipment. Only Participant F responded *“Yes.”* On the availability of practical guides and record books, most affirmed provision: *“Yes”* (Participants B, C, D, E, and F). Participant A differed, saying, *“No, they come with their own record books,”* highlighting inconsistency in practice among schools.

Regarding ICT tools, the teachers were unanimous in reporting their absence: *“No”* (Participants A–D, F). When asked about usage and challenges, Participant B responded, *“Simulations are not available and therefore not incorporated into the practical lessons,”* while Participant D stated simply, *“No.”*

Teachers also voiced concern about infrastructure. *“Laboratory turned to class...no furniture...physics lab is congested with apparatus of other subjects”* (Participant A), and *“Large class size...inadequate curriculum”* (Participant B) underscore the environmental challenges. Participants C, D, E, and F also cited *“Limited space,”* insufficient seating, and lack of storage, confirming that physical limitations hinder effective physics teaching.

Responses from Laboratory Attendants

Laboratory attendants confirmed the availability of fundamental apparatus. *“Mechanics, optics & electricity/heat related experiments are available”* (Participant A), and *“lenses, ammeters, meter rules, and retort stands”* (Participant B) were commonly cited. Despite the available tools, most attendants reported insufficiencies: *“Materials are not adequate for all students; group work is encouraged”* (Participant C), and *“Group work is emphasized”* (Participant D). Only Participant F said materials were fully adequate.

In terms of practical guides, attendants reported mixed availability. *“Not provided”* (Participant A) contrasted with *“Provided”* (Participants B, C, D, E, and F), reflecting inconsistency in instructional support. ICT tools were uniformly absent. Participants A through F confirmed *“No”* availability, with Participant E stating succinctly, *“Nothing.”* These responses affirm a critical void in digital learning tools for physics instruction.

Observational Findings

Observations confirmed the presence of essential physics apparatus across all six schools. Tools such as measuring cylinders, ammeters, resistors, and optics kits were available and actively used. This indicates compliance with basic curriculum requirements for conducting physics experiments. However, the availability of instructional resources was uneven. While teacher demonstration guides, safety posters, and record books were universally present (100%), only 33.3% of schools had and used practical manuals. Student worksheets were more common (83.3%), though one school lacked them entirely.

The ICT infrastructure was observed to be wholly inadequate. All six laboratories lacked computers, simulations, projectors, or relevant software. *“No access to computers, data loggers, or physics simulations was observed.”* Only two schools (33.3%) had internet access, suggesting minimal support for digital learning. These findings confirm

the severe shortfall in digital tools and infrastructure for effective teaching and learning of physics practicals. While core materials are largely present, technological integration remains absent, limiting the scope of student engagement and modern science education.

DISCUSSION OF FINDINGS

The Extent of Laboratory Material Usage in Studying Physics by S.3 Students

The study found that 40.3% of students agreed or strongly agreed that laboratory apparatus were adequate for practical physics lessons, while 33.3% disagreed. This disparity reflects the challenges noted by Eze and Obike (2015), who reported that only 40% of schools in rural Nigeria had basic laboratory equipment, leading to inconsistent practical experiences. The majority of students (78.5%) perceived the apparatus as well-maintained, which contrasts with UNESCO's (2021) findings that 70% of rural schools in sub-Saharan Africa lack functional laboratories. This discrepancy may stem from the study's focus on a subset of schools with relatively better resources, as indicated by the observational data showing full compliance with basic apparatus availability. However, qualitative interviews revealed that materials were often insufficient for individual use, necessitating group work, a finding consistent with the Ministry of Education and Sports (2020) report on resource shortages in Ugandan rural schools.

Practical guides were deemed sufficient by 68.0% of students, with 88.9% affirming their alignment with syllabus objectives. This aligns with Foulds and Bekoe's (2018) assertion that structured guides enhance practical learning. However, teachers reported inconsistencies in provision, with some students required to bring their own record books. The high usage of record books (67.3%) suggests that documentation is prioritized, yet the lack of uniformity in experiment documentation (50.0% disagreement) indicates gaps in implementation. These findings echo Otieno and Njeru's (2020)

observation that teacher competency and resource availability are critical for effective practical instruction.

A striking 86.8% of students reported inadequate access to ICT tools, with all teachers and laboratory attendants confirming the absence of simulations or software. This aligns with UNESCO's (2021) report on the digital divide in sub-Saharan African schools. The near-total lack of ICT infrastructure severely limits opportunities for interactive and technology-enhanced learning, a barrier highlighted by the Asian Development Bank (2018) as detrimental to modern STEM education. The minimal use of online resources (7.7% availability) further underscores the need for investment in digital tools, as advocated by the OECD (2020) for fostering 21st-century skills.

Qualitative data revealed infrastructural constraints, such as laboratories doubling as classrooms and limited storage space, which hinder effective practical sessions. These findings mirror the Ugandan Ministry of Education and Sports (2020) report on overcrowded and under-resourced rural schools. Teacher responses highlighted large class sizes and inadequate funding as systemic issues, corroborating West and Ndubuisi's (2020) findings on the impact of teacher-student ratios on practical skill acquisition. The absence of safety equipment in one school (16.7%) raises concerns, echoing Eze and Obike's (2015) warnings about the risks of poorly equipped laboratories.

While students generally perceived laboratory apparatus as well-maintained (78.5%) and practical guides as sufficient (68.0%), the qualitative data revealed significant disparities in actual availability and accessibility. For instance, teachers reported that students often had to share equipment or work in groups due to insufficient materials, a challenge exacerbated by large class sizes. This aligns with Eze and Obike's (2015) findings in Nigeria, where group work was a common workaround for resource shortages, ultimately diluting individual hands-on experience. Furthermore, the observational data

confirmed that while basic apparatus like ammeters and lenses were available, their quantity was inadequate for full-class participation, particularly during examinations. This inconsistency between perception and reality suggests that students may have adapted to suboptimal conditions, interpreting “adequacy” relative to their limited exposure to well-equipped laboratories. Such adaptation risks normalising resource scarcity, which could undermine long-term efforts to improve physics education standards in rural areas.

The near-total absence of ICT tools for physics practicals (86.8% of students reported no access) represents a critical missed opportunity for modernizing science education. In contrast to countries like South Korea and Japan, where digital simulations and data loggers are integral to laboratory work (Asian Development Bank, 2018), Ugandan rural schools remain entrenched in analogue methods. This digital divide not only limits students' exposure to contemporary scientific tools but also widens the gap between theoretical knowledge and real-world applications. For example, the inability to use software for data analysis forces students to rely on manual calculations, which are prone to errors and inefficiencies. Harlen and Holroyd (2019) emphasise that ICT integration fosters analytical skills and conceptual understanding, yet the current infrastructure in Isingiro North County fails to support this pedagogical shift. Without urgent investment in technology, students will continue to lag behind global STEM competencies, jeopardizing Uganda's aspirations for scientific innovation and economic development.

Teacher interviews revealed that while educators were committed to aligning practical guides with syllabus objectives (endorsed by 88.9% of students), systemic barriers like inadequate training and funding hindered optimal implementation. For instance, some teachers cited the lack of professional development opportunities to update their skills in using modern laboratory equipment or

ICT tools. This echoes West and Ndubuisi's (2020) study in Kenya, which found that teacher confidence in conducting practical lessons correlated strongly with resource availability and training. In Isingiro, the absence of such support has led to reliance on traditional, teacher-centred demonstrations rather than student-led experimentation, limiting opportunities for active learning. Additionally, school policies, though supportive in principle, were often undermined by infrastructural constraints, such as laboratories doubling as classrooms. This overcrowding not only compromises safety but also reduces the time and space available for practical sessions, as noted by Participant A (School A): “*Learners don't easily do practical at ease.*” These findings underscore the need for holistic interventions that address both material shortages and teacher capacity, as one without the other will yield limited progress.

CONCLUSIONS

Based on the results, it is concluded that while laboratory apparatus and practical guides are generally available and well-maintained, their adequacy is inconsistent, often requiring group work due to insufficient quantities. ICT tools are severely lacking, with nearly no access to computers or simulations, significantly hindering practical learning. Teachers effectively align guides with syllabus objectives, but documentation of experiments and utilisation of ICT resources remain major challenges, indicating a need for improved infrastructure and resource allocation to enhance physics practical skills acquisition.

Recommendations

Based on the findings, it is recommended that schools should prioritise increasing the quantity of laboratory materials to reduce reliance on group work and ensure individual student access. Investment in ICT infrastructure, including computers, simulations, and internet access, is critical to modernize physics instruction. Additionally, providing comprehensive practical

manuals and regular teacher training on integrating technology into lessons will further enhance the effectiveness of laboratory-based learning. Policymakers should allocate targeted funding to rural schools to bridge these resource disparities.

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