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An Investigation of the Relationship between Laboratory Use Skills of Grade 10 Physical Sciences Learners and their Academic Performance

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Abstract

Laboratory use skills, including basic and integrated science process skills, are taught in school science laboratories. This study aimed to investigate the relationship between the laboratory use skills of grade 10 physical sciences learners and their academic performance. Four schools from the Lejweleputswa Educational District were randomly selected. A mixed-methods approach was employed, involving focus group interviews with seven teachers and a Likert-type questionnaire administered to 187 learners. The findings revealed a significant relationship between laboratory use skills and academic performance. Practical investigations are important in teaching physical sciences, despite challenges such as limited resources, inadequate laboratories, time constraints, discipline issues, and novice teacher experience. Recommendations include workshops for novice teachers, mobile laboratories, integrating practical work into university curricula, compulsory Wi-Fi at schools, and monitoring by Departmental Heads. These findings impact teacher training, curriculum development, resource allocation, the connection between theory and practice, learners' academic success, and future career paths in science-related fields

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Introduction

It is almost impossible to discuss practical investigations without also discussing the scientific process. Learners must develop basic laboratory skills to uniformly grasp the scientific method. Combining practical investigations with theoretical lessons is crucial for reinforcing the concepts taught in physical science classes, as stated in the Curriculum Assessment Policy Statements (CAPS). The CAPS document outlines that the main purpose of physical sciences is to equip learners with basic process skills, such as classifying, communicating, designing investigations, drawing, evaluating conclusions, hypothesizing, controlling variables, observing, interpreting, predicting, and

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problem-solving skills. Science stands apart from other high school subjects because it encompasses both a vast amount of scientific knowledge and the different methods used to investigate the natural world. As a result, practical, inquiry-based learning is a crucial and essential component of science instruction. To ensure that every learner has fair opportunities for hands-on scientific experiences, South Africa's Curriculum and Assessment Policy Statement for physical sciences outlines required and recommended practical activities for high school learners across all educational settings.

The skills described in the CAPS document can be attained through effective practical investigations conducted at schools. According to the physical sciences CAPS document, schools are recommended to conduct at least one informal practical activity per term and two formal practical activities in term one and term two in Grade 10. This gives a total of six practical activities per year in Grade 10. There are still schools that cannot perform the required number of practical investigations (Probyn, 2018; Du Plessis & Mestry, 2019; Iwuanyanwu, 2025).

The CAPS defines physical sciences as the study of physical and chemical phenomena, using scientific research, models, theories, and laws to explain and predict events in the physical environment (Department of Education, 2011). In South Africa, physical sciences are taught as a combined physics and chemistry subject at the Further Education and Training (FET) level (Ogegbo, Gaigher & Salagaram, 2019). Furthermore, Ogegbo, Gaigher and Salagaram (2019) and Botha (2025) emphasize that effective science education is essential for economic development, as innovations based on physics drive technological progress. However, low academic performance in the physical sciences has limited the number of skilled individuals in South Africa's scientific community, posing a challenge to the country's economic growth. According to a 2021 report by the Department of Basic Education, 69 percent of learners in the physical sciences meet only the minimum 30 percent pass requirement, highlighting a need for improvement. Despite a recent increase in enrolment, the causes of poor performance in this subject require further investigation (Petrus, 2018).

Importance of the Study

Research highlights a lack of adequate science teaching facilities, such as laboratories, in many schools. The CAPS curriculum emphasizes that physical sciences develop essential skills—such as measurement, hypothesis testing, and data analysis—best acquired through hands-on lab work (Department of Education, 2011). Studies by Basitere & Mshayisa (2021), Botha et al. (2017) and Ramnarain (2024) affirm that practical investigations enhance understanding, interest, and learner engagement. However, inadequate lab access limits teachers' ability to conduct experiments (Isozaki, 2017). This study explores the impact of laboratory skills on the academic performance of Grade 10 learners in the Lejweleputswa district. It is unique for its mixed-methods approach during the COVID-19 period and its focus on schools from three different quintiles (1, 3, and 5), reflecting varying socioeconomic contexts. In South Africa, school quintiles determine funding based on community wealth, with quintile 1 being the poorest and quintile 5 the wealthiest. This study aims to investigate the impact of practical investigations on academic outcomes across these diverse settings.

Objectives of the Study

Main objective

- To investigate the relationship between grade 10 physical sciences learners' laboratory, skills and their academic performance.

Specific objectives

- Explore the role of grade 10 physical sciences learners' laboratory skills on their academic performance.
- Examine how resourceful school physical sciences laboratories are in enabling Grade 10 learners to apply laboratory use skills and improve academic performance.
- Identify the challenges experienced by grade 10 physical sciences teachers and learners that may hinder the successful implementation of laboratory skills for enhanced academic performance.

Hypotheses

To bring clarity to the significance of the study, the following hypotheses were also tested:

Hypothesis 1

H_0 - There is no statistically significant relationship between grade 10 physical sciences learners' laboratory use skills and their academic performance.

H_1 - There is a statistically significant relationship between grade 10 physical sciences learners' laboratory use skills and their academic performance.

Hypothesis 2

H_0 - There is no statistically significant difference in the role of practical investigations in learners' academic performance compared with the learners' chemistry and physics practical scores.

H_1 - There is a statistically significant difference in the role of practical investigations in learners' academic performance compared with the learners' chemistry and physics practical scores.

Hypothesis 3

H_0 - There is no statistically significant difference between males and females, and their academic performance.

H_1 - There is a statistically significant difference between males and females, and their academic performance.

Hypothesis 4

H_0 - There is no statistically significant difference between schools with physical sciences laboratories and those without, and the learners' chemistry and physics practical scores.

H_1 - There is a statistically significant difference between schools with physical sciences laboratories and those without, as well as the learners' scores in chemistry and physics practical scores.

Theoretical Framework

This research is grounded in the social constructivist learning theory, defined by the idea that learning occurs through students' social interactions (Sarbah, 2020). Additionally, McLeod (2024) suggests that social constructivism sees learning as a joint process. Social constructivism, as a learning theory, was appropriate for this study because it highlights the importance of social interactions where learners interact during practical investigations, and it also encourages active engagement, wherein learners actively construct their knowledge.

Practical work, science learning and academic performance

Science is fundamentally about problem-solving, and while some challenges can be effectively addressed in laboratories, many schools primarily use these spaces to teach science concepts rather than to engage in active science (Dourado & Leite, 2013). Practical investigations, however, offer learners the opportunity to actively engage in scientific inquiry, making them essential for all schools (Teig, Scherer & Olsen, 2022). Although physical sciences teachers are expected to incorporate practical investigations into their regular teaching, several challenges complicate this task. For instance, Jita and Gudyanga (2019) found that while teachers value practical investigations for developing learners' skills in demonstration, data handling, and identifying variables, they face constraints, such as a packed curriculum that can make it difficult to complete all required content in the available time. Meanwhile, Maponya (2018) observed that some teachers do not conduct practicals because they do not recognize the educational value of these activities. The impact of practical investigations extends beyond academic performance. Chan (2012) emphasizes that they also help learners build observational, practical, and experimental skills. Ngema (2016) highlights that schools lacking laboratory resources face significant obstacles to successful science learning. Practical work also enhances learners' manipulative skills and helps make science more relevant, underscoring the importance of giving learners time to practice these skills in hands-on situations.

Research by Gericke, Högström & Wallin(2022) demonstrates that practical investigations can enhance learners' understanding of classroom theory, positively influencing their academic performance. However, other factors, including students' age, attitude, and gender, also play a role in science performance, as Amir, Mohamed & Mnjokava(2016) and Bondoc (2016) explain. Practical investigations come with their challenges. Said, Friesen and Al-Azzah (2014) and Ndihokubwayo (2017) found that issues such as a lack of personnel, varying learner interest, and the time required to support learners through investigations can hinder implementation. Additionally, Bonito and Oliveira (2023) note that assessments often focus on written work rather than actual lab performance, which can be discouraging for both teachers and learners.

Method

Research Design

This study followed an explanatory sequential mixed-method design. Explanatory mixed-method design is defined as a plan where the researcher first collects quantitative data, analyzes the findings, and then enhances the findings to explain them in greater detail with using qualitative research (Asenahabi, 2019; Shambare & Jita 2024). One hundred and eighty-seven closed-ended questionnaires were administered to grade 10 physical sciences learners of schools at different quintile levels, quintiles 1, 3, and 5 in the Lejweleputswa district, to obtain quantitative results (Quan data collection and analysis), and was followed by focus group interviews (Qual data collection and analysis) with seven physical sciences teachers from four schools in the district. After analyzing both quantitative and qualitative data, the results were interpreted to see how the qualitative results explained the quantitative results.

Participants

According to Bhardwaj (2019), sampling is crucial for ensuring the accuracy of a study. This study involved 187 Grade 10 Physical Sciences learners and seven teachers from four secondary schools in the Lejweleputswa district. For the quantitative aspects of this study, simple random sampling was used, while purposive sampling was employed for the qualitative data (Ahmed & Wilkins, 2025). Participants were selected based on their active role as either teachers or learners of grade 10 physical sciences. Although over 200 questionnaires were distributed, only 187 were returned due to COVID-19 restrictions. Only teachers participated in face-to-face interviews, as they are responsible for conducting practical activities and were more accessible during the pandemic.

Data Collection Instruments

Mixed-methods research integrates both quantitative (numerical) and qualitative (descriptive) approaches within a single study. This integration combines quantitative and qualitative techniques into a single, cohesive study (Almeida, 2018). By employing a mixed-methods approach, this study enabled the researcher to explore the connection between laboratory use skills and academic performance, the part practical investigations play in performance, and the obstacles faced by both educators and learners during practical activities.

The learners responded to closed-ended questionnaires, and the teachers participated in focus group interviews.

Data Collection Procedure

The questionnaire was divided into four sections: the biographical data section, the laboratory skills section using Likert-type scale, the physics practical section, and the chemistry practical section. The practical section was based on practical investigations that were supposed to have been done already in schools. Before any data collection, pilot studies were conducted a month in advance, and changes were made to the interview questions and some questionnaire items. The questionnaire was administered on different days in all four schools, which took four days to complete. The questionnaire was administered for 30 minutes, staring at 14:00. The questionnaire data were used to test the hypotheses that were stated in the study.

The focus group interviews were meant to answer the research questions:

1. How do the laboratory skills of grade 10 physical sciences learners affect academic performance?
2. What is the role of practical investigations in the teaching of physical sciences in Grade 10?
3. How resourceful is your school's physical sciences laboratory in assisting in carrying out practical investigations?

4. Which challenges have you experienced as a physical sciences teacher when it comes to conducting practical investigations?

A venue convenient for all participants was discussed, where the single focus group interview was to be held, and other matters, such as date and time, were also addressed. The procedures in focus group interviews were followed, and the researcher led the interview. The interviews lasted 1 hour and 30 minutes.

Data Analysis and Findings

Data analysis converts raw collected data into meaningful insights, allowing it to be understood either qualitatively or quantitatively, and involves examining organized material to unveil underlying facts and insights (Alem, 2020). Simply put, data analysis refers to changing raw data into meaningful data (Taherdoost, 2020). An exploratory sequential mixed-methods research design was used to collect quantitative data through questionnaires, followed by qualitative data collected through focus group interviews. The IBM SPSS 27 program was used to analyze the quantitative data, while the qualitative data collected were analyzed thematically. Out of 189 questionnaires, 187 were returned, while two participants did not return them.

Quantitative data analysis

A Pearson correlation coefficient was performed to test the following hypotheses:

H_0 - There is no statistically significant relationship between grade 10 physical sciences learners' laboratory use skills and their academic performance.

H_1 - There is a statistically significant relationship between grade 10 physical sciences learners' laboratory use skills and their academic performance.

A Kruskal-Wallis test was employed to test the following hypotheses:

H_0 - There is no statistically significant difference in the role of practical investigations in learners' academic performance compared with the learners' chemistry and physics practical scores.

H1 -There is no statistically significant difference in the role of practical investigations in learners' academic performance compared with the learners' chemistry and physics practical scores.

Note: A Kruskal-Wallis test reveals that there is no statistically significant difference between learners who agree that a role is played by practical investigations and learners who do not agree that these play a role in their academic performance with their practical scores (chemistry and physics), X^2 (2, N = 187)

Table 1: Relationship between chemistry and physics practical scores and the learners' academic performance (N=187)

		Practical scores (chemistry and physics) %	Academic performance
Practical scores (chemistry and physics) %	Pearson Correlation	1	.789**
	Sig. (2-tailed)		0,000
	N	187	187
Academic performance	Pearson Correlation	.789**	1
	Sig. (2-tailed)	0,000	
	N	187	187
**. Correlation is significant at the 0.01 level (2-tailed).			

Note: A Pearson correlation coefficient was performed to evaluate the relationship between chemistry and physics practical scores and the learners' academic performance. The *means* for chemistry and physics scores were 69.67 (*SD* = 16.6z16), and the *mean* for academic performance was 40.65 (*SD* = 15.55). The relationship was positive, strong in strength, and statistically significant (r (185) = .79, p = .00). This implies a statistically significant relationship between chemistry and physics practical scores and the Grade 10 physical sciences learners' academic performance. These findings corroborate the study conducted by Apeadido, Opoku Mensah & Opoku-Mensah (2024).

Table 2: Differences in the role of practical investigations in learners' academic performance compared with the learners' chemistry and physics practical scores (N = 187)

Variable	The role of practical investigations	N	Median	Kruskal-Wallis H (X2)	df	*p*
Total Marks	No response	9	16.00	1.010	2	0.604
	Role	139	15.00			
	No role	39	14.00			
	Total	187	15.00			

Hypothesis Test Summary			
Null Hypothesis	Test	*P*	Decision
There is no statistically significant difference in the role of practical investigations in learners' academic performance compared with the learners' scores in chemistry and physics practical scores.	Independent-Samples Kruskal-Wallis Test	0.604	Retain the null hypothesis.

df -degrees of freedom

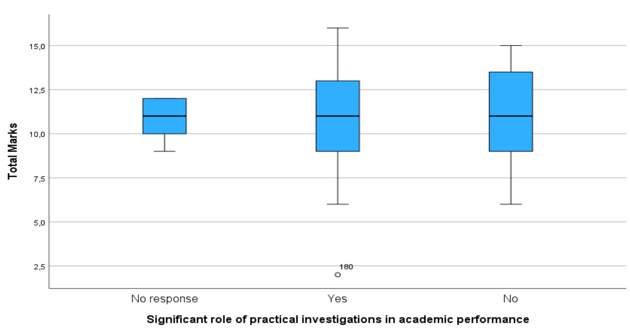

Fig. 1: The role of practical investigations on the learners' academic performance (N = 187)

= 1.01, p = 0.60. The median value of learners who agree that practical investigations play a role in their academic performance is a bit higher (Md = 15.00) than that of learners who did not agree that they play a role in their academic performance (14.00), the proximity of the medians suggests that the difference is not statistically significant, therefore, the null hypothesis (H_0) is retained. These findings differ from those of the study conducted by Twahirwa & Twizeyimana (2020) and thus require further investigation for future studies.

An independent-sample t-test was carried out to test the following hypotheses:

Table 3: Comparison of gender and academic performance (N=187)

Variable		*M*	*S D*	*t*	*df*	*p*	*MD*	*Cl*	*D*
Academic performance				2.97	185	0.003	6.60	2.20 - 11.00	0.02
	Males	43.89	16.30						
	Females	37.29	14.06						

Note: An independent-samples t-test was conducted to compare males and females and their academic performance. Data analysis in Table 3 reveals a statistically significant difference between males (M = 43,89, SD = 16.30) and females (M = 37.29, SD = 14.06), t (185) = 2.97, p < 2.97 (two-tailed). The mean difference was 6.60, with a 95 percent confidence interval ranging from 2.20 to 11.00. As the confidence interval does not include zero (0), this confirms a statistically significant difference between males and females in their academic performance. The eta squared value of 0.02 indicated a small effect size, leading to the rejection of the null hypothesis (H_0) and the acceptance of the research hypothesis (H_1). This outcome is consistent with research by Stoet & Geary (2018), though it diverges from Mahdy's (2020) findings in veterinary sciences, where gender was not a factor.

Table 4: Differences between schools with physical sciences laboratories and those without and the learners' scores in chemistry and physics practicals (N = 187)

Variable	Availability of physical science lab	N	Median	Kruskal-Wallis H (X^2)			df	P
Total Marks	No response	4	16.00	.695			2	0.707
	Available	120	15.00					
	unavailable	63	17.00					
	Total	187	16.00					

Hypothesis Test Summary			
Null Hypothesis	Test	p	Decision
There is no statistically significant difference between schools with physical sciences laboratories and those without and the learners' chemistry and physics practical scores.	Independent-Samples Kruskal-Wallis Test	0,707	Retain the null hypothesis.

df -degrees of freedom

H_0 - There is no statistically significant difference between males and females in their academic performance.

H1- There is a statistically significant difference between males and females in their academic performance.

A Kruskal-Wallis test was applied to test the following hypotheses:

H_0 - There is no statistically significant difference between schools with physical sciences laboratories and those without, as well as the learners' chemistry and physics practical scores.

H1- There is a statistically significant difference between schools with physical sciences laboratories and those without, as well as the learners' scores in chemistry and physics practical scores.

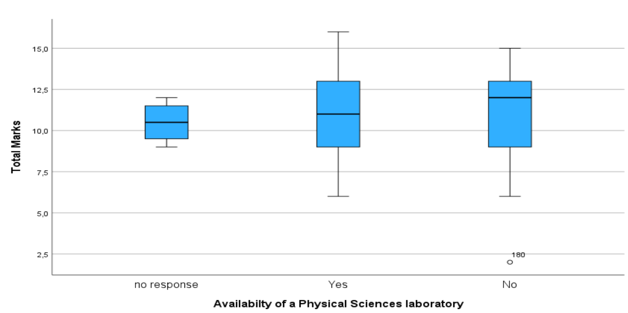

Fig. 2: Availability of laboratories and practical scores (N = 187)

Note: A Kruskal-Wallis test reveals that there is no statistically significant difference in learners' practical scores (chemistry and physics) between schools with physical sciences laboratories and those without related laboratories (X^2 (2, N = 187) = .70, p = 0.70). Schools that do not have physical sciences laboratories showed the highest median (*Md = 17.00*) compared to those with physical sciences laboratories (Md = 15.00). The null hypothesis (H_0) is retained. These findings are not in alignment with the study conducted by Adebayo, Agboola, Majebi, Adekunle, Adekula & Adekola(2019), which was related to the general availability of educational resources in South Africa, rather than specifically to the physical sciences.

Qualitative data analysis

For this study, focus group interviews were conducted with seven grade 10 physical sciences teachers from four specific schools within the Lejweleputswa district. Before the interviews, the teachers were told about the study's purpose, that their involvement was voluntary, that their identities would remain confidential and anonymous, and that the interviews would be recorded. A full explanation of the interview procedure was also provided to ensure they were well-informed. The interviews were conducted after hours at the selected schools. The teachers were selected using the purposive sampling method and were from schools in quintiles 1, 3, and 5.

The interviews were recorded. Immediately after the interviews, the researcher generated codes, identified themes, and reviewed possible themes related to the research objectives. Themes were developed, and an interpretation was provided. This data analysis resulted in four themes and various subthemes as listed below:

Theme 1: The relationship between the laboratory use skills of grade 10 physical sciences learners and their academic performance

Sub-theme 1: Learn by doing

Analysis of interview data reveals that all grade 10 physical sciences teachers agree that there is a significant relationship between laboratory use skills and the academic performance of grade 10 physical sciences learners. Teachers/participant responses were:

Teacher 2: What I have come to realize is that practicals help a lot. There are learners whereby you talk theory, and they can grasp, then there are learners who will have to see and then they can understand. If you keep on just talking, you'll think that they are not doing well but if you give them extra classes and extra work still you will not see any results. But the moment they begin to do it themselves, talk amongst themselves as they do it, you'll get amazed.

Teacher 3: The relationship is directly proportional as most learners learn by doing. When you are actively involved it makes it easier for them to remember concepts as a result it influences their academic performance positively.

Teacher 5: There is a huge relationship between the laboratory use skills of learners and their academic performance. It's a matter of learning by doing.

Sub-theme 1.2: Contribution to overall continuous assessment (Cass) marks

Teachers have explained that laboratory use skills contribute a certain percentage to the overall Cass mark; therefore, there is a relationship between laboratory use skills and academic performance, as revealed by the statements made by the teachers below:

Teacher 6: There is a relationship because practical marks also contribute greatly to the learners' Cass marks, which determine their academic performance.

Teacher 7: There is a relationship. As practical investigations are 30% of Cass marks.

Theme 2: The role of practical investigations in teaching physical sciences in grade 10

Sub-theme 2.1: Visualizing lessons

Teacher 1: To lay down knowledge by visualizing. Learners learn by visualizing and remember the part of the work. This is emphasized by Teacher 2: who explains that even though we know that some learners will pass extremely well without practicals, they can visualize in their minds, some even watch YouTube videos online.

Sub-theme 2.2: Enhancing theory.

All teachers believe practical investigations are a crucial link between theory and practical work. As highlighted by the statements below from the teachers:

Teacher 3: I think practical investigations are intended to expose learners to real-life concepts, like it makes it easy for them to relate or to understand concepts. It's like when someone talks about electrical circuits it becomes very difficult to comprehend it but if a learner is exposed to a practical where they handle circuits then it makes them understand better.

Teacher 7: The role of practical investigations is that it emphasizes what was said during theory lessons. For instance, we are now on electric circuits, it'll help if we do practicals, learners will be able to see the actual circuits. Physical sciences most topics are not based on things that the learners are able to see, so practicals will help learners to see many things. Yes, we draw circuits on the board but when they see it, it's like they are seeing it for the first time, as there is a difference between the drawn version and the real one. Even on some question papers, a real-life circuit would be there, and learners would be asked to draw it. Not only on electric circuits *but also on the heating and cooling curves. We had a practical using water and ice, and that helped to enhance the theory a lot.*

Theme 3: Resourcefulness of physical sciences laboratories in assisting in conducting practical investigations

Sub-theme 3.1: Very resourceful

Teachers from quintile 5 schools responded that their laboratories are well-equipped and that they can conduct practical investigations efficiently.

Teacher 1: 100% resourceful.

Teacher 2: We have a physical sciences laboratory that is well-equipped. If we have any shortage of laboratory apparatus, our management immediately buys it for you, even mere transport will be immediately availed for you.

Teacher 3: Well-resourced, it is never a struggle to do practical investigations as all apparatus and chemicals are available, even the laboratories are in a perfect condition.

Sub-theme 3.2: Not resourceful

Teachers from quintile 1 and 3 schools reported that they lack resourceful physical science materials and are unable to conduct practical investigations.

Teacher 5: We don't have a working laboratory with all the necessary apparatus and chemicals.

Teacher 6: We don't have a laboratory at all; we only have classes that used to be normal working laboratories, but now they are useless as science laboratories.

Teacher 7: It is not resourceful at all; it is extremely small to accommodate our large numbers of learners. It is also very disorganized if you want a certain chemical, you won't know where to start to look for it.

Theme 4: Challenges experienced by physical sciences teachers when conducting practical investigations

Sub-theme 4.1. Time constraints during the COVID-19 pandemic

Most teachers appear to struggle with setting aside time to conduct practical investigations, despite the Annual Teaching Plans allocating time for this purpose. Even the learners do not seem to take practical time seriously.

Teacher 1: From past experiences, learners see practical time as a free period.

Teacher 2: Because of COVID-19, we were disadvantaged because we used to have. Like this is a physical sciences laboratory. Before COVID, learners used to come to me in the physical sciences class, where all the chemicals and apparatus are located but due to COVID learners are situated in one class, so when I must conduct practicals, it'll mean I must carry all the chemicals and apparatus to that class and that wastes a lot of time.

Teacher 3: The length of our periods is too short; 45 minutes is not enough even with effective planning and collecting all apparatus on time.

Teacher 4: Our class periods are not enough.

Teacher 6: The time we are expected to conduct practical work is very short when we try to do it during our 50-minute periods.

Sub-theme 4.2: Learners' ill-discipline

Teacher 1: Learners are not focused on what to do; some making jokes or chasing each other in class, in other words, it changes into chaos. They either break the apparatus or steal some of the components or try to be funny and so I can't carry on…you must literally be a policeman the entire period and there is no fun in doing practical investigations. These are the main reasons why I demonstrate the practical myself.

It is disappointing that teachers no longer find practical investigations enjoyable. Another factor contributing to this is the disciplinary issues resulting from overcrowding, as pointed out by *Teacher 7:* 'It is extremely small to accommodate our large numbers of learners.'

Sub-theme 4.3: Outdated chemicals and apparatus

Teacher 5: We have expired and outdated chemicals and apparatus.

Teacher 7: Our laboratory has a lot of chemicals that are outdated. We do have some apparatus, but they are extremely old and rusty.

Sub-theme 4.4: Inexperienced teacher

One teacher explained that he had not received training on how to conduct practical investigations. This is a concern, as new teachers are entering the teaching field with little to no experience in conducting practical investigations. Novice teacher workshops are necessary.

Teacher 7: As a new teacher, I sometimes struggle as I don't know how to conduct some practicals. I have a challenge of not knowing how to deliver some practicals to the learners. I sometimes watch YouTube videos and the issue there is that they use current apparatus, and our school doesn't have that. I try to do some practicals in my own time to make sure that they are successful. For instance, the ticker timer practical investigation is very difficult for me, I don't even know how I'm going to start it. I need someone who is going to show me how it works. I am going to bring it to work and just explain to the learners how it works.

Sub-theme 4.5: Dirty and unkempt laboratories

Teacher 7: It is very dirty, and no one is assigned to clean it. It is also very disorganized if you want a certain chemical, you won't know where to start to look for it

Discussion

This study aimed to investigate the connection between the laboratory use skills of grade 10 physical sciences learners and their academic performance. To achieve this, a multifaceted approach was explored: examining the impact of laboratory skills on academic achievement, evaluating how well school physical sciences laboratories support the application of these skills, and pinpointing the obstacles teachers and students encounter that could impede the successful integration of lab skills for better academic outcomes. The study began with a quantitative phase (closed-ended questionnaires) followed by a qualitative phase (focus group interview).

This was a mixed-methods study; therefore, it is imperative that the results are discussed as separate entities, even though they are intertwined. The discussion of the findings will begin with the presentation of the quantitative results, followed by the qualitative results.

Discussion on Quantitative Data

The Pearson correlation coefficient revealed a statistically significant relationship between grade 10 learners' laboratory use skills and their academic performance.

The Kruskal-Wallis test indicated that there is no relationship between practical investigations and learners' academic performance.

An independent samples t-test showed a statistically significant difference between male and female learners in terms of academic performance.

The Kruskal-Wallis test also revealed no statistically significant difference in academic performance between schools with and without laboratories.

Discussion on Qualitative Data

Relationship between the laboratory use skills of grade 10 physical sciences learners and their academic performance in the Lejweleputswa

Teachers expressed that learners understand concepts better through hands-on activities.

Teacher 3: The relationship is directly proportional, as most learners learn by doing. When you are actively involved, it makes it easier for them to remember concepts, as a result, it influences their academic performance positively.

Teacher 5: There is a huge relationship between the laboratory use skills of learners and their academic performance. It's a matter of learning by doing.

There is a consensus amongst the teachers that laboratory skills have an impact on learners' academic performance. This is observed across the study population in the different quintiles, specifically quintiles 1, 3 and 5. The findings are in line with those made by Gomez et al. (2020), which highlighted that learners who actively participate in laboratory classes do better academically than those who are only taught traditionally.

The role of practical investigations in the teaching of physical sciences in grade 10

Teachers noted that practical investigations enhance understanding of theoretical concepts.

Teacher 1: To lay down knowledge by visualizing. Learners learn by visualizing and remembering the part of the work. This is emphasized by Teacher 2, who explains that even though we know that some learners will pass extremely well without practicals, they can visualize in their minds, some even watch YouTube videos online.

Teacher 4: Is to help learners understand/grasp abstract concepts that they might not necessarily understand if they were only taught to them in traditional methods.

Teacher 5: Practical work goes hand in hand with theory. What has been taught in theory time is now being put into practice. For example, acids and bases could have been taught in theory and are now being done practically.

The teachers' views are also supported by the findings from a study conducted by Ngwenya (2025) and Cheung (2023), who noted that learners who frequently engage in a combined use of practical activities and theory achieve significant results and improved cognitive abilities, including knowledge, application and analysis. The authors, in their various capacities as science instructors, also support the views held by the teachers, as practical work is a fundamental requirement of science.

Resourcefulness of physical sciences laboratories in schools in assisting to carry out practical investigations

Some teachers reported well-equipped labs, while others noted a lack of resources.

Teacher 1: 100% resourceful.

Teacher 2: We have a physical sciences laboratory that is well-equipped. If we have any shortage of laboratory apparatus, our management immediately buys it for you, and even mere transport will be immediately availed for you.

Teacher 3: Well-resourced, it is never a struggle to do practical investigations as all apparatus and chemicals are available, and even the laboratories are in perfect condition.

Teacher 5: We don't have a working laboratory, with all the necessary apparatus and chemicals.

There is a significant difference between the various schools in terms of their physical sciences laboratories' resources. Teachers from quintile 1 schools reported poorly resourced physical sciences laboratories, while teachers from quintile 5 indicated well-resourced laboratories. This variation may be due to the funding models of the schools, with quintile 1 being non-fee-paying schools and quintile 5 being fee-paying schools. The view is supported by the findings made by Van Dyk & White (2019), which indicate that schools in quintile 1 are located in the poorest sections, while those in quintile 5 are located in the most affluent areas, resulting in a difference in terms of laboratory availability.

Challenges experienced as a physical sciences teacher while conducting practical investigations

Challenges include learner Behaviour, outdated chemicals, and lack of experience.

Teacher 1: Learners are not focused on what to do; some making jokes or chasing each other in class, in other words, it changes into chaos. They either break the apparatus or steal some of the components, or try to be funny, and so I can't carry on … you must literally be a policeman the entire period, and there is no fun in doing practical investigations. These are the main reasons why I demonstrate the practical myself.

Teacher 7: Our laboratory has a lot of chemicals that are outdated. We do have some apparatus, but they are extremely old and rusty.

One thing that stands out about the teachers' views is that all teachers experience challenges when it comes to conducting practical work, irrespective of their school category. Akuma's (2023) study determined that there are several challenges relating to practical activities in physical sciences, which include but are not limited to learner behavior and safety of the learners, while Soyikwa & Boateng (2025) also noted that teachers face challenges such as lack of resources and large classes, these findings relate to the findings of this study.

The statistically significant relationship between laboratory use skills and academic performance supports the idea that practical engagement improves understanding. This aligns with Apeadido, Opoku Mensah & Opoku-Mensah (2024), who found that practical laboratory work supports academic performance.

Therefore, interestingly, the Kruskal-Wallis test revealed no relationship between practical investigations and academic performance. The findings are supported by Smith, Stein, Walsh, & Holmes (2020), who showed that learners' performance in practical lab work did not translate into higher academic performance on exams. This contradicts the qualitative findings, where teachers emphasized the importance of practical work. This discrepancy suggests that while practical investigations are valued, other factors (e.g., quality of delivery or time constraints) may affect their impact. The gender-based difference in performance aligns with findings from Aguillon, Ballen, Drake, Petipas, & Siegmund, (2020), suggesting that male and female learners may engage differently in science education. Despite differences in lab availability, learners' performance was unaffected according to the statistical test. The findings are echoed by a study by Haeda, Ainurridho & Cahyani (2024), who highlighted that simply having labs does not automatically imply increased academic success. Qualitative data added rich context: teachers believe practical work supports visual learning and concept retention. However, they also reported challenges, including discipline issues and outdated equipment. These findings align with those of Abbey-Kalio (2024), who highlighted that there are barriers to effective laboratory work, including the availability of laboratory resources, the correct use of the laboratories and accessibility of the laboratories.

Conclusion and Recommendations

This study found a significant link between grade 10 learners' laboratory skills and their academic performance in physical sciences, highlighting a gap between policy expectations and the realities in under-resourced schools. To address this, the study recommends targeted teacher training, improved funding for science laboratories, alignment with university programs, digital resource access such as Wi-Fi, stronger monitoring of practical work, and a greater emphasis on science foundations in primary schools. The study urges all education stakeholders to enhance the management of science teaching and learning for the benefit of South Africa.

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Declaration of interest statement

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