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# Exploring Prospective Physical Sciences Teachers' Work-Integrated Learning Experiences of Inquiry-Based Learning: A South African Case Study

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**Abstract.** Inquiry is central to the generation of scientific knowledge. Science should not be presented as a finished body of knowledge. Instead, it should be considered a human endeavour that creates empirically verified knowledge, which is tentative, fallible, and falsifiable. Prospective physical sciences teachers are expected to develop a conception of scientific inquiry that would then assist them in designing and executing inquiry-based science lessons in their careers. This study, crucial in filling the knowledge gap in teacher preparation, was conducted to determine the experiences of prospective physical sciences teachers in implementing inquiry-based science lessons. This qualitative single case study utilised the pedagogical framework for inquiry-based science education as the theoretical framework. Purposive sampling was used to select six final-year Bachelor of Education Honours students who had spent 3 months on work-integrated learning in rural schools. They were required to keep a diary of their experiences during teaching practice and to develop portfolios. The students' portfolios, lesson plans, and semi-structured interviews were used as data sources and analysed using Atlas.ti 8.0 computer-assisted qualitative content analysis techniques. While the findings indicate that students had sufficient understanding of inquiry-based lessons, they encountered challenges in implementing open inquiry, and the empirical evidence suggests that they implemented lower levels of inquiry. The findings have significant implications for university teacher preparation; hence, teacher educators and policymakers should develop approaches that enhance the development of inquiry-based learning skills in prospective teachers.

**Keywords:** pedagogical framework for inquiry-based science education; inquiry-based learning; physical sciences; open inquiry; structured inquiry; guided inquiry.

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## 1. Introduction

Inquiry-based learning is an instructional approach in which learners ask research questions, design and conduct investigations, and collect and analyse data to answer these questions (Çetinkaya & Özyürek, 2019). Researchers consider inquiry-based learning in science education as a pedagogical approach that fosters critical thinking and deepens conceptual understanding, leading to enhanced learner motivation and engagement (Lakin & Wallace, 2015; Twizeyimana et al., 2024). Empirical research has also shown that teaching science as inquiry helps learners understand the nature of science (Pedaste et al., 2015), which can attract them to science and science-related careers, particularly in developing economies such as South Africa.

Learning of physical sciences in South Africa is expected to occur through inquiry-based instructional approaches (Department of Basic Education, 2011; Ramnarain, 2024). This teaching and learning approach is also considered fundamental to science education globally (Constantinou et al., 2018). While scientific inquiry is the process by which practising scientists create and validate scientific knowledge, inquiry-based learning in schools is a process in which learning of scientific concepts occurs through methods resembling scientific inquiry (Constantinou et al., 2018).

In this pedagogic approach, learners learn scientific concepts by formulating investigative questions, designing experiments, carrying out investigations, collecting and analysing data and drawing conclusions. Pedaste et al. (2015) suggest distinct phases of inquiry learning, starting with conceptualisation, with learners asking scientific questions and generating hypotheses, proceeding to investigation, where learners explore and carry out experiments and interpret the collected data, and finally, the discussion phase, where learners reflect and communicate their findings. The inquiry approach to science learning has been found not only to enhance conceptual understanding but also to help learners gain science process skills and an understanding of the nature of science (Biswal & Behera, 2023; Qablan et al., 2024; Twizeyimana et al., 2024).

While research has demonstrated that inquiry-based learning has significant implications in science education, the implementation of inquiry-based learning in schools remains a largely unexplored area, particularly in resource-constrained rural communities (Akuma & Callaghan, 2019; Nicol, 2021). Therefore, this study aimed to fill this gap by answering the following research questions:

1. What conceptions of inquiry-based lessons do prospective physical sciences teachers hold?
2. To what extent did prospective physical sciences teachers implement what they learned during their methodology of physical sciences university modules?
3. What challenges, if any, did the prospective rural physical sciences teachers encounter in implementing inquiry-based learning during work-integrated learning?

## 2. Literature Review

Inquiry as a learning approach can be traced to the work of the American philosopher and psychologist John Dewey (Stoller, 2018). Dewey was critical of the traditional transmission mode of teacher-centred instruction and proposed that learning should occur through experiential instruction through learner-centred approaches (Nweke & Owoh, 2021; Williams, 2017). Inquiry is the set of skills and knowledge that learners need to develop as they conduct scientific investigations. Inquiry is the teaching and learning approach used in science education (Lee & Brown, 2018). It is a critical aspect of scientific literacy, considered the major goal of learning science (Lee & Brown, 2018).

There is no consensus on defining scientific literacy. To be considered scientifically literate, an individual must understand the nature of science and its role in their personal life and society (Osborne & Allchin, 2024). Scientific literacy contributes to the attainment of diverse skills such as critical thinking, creativity, problem-solving, working cooperatively, using technology effectively, and lifelong learning (Sutiani et al., 2021).

Empirical studies on the relationship between learner involvement in scientific inquiry during lessons and scientific literacy consistently show that when learners conduct scientific investigations, their scientific literacy improves (Aulia et al., 2018; Wen et al., 2020). Although scientific literacy is the main goal of science education, it has remained elusive even in developed nations (Shamos, 1995). This implies that there is a need for greater efforts in initial teacher preparation so that prospective teachers can be adequately prepared to contribute towards the achievement of scientific literacy through scientific inquiry.

Scholars of inquiry-based learning argue that more learning benefits accrue from implementing open inquiry as opposed to a cookbook recipe-type of investigation in which learners are provided with research questions, procedures of doing inquiry and confirmation of results that are already known in advance (Pedaste et al., 2015). In between these two inquiry approaches, at opposite poles of the inquiry continuum are structured and guided inquiry. Although previous research has demonstrated that open inquiry helps learners develop science process skills, critical thinking, and scientific argumentation, current research indicates that lower levels of investigation are predominantly conducted in secondary schools (Tsakeni et al., 2019).

Empirical studies conducted in South Africa show that, while teachers have a positive attitude towards inquiry-based learning and are aware of the potential benefits of using this approach, they hardly implement it in lessons (Ramnarain, 2024; Ramnarain & Hlatswayo, 2018). The reasons for the poor implementation of inquiry in science learning range from a lack of resources, overcrowding in classes and a lack of understanding of how to implement such lessons. This creates a gap in ensuring that teachers are equipped and prepared to implement inquiry-based learning. The following section discusses the conceptual framework for the study.

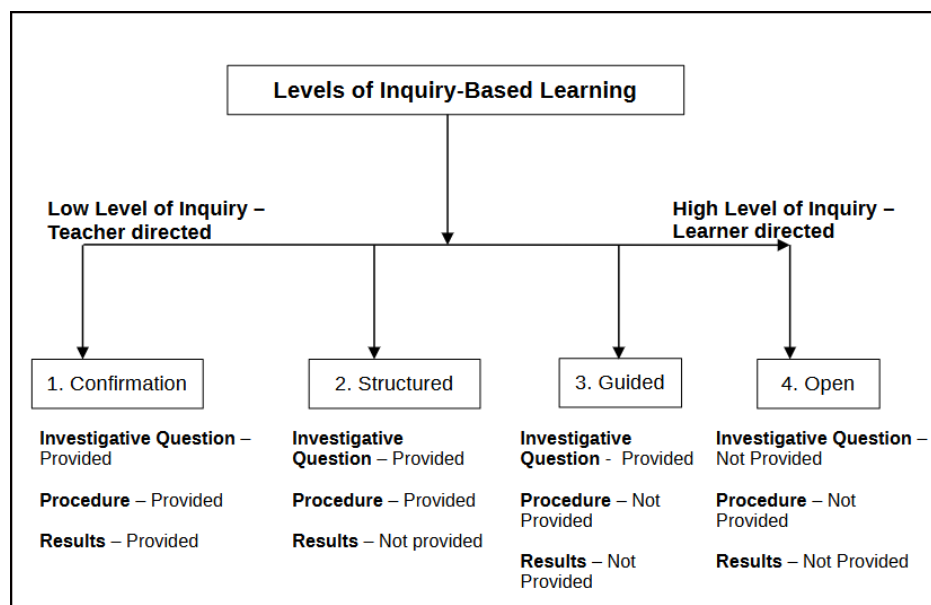
### 3. Conceptual Framework

A conceptual framework was developed to support the conduct of this study. The conceptual framework was rooted in the levels of inquiry-based learning and the pedagogical framework for inquiry-based learning for science education (Toma, 2022; Furtak et al., 2012; Van Uum et al., 2016). There is no general agreement among researchers on what inquiry-based science learning entails; consequently, the term is multifaceted (Constantinou et al., 2018; García-Carmona, 2020). Researchers concur that science should not be taught as the transmission of unchanging facts, but rather as an inquiry where scientific concepts, hypotheses, facts, and laws are continuously interrogated and are thus subject to change based on evidence (Riga et al., 2017).

Inquiry-based science education is any science curriculum incorporating inquiry activities that reflect how scientists work (Bevins & Price, 2016). The multifaceted nature of inquiry is partly due to the amount of learner control while engaged in inquiry. Inquiry activities in science education are classified as ranging from confirmation to open inquiry, with structured and guided inquiry in between (Toma, 2022; Bevins & Price, 2016). Confirmation inquiry is regarded as the lowest form, and open inquiry as the highest.

Confirmation inquiry is a form of inquiry in which learners are explicitly asked to verify a scientific principle (Figure 1). The results of the inquiry activity are known in advance, and learners are provided with instructions to follow to confirm the principle (Toma, 2022). In a structured inquiry, learners are provided with the investigative question, the procedure and materials to carry out the investigation, but they collect results which they will analyse to conclude that they may not have been aware of, but which in most cases are already known to the teacher.

In a guided inquiry, the teacher provides the investigative question, and learners are required to design an experiment, including aspects such as controlling variables and determining the measurements to be taken and how they will be measured. They also collect results and analyse them to conclude that they did not know in advance (Toma, 2022). An open inquiry involves the teacher providing only the topic, such as rates of reactions. Learners are asked to investigate the factors that can affect the rate of response (Jere & Mpetta, 2024). Learners would need to design the investigation, decide on the type of data to be collected, and determine how to control for extenuating variables. They also analyse the data to arrive at a conclusion that confirms or refutes their hypothesis (Figure 1).



**Figure 1: Levels of Inquiry-Based Learning in Secondary Schools**

According to the pedagogical framework for inquiry-based science education (Van Uum et al., 2016), teachers must guide learners during the various phases of inquiry activities to ensure that critical domains of scientific knowledge are addressed. These authors argue that teachers must address the procedural, epistemic, social and conceptual domains of scientific knowledge during various phases of inquiry activities. While they presented inquiry as proceeding in seven steps, it must be acknowledged that researchers have advanced multiple numbers of phases in inquiry activities. One of the most famous models is the 5E inquiry model, which consists of five phases: engage, explore, explain, elaborate, and evaluate (Bybee et al., 2006). Teachers must ensure that various domains of scientific knowledge are addressed throughout the phases of inquiry activities to facilitate meaningful learning. The following section presents the methodology of the study.

## 4. Methodology

This section describes the methodology adopted for the study, beginning with the research design, followed by the sampling and data collection and analysis methods employed.

### 4.1 Research Design

A single-case study research design (Ridder, 2017) was employed to investigate the inquiry-based learning experiences of university final-year students specialising in physical sciences education. This design was suitable for this study as it enabled us to answer the “*how*” and “*why*” questions (Schoch, 2020) related to the case study, which involved the implementation of the inquiry-based learning approach by prospective teachers, and to compare this with the expected theoretical approaches. The interpretivist paradigm was used to generate theory from the experiences of the prospective physical sciences teachers (Ridder, 2017).

## 4.2 Sampling and Data Collection

Purposive sampling was used to select six participants from a cohort of 30 students. Most of the participants were under 30 years old, and both genders were well represented, as shown in Table 1. All participants were in their final year of the Bachelor of Education (Honours) degree. The degree prepares prospective teachers to teach physical sciences in the Further Education and Training phase, grades 10 to 12, in South Africa. The prospective teachers did not have prior teaching experience involving an inquiry learning approach. Still, they had taken a module on the methodology of physical sciences to prepare them for implementing this approach in their work-integrated learning.

**Table 1: Sample Characteristics**

Participant	Gender	Age
1	Male	27
2	Female	28
3	Female	27
4	Male	31
5	Male	26
6	Female	26

As the case study employed qualitative research, the sample size was small, and consideration was given to selecting participants who were knowledgeable about the case under study (Schoch, 2020). In this case study, those students who had previously demonstrated understanding of inquiry-based learning were selected. Informed consent was obtained from the participants, and the institutional ethics committee granted permission to conduct the study.

Data collection was conducted by document analysis and semi-structured interviews (Ridder, 2017; Schoch, 2020). The participants were required to keep diaries in the form of portfolios during the work-integrated teaching practice and to keep files of their lesson plans. The document analysis of these portfolios and lesson plans was used in the data analysis. Triangulation of the data (Ridder, 2017) was achieved by the semi-structured interviews and document analysis to gain an in-depth understanding of their experiences with the case. One of the researchers conducted telephonic interviews with each of the participants.

Each interview lasted for approximately one hour, and each participant was asked for permission to record the interview using an electronic device. The interviews were recorded after obtaining permission. Software was used to conduct a verbatim transcription of the interviews. After transcribing, each participant was provided with a copy of the transcript to confirm if the transcript contained their opinions. Participants agreed that the transcripts accurately represented their views. Data analysis commenced after the member-checking process was completed.

## 4.3 Data Analysis Procedures

The interview transcripts, lesson plans and portfolios were loaded into ATLAS.ti 8.0 and were analysed by following six steps – familiarising with data, coding, generating themes, reviewing themes, naming themes and producing the report

(Braun & Clarke, 2006; Kushnir, 2025). We used a recursive and iterative process in data analysis by constantly carrying out a comparative study across and within data sets rather than a linear progression as is customary in qualitative research (Braun & Clarke, 2006). The data analysis involved reading the transcripts several times to ensure familiarity with the data, followed by inductive and deductive coding (Saldaña, 2021). The initial codes were applied to data excerpts using ATLAS.TI's coding functions, such as *Code in Vivo* or *Open Coding*, and the codes were organised into code groups (Saldaña, 2021). Within ATLAS.ti, similar codes were used to create subthemes and themes. These themes were refined in the final phase of the data analysis. The following coding scheme provides examples that illustrate how the final themes were developed from the raw data.

**Table 2: Coding Scheme**

Raw Data (Quotations)	Initial Codes	Sub-theme	Overarching Theme
<i>"Okay, I understand it to be a type of learning where you allow learners to either do an experiment or observe an experiment ..."</i>	Inquiry-based learning as experiential learning	Active learning	Pre-service teachers' conceptualisation of inquiry-based learning
<i>"Okay, how I would plan for it is that I will have to look at the learning objectives."</i>	Inquiry-based learning should align with learning objectives	Objectives	Instructional design and strategies for inquiry-based learning
<i>"Learners will start by formulating the question, considering why they are doing the experiment and what they hope to achieve. Then, they will do the experiment, observe and analyse the data, and then, from there, come up with a conclusion based on their observation of the experiment's outcome."</i>	Strategy to enhance active learner participation	Science Process Skills	Inquiry-based learning is a learner-centred approach
<i>"Argumentation helps learners think critically and defend their ideas with evidence. This also helps them improve their reasoning."</i>	Benefits of scientific argumentation	Scientific reasoning, argumentation, critical thinking	Inquiry-based learning as a strategy for enhancing critical thinking and scientific argumentation
<i>"... my strategy or idea of using locally sourced materials, PhET simulations, and photocopying information worked perfectly, and it assisted me throughout."</i>	Challenges to inquiry learning and potential solutions	Potential solutions	Challenges to inquiry learning and potential solutions

#### 4.4 Ensuring Trustworthiness Through Triangulation

Strategies used to ensure the trustworthiness of the study include confirmability, credibility and dependability (Lemon & Hayes, 2020). Member checking was used to ensure confirmability and that the findings accurately reflected the lived experiences of the participants. An audit trail was maintained by keeping a detailed record of all data sources, including audio recordings of interviews, participants' lesson plans and portfolios, and data analysis memos.

This was instrumental in ensuring the dependability of the data analysis. Moreover, method triangulation, carried out by collecting data from multiple sources, including semi-structured interviews, students' portfolios, and lesson plans, further enhanced the credibility and dependability of the data analysis process (Lemon & Hayes, 2020). The study's findings are discussed under the themes that emerged from the analytical method in the following section.

### 5. Results and Discussion

Thematic analysis of the semi-structured interviews yielded five themes: participants' conceptualisation of inquiry-based learning; instructional design and strategies for inquiry-based learning; inquiry-based learning as a learner-centred teaching strategy; inquiry-based learning as a strategy for enhancing critical thinking and scientific argumentation; and challenges to inquiry learning and potential solutions.

#### 5.1 Pre-service teachers' Conceptualisation of Inquiry-based learning

The participants perceived inquiry-based learning as a form of experiential learning that involves learners conducting scientific investigations to either confirm what they learn in theory lessons or discover empirical knowledge regarding scientific phenomena. For example, participant 1 stated that:

*"Okay, I understand it to be a type of learning where you allow learners to either do an experiment or observe an experiment, then they can learn something new, or they can confirm what they have already learned through an experiment."*

Participant 2 described inquiry-based learning as:

*"a kind of student-centred approach where learners are active, meaning most of the work there is done by the learners."*

Participant 2 further elaborated by stating the following:

*"It's learner-centred instruction; the learners will have to consult different books or the internet to search for information on how to carry out the investigation and then plan and carry out the investigation."*

The participants' conceptualisation of inquiry-based learning aligns closely with how this pedagogic approach to science teaching is understood in science education. For example, Pedaste et al. (2015) conceptualise inquiry-based learning as an approach that occurs in five phases and involves the following: the conceptualisation phase, which is divided into two sub-phases, questioning and hypothesis generation; the investigation phase, divided into three sub-phases,

exploration or experimentation leading to data interpretation; and the discussion phase, which is divided into two sub-phases, reflection and communication. In line with this conceptualisation of inquiry-based learning, Bogars (2019) defines it as a learning approach that enables learners to be active throughout the learning process by asking questions, analysing information, and inquiring. It, therefore, involves learners carrying out scientific investigations.

The existing science education literature reveals different forms of inquiry-based learning, depending on the degree of control learners have over the inquiry. These approaches range from confirmatory, structured, and guided to open inquiry, reflecting the increasing autonomy levels of learners (Bogars, 2019). The participants noted that confirmatory inquiry was the lowest form, requiring nothing more than the learners confirming what they already know. Participant 2 said:

*“During the confirmatory inquiry, ... learners might be given the materials and the procedure, but at the end, they already know the conclusion; they are just confirming it. ... they are given all the major things. They are given the research question, the investigative question, the method, and everything. All they need to do is to carry out the experiment and confirm.”*

According to the participants, this form of inquiry does not seem to achieve the aims of science education. They indicated that they prefer their learners to engage in structured or guided inquiry rather than a confirmatory one. Participant 3 stated that:

*“... guided inquiry is the best because learners are given the problem, and they can explore while getting support, especially in areas where they might be doing experiments.”*

The participants were inclined towards structured and guided inquiry as indicated by their responses. They did not favour a confirmatory or open inquiry. The pedagogical framework for inquiry-based science education requires learners to obtain guidance in procedural, epistemic, social and conceptual domains of scientific inquiry knowledge. This guidance is needed for all forms of inquiry, from confirmation to open inquiry. The preservice teachers place more emphasis on learner guidance in inquiry-based learning, aligning with this theoretical framework.

## **5.2 Instructional design and strategies for inquiry-based learning**

In designing inquiry-based learning, the pre-service teachers believed inquiry must be based on the learning objectives. This suggests that, according to these participants, guidance must be offered to learners for effective learning to occur. In the semi-structured interviews, the participants stated that:

*“I think I would start by setting clear goals for the lesson and preparing activities that allow learners to explore. Because, as I said, inquiry-based learning is when learners explore questions, so we create guiding questions to help learners stay focused.”* Participant 3.

*“Okay, how I would plan for it is that I will have to look at the learning objectives. If it requires that learners can explain in detail a specific phenomenon in physics, then that is when I can be able to use it. Then, I can design an experiment for learners to do themselves,”* Participant 1.

Document analysis of the students' portfolios indicated that they tried to learn by implementing an inquiry-based learning approach in their lessons. For example, Participant 2 stated in the portfolio that to teach Grade 10 *Mechanical Energy Transformation*, the lesson started by posing the question:

*“Have you ever wondered how a roller coaster operates? How does it accelerate or decelerate during the ride?”* Extract from Participant 2's portfolio.

As the teacher used a guided-inquiry approach, the learners were provided with materials that included ramps to form an incline, allowing the ball to roll down, balls, a stopwatch, a measuring tape, a calculator, and chart paper. They were then asked to design an experiment to investigate the conversion of potential energy to kinetic energy and measure and record their results. The teacher stated that the learners carried out their experiments in groups, with each member assigned a specific role within the group. They presented their findings to the class. The teacher used their findings to summarise the lesson.

While science education literature suggests that more benefits are derived from open inquiry, where learners pose their questions, design their experiments, collect evidence and empirical data, analyse and interpret the data, and based on the empirical evidence, draw their conclusions, the participants in this study believed that their learners would benefit more from guided inquiry than open inquiry (Pedaste et al., 2015). According to the theoretical framework, this implies that prospective teachers are more inclined towards implementing the middle levels of inquiry, specifically structured and guided inquiry.

### **5.3 Inquiry-Based Learning as a Learner-Centred Approach**

The participants regard inquiry-based learning as an approach to teaching that fosters learner-centred principles. According to the participants, inquiry enables learners to engage in activities such as setting up investigative questions, designing experiments, conducting the investigation, interpreting data, and drawing conclusions. Inquiry also helps learners develop their communication skills. These activities mean that learners are given autonomy to decide the best approaches to carry out the investigation, and based on the empirical data collected, they interpret it, implying that they do not depend on rote learning by direct transmission from the teacher. The participants stated the following:

*“Learners will start by formulating the question, considering why they are doing the experiment and what they hope to achieve. Then, they will do the experiment, observe and analyse the data, and then, from there, come up with a conclusion based on their observation of the experiment's outcome,”* Participant 1.

*"I would encourage learners to share their findings through a short presentation. When they present, they can communicate their findings by text or posters. So, I would help them explain their process and practice speaking clearly. So, I would encourage learners to share their findings through presentations, which is good for them to present, so learners can communicate their findings effectively," Participant 3.*

*"Okay, I think in guided inquiry, learners are just provided with the general question. The role of the teacher there is only guiding them to conduct that experiment, so I think in guided inquiry, the learner they are doing everything on their own. Okay, so in other words, they will plan how to do the experiment, they will have to come up with the procedures themselves, how to collect the data, and how to analyse it," Participant 2.*

The experiences of the prospective teachers suggest that they are inclined towards addressing the procedural and conceptual domains in the pedagogical framework for inquiry-based science education. The learner-centred instructional approach achieves this. The finding that inquiry activities in learning science foster learner-centred principles with numerous benefits to learners is supported by extant literature. For example, Dobber et al (2017) argue that inquiry-based learning focuses on thinking skills and promotes an understanding of the nature of science. Furthermore, Dobber et al. (2017) claim that inquiry improves self-regulation as learners search for information on the research topic, enhancing conceptual understanding.

#### **5.4 Inquiry-based learning as a strategy for enhancing critical thinking and scientific argumentation**

The participants regarded inquiry-based learning, mainly guided inquiry, as a strategy for enhancing critical thinking and scientific argumentation. For example, Participant 2 stated that.

*"The one that I consider more effective is the guided inquiry approach because this type of approach helps the learner in many ways, like how to think critically. ... when I am talking about the guided inquiry, the teacher guides them. So, they might choose a different process. This helps them think critically and make decisions, such as which material to use."*

This perception was supported by Participant 3, who said:

*"Argumentation helps learners think critically and defend their ideas with evidence. This also helps them improve their reasoning. When I share my view about what I have, and someone comes up with something different from what I am talking about, I have to provide evidence of what I am talking about, and the other person comes up with their own evidence. Then, it also helps one's reasoning. It helps their reasoning. It also helps communication skills because when learners argue, it is based on the collected evidence."*

This perception of guided inquiry learning aligns closely with science education literature. For example, in an empirical study, Duran and Dökme (2016) found that science learning supported by guided inquiry activities significantly affects

students' critical thinking skills in science courses. Inquiry-based learning, including guided inquiry, prioritises vital thinking, problem-solving, decision-making, and asking questions, thus allowing learners to develop the skills they need throughout their lives (Bogars, 2019).

In line with this, Wale and Bishaw (2020) empirically found that inquiry-based argumentative writing instruction enhances learners' critical thinking skills. They claim that argumentation is achieved by enhancing learners' interpretation, analysis, evaluation, inference, explanation, and self-regulation, which are considered core critical thinking skills.

### 5.5 Challenges to inquiry learning and potential solutions

The study revealed that although the pre-service teachers value engaging their learners in inquiry activities, they encounter challenges such as a lack of materials to conduct meaningful inquiry and learners' perception of science as a theoretical learning area where the teacher should transmit knowledge. A document analysis of Participant 1's portfolio summarised the challenges that preservice teachers encountered in implementing an inquiry-based approach in teaching. The participant said:

*"The first challenge I faced was of lack of resources; my school did not have a laboratory, enough textbooks and a library,"* Participant 1.

The participant employed various strategies to overcome the challenge of limited resources. The strategy included the use of locally available materials to substitute for standard laboratory apparatus and chemicals, as well as the use of computer simulations. In this regard, the participant stated the following in the portfolio:

*"... my strategy or idea of using locally sourced materials, PhET simulations, and photocopying information worked perfectly, and it assisted me throughout. This challenge taught me to be resourceful and make use of what I have at my disposal,"* Participant 1.

The lack of motivation for inquiry among learners is a result of teachers, including mentors, using traditional teaching approaches. When the pre-service teachers attempt to use the inquiry teaching approach, the learners regard this method as a new approach to learning. Regarding these challenges, the participants stated the following:

*"The challenge that I faced is that the learners ... are not really into having to ask questions. They are not really into that. Even though, as a teacher, you can ask a question in class, they will just keep quiet, and there won't be anything that they will say. So, it becomes a challenge because inquiry-based learning is when learners actively explore questions and problems,"* Participant 3.

*"The challenges, besides the shortage of the equipment that you need to use, the other challenge you face is the willingness of learners to take part*

*in the experiments. I think learners are still viewing physical science as a theoretical subject, not a practical one," Participant 1.*

*"The first challenge was the issue of the resources. As I said in the beginning that it has to be some type of inquiry-based learning. It has to be the teacher who comes up with the resources and decides what kind of resources the learner must use. I was facing the challenges there because the schools where I was doing the practicals didn't have most of the equipment," Participant 1.*

Addressing the challenges teachers encounter in implementing inquiry-based learning requires deliberate efforts to increase the availability of resources that support this approach to science teaching. The findings of this study align with previous studies, which show that teachers encounter barriers to implementing inquiry-based learning due to a lack of sufficient time, resources and skills gaps in the teachers' understanding of inquiry (Fitzgerald et al., 2019; Nicol, 2021; Talafian et al., 2025).

Therefore, there is a need for continuous professional development and support for teachers (Sam, 2024). Aligning assessment practices with inquiry-based teaching would also go some way in ensuring that learners are motivated (Sam, 2024). If the assessment is not aligned with the teaching approach, but is tilted towards rote memorisation, learners may not see the need for engaging in inquiry activities.

The significant finding of this study was that prospective physical sciences teachers preferred structured and guided inquiry. They lacked the motivation, skills and capabilities to implement open inquiry. These findings are supported by previous research, which found that in South Africa, secondary school teachers tend to focus on lower levels of investigation, and open inquiry is often not given priority (Akuma & Callaghan, 2019; Tsakeni et al., 2019).

The study found that learners were less motivated and lacked readiness to participate in inquiry-based learning. This finding contradicts Gholam's (2019) results, which showed that learner readiness does not negatively affect the participation of learners in inquiry-based learning. It is, therefore, essential for university teacher educators to design learning programs that place a greater emphasis on ensuring that prospective physical sciences teachers can effectively implement open inquiry activities.

## **6. Implications and Recommendations**

The finding that prospective physical sciences teachers are more inclined towards the lower levels of inquiry-based learning implies the need for curricular, professional development and institutional policy changes in the initial teacher preparatory phase. Policy makers should consider increasing the duration of work-integrated learning from one school term to a full academic year, providing sufficient time for prospective teachers to establish rapport with learners and deepen their confidence in implementing inquiry-based learning. University teachers should support both the prospective teachers and their mentors during

the work-integrated learning process through meetings and workshops. Curricular changes to methodology courses, such as the introduction of an inquiry-based learning methodology module, can deepen the student teachers' understanding of this approach to physical science teaching and learning.

## 7. Conclusion

The study revealed that while prospective physical sciences teachers understood inquiry-based learning, which they strived to implement in their lessons, they vastly preferred structured and guided inquiry. They did not believe that a confirmatory investigation would benefit the learners. They also did not think their learners had the skills to participate in open investigations. Previous research has indicated a lack of skills among practising teachers in implementing open inquiry in South African schools.

The study revealed that while the prospective physical sciences teachers attempted to implement what they had learnt in their methodology courses, they struggled with some challenges. They cited several challenges that make it difficult to implement inquiry activities, such as a lack of resources and learners' negative attitudes towards inquiry. We have suggested some policy changes that may address these challenges. The study had several limitations that should be taken into consideration. As this was a case study, generalisation of the findings should be made cautiously. Similar findings can be made in similar contexts, such as areas with limited resources. Future research should employ mixed methods to address some of the limitations of this study.

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