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In-Depth Analysis of Contributing Factors Impacting Grade 12 Learners' Performance in Life Sciences "Investigation Questions": A South African Case Study

Sakyiwaa Boateng* **and Bongeka Maliwa**
Walter Sisulu University
Mthatha, South Africa

Abstract. This study sought to explore contributing factors affecting grade 12 learners' performance in Life Sciences "investigation questions" in rural high schools in the Oliver Reginald Tambo Inland District of South Africa. The study was underpinned by the social constructivism theory. A qualitative case study design was employed to collect the data. Purposeful sampling was used to select three schools from one circuit. Three Life Sciences teachers and nine learners were purposefully selected to participate in the study. The interview was the main instrument used to collect data. The data were analysed using thematic analysis to generate themes. The main findings of the study indicated: teachers' low pedagogical content knowledge on practical investigation questions; a lack of teaching resources; a lack of parental support; and language proficiency influence on learner understanding. Thus, it is recommended that the Department of Basic Education provide all rural schools with well-furnished laboratories to enable the teachers to conduct practical investigation activities. Furthermore, teachers need to be trained regularly to enhance their content knowledge and equip them with the different pedagogies in teaching Life Science investigations.

Keywords: Life Sciences; learners; learner performance; scientific investigation; teachers

1. Introduction

Education is a fundamental aspect of societal progress, and the academic achievement of students is a vital measure of the efficiency of educational institutions. Science education fosters scientific literacy in the present and future generations (Maharma & Abusa'aleek, 2022). Life Sciences advance students' scientific comprehension and develop critical thinking abilities (Naidoo, 2017). Given the significant increase in scientific applications, it is expected that there

* Corresponding author: Sakyiwaa Boateng, sboateng@wsu.ac.za

would be a matching interest in science in the classroom, as well as a greater understanding of fundamental scientific concepts and reasoning (Naidoo, 2017). However, evidence suggests that this is not the case (Jamil et al., 2018; Netshivhumbe & Mudau, 2021). South Africa's progress and economic growth are jeopardised by the students' subpar performance in sciences and an insufficient number of students enrolling in science faculties at higher education institutions (Moshoeshoe, 2023; Muzah, 2011). This issue is particularly pronounced in rural schools, where unique challenges have a substantial impact on students' academic achievements (Mji & Makgato, 2006). This observation required an investigation into the reasons behind the low academic achievement of learners in Life Sciences, particularly concerning "investigation questions". This will enable appropriate measures to be taken to improve the teaching and learning of Life Sciences, thereby contributing to the ongoing discourse on educational equality and quality.

Globally, the Next Generation Science Standards of the United States require students to exhibit understanding by creating models, conducting investigations, constructing explanations, analysing, and interpreting data sets, presenting evidence, and using argumentation to support their findings (Jorgenson et al., 2014). Therefore, scientific inquiry is comparable to a perspective of scientific proficiency that includes abilities and understanding associated with scientific and engineering methodologies (Lederman et al., 2014). In New Zealand, students' capacity to conduct a science study under guidance was evaluated to earn credits and grades towards the National Certificate in Educational Achievement (NCEA). Hume and Coll (2008) argue that 11th grade students developed a limited understanding of scientific research, specifically with fair testing. They observed that, while learning was occurring, students' remarks suggested that they relied on memorisation and engaged in superficial thinking throughout their investigative tasks. This finding was ascribed to the limited curriculum encountered by students as a result of schools' scientific teaching programmes that were affected by the demands of the national assessment policy.

In the African context, a study by Ayeni (2021) shows that the teaching of science investigation is hindered by a shortage of science resources and equipment, which are necessary for the successful facilitation of science teaching and learning. A study conducted in the Igbo Etiti local government area of Nigeria by Akindele et al. (2022) reveals that the inadequate teaching of science in high schools can be attributed to several factors, including the absence of laboratories, insufficient instructional materials, and incompetent teachers. These factors have hindered learners' ability to conduct investigative activities, resulting in poor performance in Life Sciences (Akindele et al., 2022). In the South African context, learner performance in Life Sciences, particularly in rural areas, has experienced a notable drop. The South African Department of Basic Education (DBE) diagnostic report for 2022 revealed that learners' performances in Life Sciences Investigation Questions in paper 1 and paper 2 were 37% and 44% respectively. Numerous studies (Dhurumraj & Broadhurst, 2023; Maduna, 2022) provide empirical evidence of low learner performance in rural schools and attribute it to the high prevalence of untrained Life Science teachers and high learner-to-teacher ratios. Furthermore, teachers' inadequate understanding of scientific inquiry (Anderson,

2002) results in learners acquiring a limited grasp of scientific reasoning and practice due to pedagogical methods that prioritise learners' engagement rather than their comprehension of scientific concepts (Windschitl et al., 2008). Maciver et al. (2002) argue that the influence of research and policy on teaching investigation in schools has been minimal due to the formation of entrenched views about science investigation among secondary education learners.

The DBE's Curriculum and Assessment Policy Statement (CAPS) emphasises the need to involve learners in scientific research and apply their knowledge to new situations (DBE, 2011). Science investigation is suggested globally as it helps learners comprehend the nature of science and enhances the authenticity of scientific education by emphasising the importance of empirical evidence (Baskerville & Anderson, 2023). Berg et al. (2003) argue that engaging in science exploration equips students with the necessary skills and knowledge to actively participate in science in the future. This is considered beneficial in both secondary and tertiary levels of science education.

A convergence of these studies has shown that a lack of resources, language proficiency fears, inadequate teacher professional competence when conducting science investigations and limited opportunities for meaningful engagement were some of the factors that contributed to learners' poor performances in Life Sciences investigation questions (Dhurumraj & Broadhurst, 2023; Ndayambaje et al., 2021; Teppo et al., 2021). However, there is little empirical study that focuses on teachers' investigative abilities (Davis et al., 2006). Little is known about factors contributing to learners' performances in Life Science investigation questions from the viewpoint of both learners and teachers. Given this background, this study explored factors that affect the performance of grade 12 learners in Life Science "investigation questions" in rural schools.

The following research questions guided the study:

1. What are the factors affecting grade 12 learners' performances in Life Science "investigation questions" in rural schools?
2. How does the poor performance of grade 12 learners in Life Sciences in rural schools influence their overall academic outcomes and future educational opportunities?
3. What are the best ways for learners to get the help they need to succeed in Life Sciences investigation questions?

2. Review of related literature

2.1 Science investigation in South Africa's curriculum

Scientific investigation encompasses the many methods employed by scientists to examine the natural world and formulate interpretations grounded in the data obtained from their research (Small, 2023). This concept was established based on comprehending the methodology of scientific progress and is not influenced by educational procedures. South Africa's Curriculum and Assessment Policy Statements (CAPS) in Specific Aim 2 states, "Investigating phenomena in Life Sciences." Thus, learners are expected to "confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem-solving, critical thinking and other skills" (DBE, 2011, p. 23). Thus, Life Sciences teachers are expected to assess investigative skills once per term, accounting for 15% of the promotion marks in grades 10 and 11 (DBE, 2011). In South African schools, scientific investigative activities are conducted through project works (such as testing for the salinity of water) and practical exercises (measuring the amount of air that enters and leaves the lungs using a spirometer). The emphasis is on acquiring scientific knowledge through hands-on experimentation and project-based learning. The CAPS curriculum incorporates an investigative process that consists of four distinct phases: design and planning, performance, reflection and recording and reporting (DBE, 2011). These steps occur simultaneously rather than in a sequential manner. For instance, when scientists are planning their inquiry, they are already assessing the methodologies they will employ (Tait et al., 2021).

In the context of classroom science, investigation is distinct from other forms of practical work due to the limited guidance provided to students on data gathering, processing, and analysis, which are necessary for problem-solving. A student examines the given situation and uses his/her prior contextual and procedural knowledge to formulate a hypothesis. Then the student devises and executes the inquiry, assesses the procedure, and implements any required modifications. Alameh et al. (2022) argue that doing a comprehensive inquiry of this sort empowers students to engage in scientific practices, grasp scientific concepts, and comprehend the essence of science. According to Abrahams and Millar (2008), students must possess both substantive knowledge of science ideas and an awareness of science methods to effectively conduct a scientific inquiry. Utilising simulation models in a virtual laboratory enhances student comprehension of the idea, hence improving the organisation of the educational process (Ashrab o'g'li, 2023). Additionally, students should be given opportunities to showcase their expertise through scientific inquiry. It is recommended to incorporate regular discussion questions or checkpoints to reinforce and motivate group members to interact with one another (Aikens & Kulacki, 2023).

2.2 Teacher knowledge and understanding of science investigation

The proficiency and comprehension of scientific inquiry by teachers are crucial in influencing the educational experiences and achievements of learners. Teachers serve as facilitators, guiding students as they engage in the process of scientific inquiry and exploration. The chief marker for the National Senior Certificate examination (NSC) (DBE, 2020) reported that a significant number of learners performed poorly in science investigation questions. An underlying factor contributing to this subpar performance was the inadequate training of teachers in science investigations (Jiang et al., 2023). As argued by the National Research Council (2000), and Mupa and Chinooneka (2019), teachers must possess a solid knowledge of the science investigation process to effectively employ an investigative approach as a teaching technique. The scientific investigation, as a teaching approach, involves fostering critical thinking, inquiry, and discovery among students. This approach emphasises questioning, investigation, reasoning, and attempting to present findings (Hijar et al., 2020; In'am & Hajar, 2017; Pohan et al., 2020) across various science disciplines. It promotes students' active construction of knowledge through the process of producing, testing, and evaluating scientific assertions and ideas (Hijar et al., 2020). Teachers elicit inquiries and reactions from students by employing the scientific method to evaluate their comprehension and foster active participation in the educational process (Gunawan, 2019).

Research by Zaim (2017) demonstrates that employing the scientific approach, as opposed to traditional teaching methods, may enhance students' capacity to generate mathematical problems. According to Celik (2023), teachers' understanding of science investigation is crucial for their instruction of it. Enhanced confidence in pedagogical content knowledge regarding practical work enables teachers to expand their repertoire of effective strategies employed in their teaching practices, thereby raising the likelihood of a positive impact on learners' academic performances (Ogbonnaya, 2019; Oliveira & Bonito, 2023). Therefore, due to the inability of teachers to carry out science investigations (Smith & Wilson, 2019), learners are unable to grasp science investigation questions and the reasoning required to respond to these questions in examinations. A synthesis of the literature has indicated that most teachers prioritise student engagement rather than fostering a deep understanding of scientific concepts (Brown & Jones, 2018; Smith & Wilson, 2019). Consequently, according to Sisson (2023), some of these students eventually become teachers themselves and perpetuate simplified and questionable interpretations of the investigative process to the next generation.

Nevertheless, according to Sancar et al. (2021), student success is directly impacted by teachers' pedagogical content knowledge on the topic. Research conducted by Huang and Lajoie (2021) suggests that teachers who possess a greater depth of content knowledge are more likely to facilitate better levels of academic achievement among their students. Still, many teachers fail to include practical-based teaching or inquiry activities in problem-based learning, as well as cooperative strategies, due to their reluctance to step outside of their comfort zones. In addition, many Life Sciences teachers lack a thorough comprehension of the fundamental principles of scientific inquiry (Maeng et al., 2020). Teachers may also refrain from utilising problem-based learning due to their lack of confidence or discomfort in facilitating hands-on practical sessions with students (Maeng et al., 2020).

2.3 Issues with the implementation of science investigation approaches in Life Science teaching

Danso (2020) indicates that the transmission mode of teaching is ineffective for imparting scientific procedures and skills. Instead, hands-on practical and self-discovery approaches are recognised as more appropriate for teaching science (Amrulloh & Galushasti, 2022; Bay et al., 1992). According to Kurdi et al. (2022), teachers tend to eschew problem-based learning and cooperative learning methods because of factors such as a crowded curriculum, time limitations, and institutional pressures. Inadequate resources, learners' attitudes, the language of instruction, a lack of parental support and substandard facilities, particularly in rural schools, are key factors that contribute to students' underperformance in Life Sciences investigation questions (Akinbadewa & Sofowora, 2020; Ndayambaje et al., 2021; Ntekane, 2018; Sutherland et al., 2019). Du Plessis and Mestry (2019) argue that South African schools still face the problem of unequal allocation of resources across provinces, as well as between rural and urban regions. Rural high school students studying Life Sciences lack practical experience, which hinders their ability to answer science investigation questions and understand the content of investigations. If Life Sciences teachers do not conduct practical work, they will be unable to effectively teach science investigations. This can lead to a negative attitude towards science investigation questions and ultimately result in a high failure rate in the subject.

3. Theoretical framework

The theoretical basis of this study was the social constructivist theory of learning proposed by Vygotsky in 1968. Vygotsky posited that the continuous process of growth is contingent upon social contact and that cognitive development is facilitated by social learning. Put simply, learners of any skill level may complete all learning activities with the help of adult guidance or by working together with their peers. This approach provides opportunities for learners to work together with their teachers and classmates in building knowledge and understanding. Kapur (2018) notes that the social creation of knowledge occurs through many means and in varied settings. It can be accomplished by collaborative discourse, collective effort, or any pedagogical engagement inside an educational and training establishment. Constructivist pedagogy necessitates a dynamic exchange between the teachers and the learners, activating pre-existing knowledge, inquiry, and contemplation (Holley & Park, 2020). Constructivism allows learners to actively create knowledge by engaging in experiences, observations, recording, analysis, and reflection, rather than passively acquiring information (MacLeod et al., 2022). Hence, this study employed the social constructivism theory as a framework to examine how learners construct meaning through their interactions with teachers during practical inquiry activities.

4. Methods

4.1 Research approach

This study employed a qualitative approach. This methodology was appropriate for this investigation as it enabled the researchers to get a more profound comprehension of the elements that lead to learners' underperformance in Life Science investigation questions from the viewpoints of the teachers and learners who encountered the phenomena. Hence, this study did not aim to rigorously analyse evidence using statistical methods but instead focused on interpreting the perspectives of the study's participants. In this study, a multiple case study design was chosen to enable the researchers to examine sub-units within a larger case study (Yin, 2018). This approach allowed for a more thorough and detailed investigation of the factors that contribute to underperformance in Life Sciences investigation questions among learners in rural high schools.

4.2 Participants of the study

In this study, the researchers employed purposeful sampling to select the participants. Three rural high schools were selected as research sites. The data were collected from three Life Sciences teachers from Schools A, B, and C, resulting in a total of three Life Sciences teachers and a total of nine Life Sciences learners from the three selected high schools. All three sample teachers from the three high schools taught Life Sciences in grade 12. They are all qualified to teach Life Sciences in FET phase as they all hold Bachelor's degrees in Natural Sciences Education. Two teachers majored in Life Sciences and Mathematics and one teacher majored in Life Sciences and Physical Sciences. One teacher had five years' experience in the field and the other two teachers had more than ten years' experience in teaching Life Sciences. All three teachers are South Africans and ranged between 27 and 45 years old. One teacher is a male and the other two are females. All three teachers were given pseudonyms.

Table 1: Demographic profile of Life Sciences Teachers

Teacher pseudonyms	Gender	Age	Qualifications	Teaching Experience	Subjects taught
Teacher A	Male	27	Bachelor of Education(Life Sciences majors)	5 years	Life Sciences
Teacher B	Female	30	Bachelor of Education (Life Sciences majors)	8 years	Life Sciences
Teacher C	Female	47	Bachelor of Education (Life Sciences majors)	10 years	Life Sciences/ Physical Sciences

Table 2: Demographic Profile of Life Sciences Learners

Criteria	Learners	Frequency
Gender	Males	5
	Females	4
Age	17	1
	18	6
	19	2
Grade	12	9
Pseudonyms	LSCL1, LSCL2, LSCL3, LSCL4, LSCL5, LSCL6, LSCL7, LSCL8, and LSCL9	

The nine sampled learners registered for Life Sciences as a subject in grade 12. Five learners are males and four are females. The learners are all South Africans, and their ages ranged between 17 and 19 years. All nine learners were given pseudonyms such as LSCL1, LSCL2, LSCL3, LSCL4, LSCL5, LSCL6, LSCL7, LSCL8, and LSCL9.

4.3 Data collection

Data were collected through semi-structured interviews. Belina (2023) asserts that careful and theorised preparation is necessary for conducting semi-structured interviews. The researchers utilised one-on-one, semi-structured interviews to facilitate more comprehensive responses. The researchers developed the interview protocol for the study. The interview protocol had two sections. Section A required respondents to provide their background information. Section B consisted of 10 predetermined questions designed to elicit comments about the perspectives of teachers and learners on the elements that influence performance in Life Sciences (investigation questions). Data collection began in the second term of the academic year in 2023 after obtaining ethical approval from the appropriate institutions (protocol number FEDSREC2005-05-23). The data were collected face-to-face. One researcher formally sought permission to carry out the study. Before conducting the interviews, the researcher also developed a positive and harmonious relationship with the schoolteachers and the learners. The interviews began with the teachers and were followed by the learners in each school. Every interview had a duration of 45 minutes.

The researchers in this study ensured the trustworthiness of the findings by including member checking (López-Zerón et al., 2021). We shared our initial findings, interpretations, or summaries of the data with the participants who were part of the study. They were asked to review the information and verify whether the interpretations and representations aligned with their own experiences. Despite its drawbacks, Lincoln and Guba (1985) regard member checking as the most crucial method for establishing credibility. In this study, the researchers enhanced the transferability by providing a detailed description of the research techniques, settings, and underlying assumptions (Seale, 1999). The researchers elucidated the fundamental assumptions and theoretical framework of the study and provided a comprehensive account of the data collection process through the establishment of an audit trail.

4.4 Data analysis

The researchers utilised thematic data analysis to examine the data (Braun & Clarke, 2006). This facilitated the identification and extension of emergent themes from the data. The researchers began the data analysis procedure by fully engaging with the data and thoroughly examining the transcripts. Subsequently, the researchers accurately analysed the data, rearranging them by highlighting the text using different colours to produce codes. The researchers revisited the transcripts to ascertain whether there were any noteworthy phrases and terms that had been inadvertently disregarded and accurately reviewed these codes and phrases until they could successfully classify them. Uncategorised words and phrases were omitted until they could be associated with other words and phrases to create a category.

The themes and sub-themes identified from the data were thoroughly reviewed and, indeed, they yielded the exact information that the researchers required. By merging the data obtained from both teachers and learners, the researcher facilitated an inductive analysis and the identification of underlying themes using a constructivist analytical framework, as demonstrated in this study.

The limitations of this study were delays, time constraints, financial considerations, and the desire of teachers to participate. The researchers made a concession and terminated some sessions due to an unfavourable time frame for data collection that did not benefit either the researchers or the participants.

5. Results

Based on the gathered data, Table 3 shows the generated themes and sub-themes which are used to present and discuss the results of the study.

Table 3: Generated themes and sub-themes

Research questions	Generated themes	Generated sub-themes
1. What are the factors affecting grade 12 learners' performance in Life Science "investigation questions" in rural schools?	Theme 1: Factors contributing to poor performance in Life Sciences investigation questions	Lack of teaching-learning resources. Language proficiency influences on learner understanding. Role play by teachers in teaching investigation questions. Lack of pedagogical content knowledge. Lack of support from parents.
2. How does the poor performance of grade 12 learners in Life Sciences in rural schools influence their overall academic outcomes and future educational opportunities?	Theme 2: Effects of poor performance of Life Sciences investigation questions on learners learning	Lack of science knowledge and skills. Development of negative attitudes on learners and teachers.
3. What are the best ways for learners to get the help they need to succeed in Life Sciences practical investigations question?	Theme 3: Ways for learners to get the help they need to succeed in Life Sciences practical investigations	Assistance from the Department of Education. Mandatory practical activities by the teacher. Involvement in group work, practical activities and peer tutoring. Engagement in science competitions in the community.

Theme 1: Factors contributing to poor performance in Life Sciences investigation questions

Sub-theme 1: Lack of teaching-learning resources

When the participants were asked about factors contributing to poor performance in Life Sciences investigation questions, the results indicated: a lack of laboratories in their various schools; a lack of textbooks; no access to a school library; and non-exposure of learners to investigation activities by teachers. Most learners highlighted that they were not exposed to practical activities due to the lack of well-equipped laboratories and this led to their poor understanding of the science concepts. One of the learners narrated:

> *"Ah … well, my poor performance in Life Sciences and, in particular, in investigation questions, is caused by lack of exposure to practical activities and investigation work, since my school does not have a laboratory to do practical investigations"* (LSCL2).

This finding was confirmed by the responses from the teachers. Most of the teachers were of the view that they were not able to conduct practical activities because of a lack of a laboratory in their schools. One teacher shared the following sentiment:

> *"No functional laboratories and libraries in our school. As a result, I am not able to conduct practical work with my students. Hence, they find it difficult to respond to investigation questions in their examinations"* (Teacher A).

Findings indicate that the absence of practical investigations in laboratories is detrimental to learners, as some of them learnt better through hands-on experience and practical activities.

Sub-theme 2: Language proficiency influence on learner understanding

When the participants were asked about factors contributing to poor performance in Life Science investigation questions, most learners complained that they did not understand the complex English used in Life Sciences textbooks and the information from the teacher during classroom instructions. Participants alluded that, since English is not a mother tongue to both the learners and their teachers, it makes the scientific concepts more complicated and difficult to understand. Some learners were not able to pronounce and understand some concepts in Life Sciences because they were in English. One learner shared the following sentiment:

> *"English language that is used in most Life Sciences textbooks is difficult to understand; its better with demonstration. Even, sometimes the class complain to the teacher to teach in our local language to enable us to understand the concepts, especially during investigation activities"* (LSCL5).

However, responses from the teachers indicated that learners failed to understand and respond to investigation questions because they did not understand the questions posed to them in the examination question paper, especially investigation questions. Therefore, English becomes barrier because they do not understand it. Two teachers shared their sentiments as follows:

> *"Learners find difficulties in understanding some terminologies in Life Sciences investigation questions if they are not interpreted in their mother tongue language"* (Teacher C).
>
> *"Some scientific terms used in the investigation questions are difficult to be understood by some learners; even spelling them is a challenge"* (Teacher C).

This finding indicates that English is a barrier for learners in rural areas to understand scientific knowledge and skills and if those skills are not acquired, their performance will remain poor for Life Sciences investigation questions.

Sub-theme 3: Role played by teachers in teaching investigation questions

Responses from all the learners indicated that their teachers assisted them "a lot" when doing and answering investigation questions. The respondents were of the view that their teachers usually read and analysed the Life Sciences investigation questions with them before they embarked on the task. The teachers assisted them by first demonstrating what was supposed to be done since they understood that the learners lacked scientific skills and provided them with the strategies to approach investigation questions. One learner noted:

> *"We usually do not carry out investigation activities. However, we are taught how to approach investigation questions in Life Sciences examination question papers. My teacher provides simple way of solving investigation questions instead of doing the investigation activities and developing a better understanding of the practical investigation activities"* (LSCL9).

This finding revealed that teachers do not actually demonstrate or give students the opportunity to get acquainted with practical hands-on activities to enable them to be exposed to practical investigation.

Sub-theme 4: A lack of pedagogical content knowledge

The responses provided by participants suggested that most teachers in the field of Life Sciences had not received adequate preparation in the Life Science curriculum regarding practical investigation. It became evident in the responses from the learners that some Life Sciences teachers had low content knowledge on practical and investigation activities. The results indicated that some Life Science teachers were poorly equipped to deliver the subject matter and failed to adequately clarify the material for their learners, particularly those who need more concrete examples, individual attention, and explanations. This finding was supported by the responses from the teachers. The results showed that, although some of the Life Science teachers are professionally qualified to teach Life Science, their training does not align with the new curriculum as they have low content knowledge in the subject. One Life Science teacher asserted:

> *"Honestly, I find myself struggling to answer investigation questions and conducting practical activities because I do not have much knowledge when it comes to practical activities. So, what I normally do is to explain the investigation tasks I receive from the subject advisors for the term to my learners before they do the task"* (Teacher B).

Based on these results, it is evident that knowledgeable teachers of Life Sciences play a crucial role in ensuring that learners benefit from effective pedagogical strategies available for teaching the subject.

Sub-theme 4: Lack of support from parents

Most respondents indicated that there was a lack of support from parents regarding learners' schoolwork, especially when doing Life Science research projects and science investigation activities. Both teachers and learners indicated that parents were unable to assist their children, as some are illiterate, and others have limited knowledge of the Life Sciences. Most learners did not get assistance from their parents because they did not live with them. One of the learners narrated:

> *"My parents are illiterate. There is nothing they can do to help me at home when I come back from school. The only thing my father does is to tell me to go and do my homework"* (LSCL 6).

Responses from the teachers indicated that their schools involved parents in meetings which are held each term where the importance of their children's financial and emotional support is explained to them. Two teachers narrated that:

> *"Parents get involved in meetings held per term where the importance of their financial and emotional support is readily explained to them"* (Teacher C).
>
> *"We involve parents by asking them to buy some of the resources that will be needed in that particular investigation. However, we always find ourselves not being able to organise such investigation activities because parents could not afford to contribute"* (Teacher A).

This finding demonstrated that parental involvement in their children's education is regarded as influential for teaching and learning, as well as for the academic performance of the learners.

Theme 2: Effects of poor performance of Life Sciences investigation questions on learners learning.

Sub-theme 1: Lack of science knowledge and skills
When the participants were asked about the effect of poor performance of Life Sciences investigation questions, the most common response was that learners were underperforming because they lacked scientific skills and did not understand scientific concepts. Some learners shared their sentiment as follows:

> *"Bad, because not being able to do practical and assuming that we did them whereas we did not. What I mean is, we do not actually conduct practical work, but we write practical tasks for continuous assessment"* (LSCL4).
>
> *"Low performance because I cannot understand scientific concepts"*(LSCL17).

This finding was evident in the teachers' responses that most learners were not doing well in Life Sciences investigation questions because they did not understand the science concepts and, as a result, they were unable to answer the science investigation questions. One teacher explained:

> *"These learners are not able to acquire enough scientific knowledge and understanding in science practical investigation questions because we, as teachers, are unable to make them practice and be hands-on on science concepts"* (Teacher C).

This finding indicated that learners developed low content knowledge in science investigation tasks and hence lacked scientific skills and were not able to analyse science investigation questions in examinations.

Sub-theme 2: Development of negative attitudes of learners and teachers
During the interviews, it emerged from both teachers' and learners' responses that attitude and motivation played a significant role in the performance of learners. According to the participants, some learners lacked motivation and had negative

attitudes towards Life Sciences practical investigation. Most learners performed poorly on practical investigations because they said that practical work was not interesting and they were not confident about science investigation skills. One student asserted:

> *"I have a negative attitude towards Life Sciences practical investigation because it is not interesting and we do not actually conduct practical investigation activities in the classroom because our teacher will make us answer practical investigation questions without actually doing the investigation"* (LSCL2).

One teacher agreed with LSCL2 and said:

> *"As a Life Science teacher, I also have a negative attitude towards practical investigation because I do not have laboratory and equipment to conduct practical investigation with my learners. Because of this, teaching learners Life Science is simply too much for them, which increases their hostility towards the teacher"*(Teacher B).

Theme 3: Ways to help learners succeed in Life Sciences practical investigations

Sub-theme 1: Assistance from the Department of Education

When the participants were asked about the kind of assistance they needed, they suggested that the Department of Education should provide schools in rural settings with well-equipped laboratories, computers, relevant textbooks, Life Sciences past question papers, Wi-Fi, a library and more work activities based on practical investigations. Some participants listed the resources they needed to acquire scientific concepts and skills:

> *"By helping us with laboratories"* (LSCL1).
>
> *"By providing enough learning equipment like textbooks, study guides, and past papers to assist learners on learning how to answer exam questions"* (LSCL3).
>
> *"Help our school with textbooks so that we don't share them. Help our school with Wi-Fi so that we don't depend on the information on the textbook"* (LSCL2).

Amongst the wish lists participants wrote, the most popular one was that they wished for assistance from the Department of Education for functional laboratories. Teachers also requested Life Sciences laboratory kits, study guides and other materials that would allow them to conduct practical investigations. Some of the teachers said:

> *"The department can assist schools with laboratories"* (Teacher B).
> *"To assist us with more microscopes and assist in upgrading our laboratory"* (Teacher C).
> *"Material for conducting practical investigation"* (Teacher A).

Both teachers and learners requested the Department of Education to provide functional laboratories to the schools and other resources that are needed for successful teaching and learning of science investigations.

Sub-theme 2: Mandatory practical activities by the teacher

The learners indicated that teachers should organise and conduct practical investigation activities with the learners and suggested that the Life Sciences teachers must elaborate and give detailed explanations before the start of practical work in IsiXhosa so that learners are able to understand. Below are some of the suggestions made by learners for their improvement in performance of science investigations questions:

> *"In fact, I want my Life Science teacher to conduct practical investigation as often as possible and explain the entire process and procedure to the class using both English and IsiXhosa when explaining so that we can all hear or understand nicely"*(LSCL3).
>
> *"Teachers must help learners to interpret and analyse diagrams of Life Sciences and also conduct practical investigation activities so that if we find such questions in examinations, we will be able to do it and pass our Life Science examinations with flying colours"* (LSCL1).

Some of the participants suggested that teachers must also use models to demonstrate what they need to do during science practical investigation activities.

Sub-theme 3: Involvement in group work, practical activities and peer tutoring

Participants suggested that debates and group discussions, class presentations and creation of songs with scientific lyrics could improve their understanding of the scientific concepts. Learners explained that each learner must be given a chance to do the practical work so that they can understand all these scientific skills and concepts. One learner commented:

> *"We can do our own practical investigation activities and work together on examining ourselves on task to do with investigation"* (LSCL1).

Most teachers explained that group discussions, debates, visits to other schools and Life Sciences quizzes on certain topics could improve the learner's scientific skills. Respondents also indicated that peer education was an important component of teaching and learning because learners got a second chance to understand what was taught in class by the teachers, but on a different platform.

Sub-theme 4: Engagement in science competitions in the community

Most learners suggested that the community can assist by providing what is needed for the successful teaching and learning of Life Sciences. Some of the participants listed the support they needed from the community as follows:

> *"By trying to communicate with DBE and try to improve the needs of the community to help us by hosting science competitions at the community resource centres to engage all learners in learning sciences"* (LSCL1).
>
> *"There must be competitions that include prizes so that we will be more motivated and interested"* (LSCL2).

The findings from both teachers and learners indicated that the community must be actively involved in the performance of learners in Life Sciences, especially in investigation questions.

6. Discussions

The theme emphasising the factors contributing to poor performance of learners in Life Sciences investigation questions had five sub-themes: 1) lack or shortage of teaching and learning resources; 2) language proficiency influence on learner understanding; 3) role play by teachers in teaching science investigation; 4) a lack of pedagogical content knowledge; and 5) a lack of parental support. These findings imply that the lack of teaching and learning resources results in the non-attainment of scientific knowledge and skills in Life Sciences. Furthermore, this finding corroborates the assertion by Teppo et al. (2021) that poor learner performance in science is due to poor infrastructure and non-availability of standard science laboratories in most schools. In accordance with Vygotsky's (1968) constructivist theory, experience is the source of knowledge and learning success as learners construct their knowledge while they engage with the available resources.

The study further found that language was a barrier for learners in rural areas to understand scientific knowledge and skills. The literature revealed that learners perform poorly in examinations because teachers do not explain concepts in their mother tongue (Ndayambaje et al., 2021). Many scientists and users of scientific information, such as policymakers, communicate daily in languages other than English, which inevitably creates barriers to the transfer of knowledge between communities (Sutherland et al., 2019).

This study provided evidence relating to the teachers' content knowledge on Life Science practical investigation activities. Teachers with higher content knowledge tend to have learners with higher achievements in the subject (Huang & Lajoie, 2021). This finding implies that when the teacher is not qualified to teach Life Sciences, it is going to be difficult to transfer scientific skills and knowledge to the learners. In response to the criticism that many Life Science teachers are not competent, Mupa and Chinooneka (2019) suggest that teachers should possess some competencies in the content of teaching Life Sciences in order for effective teaching and learning to occur. Another finding obtained from the study was a lack of parental support. According to Ntekane (2018), it is the responsibility of the parent to assist the learner in the learning process. In this way, parents become active participants in decisions regarding their children's futures.

The second theme addressed the effects of poor learner performance in Life Sciences investigation questions. The findings indicated that a lack of knowledge and a lack of interest in doing practical investigations affected learner performance in Life Sciences investigation questions. Within this theme, two sub-themes emerged: 1) a lack of science knowledge and skills; and 2) negative attitudes by learners and teachers. According to Akinbadewa and Sofowora (2020), learners' attitudes, whether positive or negative, affect their learning directly or indirectly. Positive attitudes result in successful learning, and negative attitudes were linked to the poor performance of learners. Findings from this study and the findings from the literature appear to agree that it is the responsibility of both the teacher and the learners to demonstrate a positive attitude towards Life Sciences, as such an attitude may have a beneficial impact on the learners' academic achievement. The study gave evidence that the content knowledge of teachers was low relating to science investigation. This perspective aligns with Ogbonnaya's (2019) contention that "the quality of education cannot exceed the quality of the teacher." Improved teacher knowledge and pedagogical abilities in the Life Sciences would improve the academic performance of grade 12 students in Life Sciences.

The third and last theme addressed ways in which learners could be assisted to succeed in Life Sciences. The findings of the study indicated that the attainment of science knowledge and skills is possible through effective hands-on practical work in a teaching and learning situation and provision of all resources needed for science practical investigation activities. Within this third theme, four sub-themes emerged: 1) assistance from the Department of Education; 2) mandatory practical investigation activities by teachers; 3) involvement in group work practical activities and peer tutoring; and 4) engagement in science competitions. The findings indicated that the DBE should ensure that all resources and materials for science learning and teaching are provided to all schools. In addition, the study found that teachers often need to conduct practical activities and develop competencies in science practical investigations, as they engage learners in peer interactions or group work to provide immediate benefits to learners' self-efficacy over the course of the activity. This finding is in agreement with Oliveira and Bonito (2023) who show that, if teachers are more confident in their professional content knowledge, and also in practical work, they will increase the range of appropriate strategies to adopt in their teaching practices, which will be positively reflected in learners' academic performances. The finding is also in line with Aikens and Kulacki's (2023) study which discloses that providing learners with opportunities to demonstrate their mastery, while also building in frequent discussion questions or checkpoints to reinforce and encourage group members to collaborate with one another, will enhance their self-efficacy. Another finding was that the participants indicated that the community should hold events where the teachers would get a chance to engage with parents for the betterment of the children academically. According to Kusumawati (2022), the establishment of a school committee will spur community empowerment efforts to improve the quality of education, in line with the community-based concept. The increased sense of belonging will lead to an increased sense of responsibility and dedication by the school's citizens.

7. Conclusion

This study sought to explore factors that contribute to the poor performance of students in Life Science investigation questions in rural high schools. Using social constructivism and the scientific inquiry as theoretical frameworks, the study showed that poor performance of Life Sciences investigation questions by grade 12 learners was caused by: a lack of teaching and learning resources; language proficiency influence on learner understanding; low pedagogical content knowledge of teachers; and a lack of parental support. The findings confirmed that these challenges lead to the lack of scientific knowledge and skills, and the development of learners' negative attitudes which results in learner underperformance in the subject. Hence, the study provided insights into the strategies to improve the quality of teaching and learning of science practical investigation activities to enhance learner knowledge and skills in Life Sciences investigation.

8. Recommendations

In order to mitigate subpar learner performance in Life Sciences at the high school level, a comprehensive strategy is needed, incorporating instructional methodologies and student support systems. Teachers' ought to prioritise the assessment and adjustment of their instructional approaches to guarantee that they are congruent with the wide array of learning styles. By integrating experiential and practical exercises, such as laboratory investigations, Life Sciences principles can be rendered more palpable and captivating to learners. Furthermore, it is recommended that teachers utilise technological resources at their disposal, including virtual simulations and educational applications, to augment the visual and interactive components of science teachings. This methodology will not only accommodate diverse learning preferences but will also promote a more profound comprehension of intricate biological principles. Furthermore, consistent utilisation of formative assessments, in line with investigative questions, can facilitate the early detection of students who are encountering difficulties, thereby enabling prompt intervention and individualised assistance. It is recommended that the DBE should build partnerships with non-governmental groups to establish laboratories for hands-on experiments in all educational institutions and ensure that every learner has access to an adequate number of science resources. Finally, teachers ought to participate in workshops focused on addressing gaps in subject knowledge to improve their understanding of practical inquiry activities in Life Sciences.

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