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Roots and Wings: Understanding What Derails Learners' Performance in Life Sciences in Rural Schools in South Africa

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ABSTRACT
This study explores the factors that affect the performance of grade 10 life sciences learners in selected schools in the Chris Hani East District of South Africa. The study was framed within the *roots* and *wings* concept as a compelling metaphor for understanding the educational journey in life sciences education. The study was based on the theoretical framework of social constructivism. The data was collected using interpretivist qualitative case study methods. The focus of this study was on both life sciences teachers and learners. Four schools in the Chris Hani East district were selected using purposeful sampling. Four life sciences teachers were purposefully chosen from the sample schools (schools A, B, C, and D), and twelve learners were chosen randomly from the selected schools. The interview schedule served as the primary tool for data collection. Thematic analysis was employed to analyse the data and identify themes. The study found that multiple interrelated factors, including resource limitations, language barriers, socioeconomic challenges, and ineffective teaching methods, influence the performance of Grade 10 life sciences learners. The study suggests enhancing life sciences education through continuous professional development programs, effective teaching strategies, curriculum delivery, and innovative technology adoption and implementation in life sciences classrooms.

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INTRODUCTION

Educational research has focused on learners' academic performance in life sciences due to its significant implications for their future academic and career opportunities. Life sciences, as a subject, play a crucial role in developing critical thinking, problem-solving, and scientific literacy, which are essential for learners' success in various fields, including medicine, environmental science, and biotechnology (DBE, 2011). Despite its importance, many South African learners struggle with mastering the content, leading to poor academic performance.

We have framed our study within the *Roots* and *Wings* concept as a compelling metaphor for understanding the educational journey in life sciences education. Within this metaphor, *Roots* epitomises the foundational knowledge and support systems essential for learners' achievement, while *Wings* reflects the opportunities and aspirations facilitated through education. The foundational aspect, akin to the roots of a tree, provides the stability and nourishment necessary for learners to embark on an academic journey. This is particularly evident in life sciences, where a robust understanding of core concepts can fuel higher learning and critical thinking, similar to how foundational literacy skills influence educational outcomes (Hudson et al., 2021). Al-Bahrani et al. (2020) emphasise that establishing a solid knowledge base in learners is crucial for raising aspirations and enabling them to navigate academic challenges successfully. Moreover, *Wings*, in this context, represent the potential for growth and exploration that education can offer. Learners can aspire to greater academic and career heights with access to relevant tools and supportive environments (Makhene, 2022). In rural settings where resources may be scarce, the absence of such supportive structures can hinder opportunities for learners, thereby limiting their prospects of flying high, as symbolised by the *Wings* (Zhou & Landa, 2019).

Globally, research highlights that learners' performance in life sciences is influenced by various factors such as socioeconomic status, teaching methods, and availability of learning resources. For example, studies in countries like the United States and Finland emphasise the importance of teacher quality, parental involvement, and school infrastructure in shaping learners' outcomes in science subjects (OECD, 2018). International assessments, like the Programme for International Student Assessment (PISA), show that well-resourced schools with effective instructional practices consistently produce better-performing learners (OECD, 2019). In contrast, schools with poor resources produce underperforming learners.

In North Africa, the education systems are marked by disparities in resources and quality across urban and rural areas, significantly affecting learner performance, especially in science subjects. Studies in Egypt and Morocco indicate that teacher qualifications, instructional quality, and socioeconomic conditions profoundly impact learner achievement. Moreover, overcrowded classrooms, insufficient laboratory equipment, and outdated curricula contribute to the challenges faced by learners in understanding sciences (UNESCO, 2020). These factors hinder the region's potential to produce high-achieving learners in STEM fields.

In Southern Africa, learners' performance in life sciences varies widely, with socio-economic inequalities and school infrastructure playing major roles. Countries within the Southern African Development Community (SADC) face significant challenges related to underfunded schools, lack of adequate science laboratories, and poorly trained teachers (Spaull, 2015). In South Africa, several factors influence learner performance in the subject (Boateng & Maliwa, 2024). According to the Chief Examiners' Report, many learners struggle with the subject due to a lack of foundational understanding from earlier grades, inadequate practical work, and poor language proficiency, which affects their understanding of scientific terminology (DBE, 2021). Moreover, the report highlights that teachers often face challenges in delivering the curriculum effectively due to large class sizes and limited access to laboratory equipment (DBE, 2021). These factors collectively contribute to lower learner performance in the subject, necessitating targeted interventions to improve outcomes.

Despite the existing literature, there are notable gaps that warrant further investigation. For instance, while much research has focused on individual psychological factors, there is a lack of comprehensive studies exploring the interplay between these factors and socioeconomic influences in life sciences education. Also, while innovative pedagogical approaches like problem-based and cooperative learning have been explored, limited research specifically targets their effectiveness in the Chris Hani East region and among Grade 10 learners. Moreover, the impact of cultural and community factors on learners' performance in life sciences has not been extensively studied. While some studies have highlighted the importance of instructional leadership and teaching methodologies in improving academic outcomes (Bakokonyane, 2022; Soyikwa & Boateng, 2024), there is a need for targeted research that evaluates specific teaching strategies within the life sciences curriculum in rural contexts. Against this backdrop, this study aims to explore the factors derailing the academic performance of Grade 10 learners in life sciences in Chris Hani East district schools, exploring the *roots* that anchor learners' underperformance and the *wings* that help them rise above their challenges.

Addressing these challenges is imperative to improve learner outcomes and ensure that learners in these regions have equitable opportunities to succeed in this subject. Hence, the study sought to answer the following questions:

1. Which factors influence the performance of Grade 10 learners in life sciences in schools in Christ Hani East District?
2. What is the effect of Grade 10 learners' poor performance in life sciences in Christ Hani East District schools?
3. How can Grade 10 learners be effectively supported to succeed in life sciences in Christ Hani East District schools?
4. How do 21st-century teaching innovations influence life sciences performance and learner engagement in rural South African schools?

Theoretical Literature

We framed our study within the Sociocultural Theory (Vygotsky, 1978). Vygotsky's Sociocultural Theory emphasises the role of social interaction and cultural context in cognitive development. According to Vygotsky (1978), learning is a social process, and the interaction between learners and their more knowledgeable peers or teachers can greatly enhance cognitive development. In the context of Grade 10 life sciences, the social environment, including teacher support and peer collaboration, is crucial in shaping students' understanding and performance (Wertsch, 2018). This theory suggests that an enriching and supportive learning environment can positively impact students' performance by providing the necessary scaffolding to understand scientific concepts. This theory suggests that learner performance in life sciences is affected by the sociocultural context, students' self-efficacy, and active engagement with the learning material (Lave & Wenger, 1991; Vygotsky, 1978).

The Empirical Literature

Numerous studies have been conducted on factors impeding learners' science performance and life science specifically. Life sciences require a properly organised laboratory and effectively administered practical lessons to enhance learners' scientific reasoning. Extensive research (Muwanga & Zake, 2008; Boateng & Maliwa, 2024) has shown that underperformance in life sciences is often linked to a lack of essential resources, particularly laboratories and scientific equipment. Similarly, Munda et al. (2000) found that some learners attributed poor academic outcomes to inadequate physical facilities. Supporting this, Dhurumraj (2013) highlighted that schools in the Pinetown District of KwaZulu-Natal Province had poorly equipped laboratories, limiting the effectiveness of practical life sciences instruction. These findings suggest that life sciences cannot be taught effectively in standard classroom settings alone.

In addition, socio-economic factors and classroom environment have been shown to affect learner performance (De Silva et al., 2018). In addition to socioeconomic factors, the pedagogical approaches employed in life sciences classrooms significantly influence student outcomes. Traditional, teacher-centred methods are prevalent in many South African schools, where rote memorisation is often emphasised over critical thinking and inquiry-based learning (Buma & Nyamupangedengu, 2020). This approach can lead to disengagement among students, as they may struggle to see the material's relevance. Studies have shown that more interactive and student-centred teaching methods can enhance student engagement and understanding of life sciences concepts (Lehesvuori et al., 2017). However, a lack of teacher training and support often hinders the transition to these more effective pedagogical practices (Dhurumraj & Moola, 2023). Teacher competency is another crucial factor affecting student performance in life sciences. Research indicates that many teachers in South Africa lack adequate training in content knowledge and pedagogical skills, which can negatively impact their ability to teach effectively (Maharajh et al., 2016).

The relevance of the life sciences curriculum to learners' lives and future careers also plays a significant role in their academic performance. When learners perceive the subject matter as relevant and applicable to real-world situations, they are more likely to engage with the content and perform better academically (Mnguni, 2018). Moreover, the impact of language on learning cannot be overlooked. South Africa is a linguistically diverse country, and many students are taught in a language that is not their mother tongue. This language barrier can hinder students' understanding of complex scientific concepts, leading to lower performance in Life Sciences (Msimanga et al., 2017). Research has shown that students who struggle with the language of instruction often find it challenging to engage with the curriculum fully, which can result in poor academic outcomes (Msimanga et al., 2017). Furthermore, parental involvement and community support in students' academic success cannot be underestimated. Research indicates that students whose parents are actively involved in their education tend to perform better academically (Mogashana et al., 2023). Encouraging parental involvement and promoting community support for education can help create a more conducive learning environment for students, ultimately leading to improved performance in life sciences.

One of the most critical strategies for improving student performance in life sciences is the implementation of student-centred teaching methods. Research indicates that student-centred approaches, such as inquiry-based and project-based learning, significantly enhance student engagement and understanding of complex biological concepts (Kurt et al., 2024). These methods encourage active participation, allowing students to explore and construct knowledge rather than passively receiving information. Technology, such as virtual laboratories and simulations, can provide students with hands-on experiences that reinforce their learning and understanding of complex biological processes (Penn & Ramnarain, 2019). Mokhtar et al. (2023). discuss the potential of technology to facilitate the development of critical 21st-century skills necessary for effective student participation in academic and professional realms. In rural contexts, where access to physical resources may be limited, e-learning and other digital pedagogies present innovative solutions to traditional teaching methodologies, thereby enhancing engagement in life sciences (Clark et al., 2023). Also, inquiry-based learning models significantly affect student engagement and performance. Syahdi et al. (2023) report that inquiry-based pedagogies enhance the acquisition of 21st-century skills, especially in science education contexts. Students in rural areas often find inquiry-based approaches more engaging as these methods are relevant to their immediate environment and experiences.

METHODS

Research approach

This study adopted a qualitative interpretivist paradigm (De Villiers, 2005). This paradigm is appropriate for examining factors affecting learner performance as it allows the researchers to collect data and identify patterns and themes of social phenomena within their real-life context. Qualitative research is particularly effective in educational settings because it allows for an in-depth examination of social phenomena within their real-life context (Merriam & Tisdell, 2016). In this case, understanding the key factors contributing to or hindering learner performance in life sciences is necessary to devise means to support them in improving their performance.

Research Design

A case study design was employed in this study. Yin (2018) described a case study as "an empirical method that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context" (p. 15). In this study, a multiple case study was suitable for the study to give the researcher the power ability to look at sub-units that are located within a more significant case to support a more profound and more detailed exploration of the factors contributing to learners' underperformance in life sciences in schools in Chris Hani East district.

Population and Sampling

This study's population comprised all Grade 10 learners enrolled in the life sciences subject and their life sciences teachers within selected Chris Hani East district secondary schools. This population is chosen due to the centrality of Grade 10 as a critical transitional phase in the South African educational system, where learners are introduced to more complex scientific concepts foundational for their academic progression (Department of Basic Education, 2018). The researchers used a purposeful sampling of four rural high schools within the

Chris Hani East as research sites. The four rural high schools were the schools with grade 8 at the entry point to grade 12 and underperforming in life sciences. The sample size of this study was as follows: four life sciences teachers, each from schools A, B, C and D. A simple random sampling of three (3) Grade 10 life sciences learners was drawn within each selected school. This method has ensured that the sample is representative of the entire population while accounting for potential variances in educational quality and resources across different school settings (Etikan & Bala, 2017). This approach has enhanced the generalizability of the study's findings to the broader population of Grade 10 life sciences learners in the district.

Instrumentation and Data Collection Procedure

To gather data from teachers and learners, we utilised semi-structured interviews; a method well-suited for in-depth exploring personal experiences and perceptions, yielding rich and nuanced insights (Merriam & Tisdell, 2016). The interview guide was divided into two sections: Section A captured the participants' background information. At the same time, Section B included 10 structured questions designed to explore teachers' and learners' perspectives on factors influencing learners' performance in Life Sciences. Data collection occurred during Terms 3 and 4 of the 2024 school calendar. Following ethical clearance, the research team visited the participating schools and formally requested permission to conduct the study. Rapport was first established with both teachers and learners to create a comfortable interview environment. Interviews were conducted with teachers first, followed by the learners, with each session lasting approximately 30 minutes.

Data Treatment and Analysis

We analysed the interview data using thematic analysis, where recurring themes and patterns were identified and categorised (Braun & Clarke, 2019). In this study, the interview data was captured and transcribed. The researchers initiated the data analysis process by thoroughly familiarising themselves with the content by reading the interview transcripts. Each researcher independently examined the raw data, highlighting key segments in different colours to identify emerging codes. This process involved reorganising the data in a meaningful way to uncover patterns. They then revisited the transcripts to ensure that no important terms, phrases, or insights had been missed during the initial coding phase. The researchers repeatedly read through these codes and phrases until they arrived at common themes and categories.

Ethical Consideration

The researchers obtained permission from the WSU Faculty of Education and the Eastern Cape Department of Education. This ensures that the research adheres to institutional and regional regulations and respects the administrative protocols of the participating schools (Creswell & Creswell, 2018). Furthermore, parental or guardian consent is required for all learners under the age of 18, acknowledging the role of guardians in safeguarding the interests of minors in research contexts (Cohen, Manion, & Morrison, 2018). This was achieved by sending letters of assent to the parents to seek permission to allow their children to participate in the study.

To protect the identities of the participants, all data collected was anonymised. This implies that personal information was replaced with coded identifiers to protect participants' identities and ensure that individual learners could not be traced through the research findings (Saunders, Lewis, & Thornhill, 2019). The researchers stored all data in secure, password-protected files and shared results only in aggregate form without revealing the identities of individual participants. This practice is essential to maintain trust between the researcher and participants, ensuring that sensitive information is handled with the highest level of care (Kumar, 2019). Participants were thoroughly informed of their rights, including the freedom to withdraw from the study at any point without facing any consequences. They were also given clear information about the study's purpose, methodology, and potential implications (Babbie, 2020). Ensuring that participants are aware of their rights was an ethical requirement and a cornerstone of conducting research, as well as respecting all participants' autonomy and dignity.

Trustworthiness

In qualitative research, establishing trustworthiness is essential and encompasses four key criteria: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Credibility was enhanced through extended interaction with participants and member checking, allowing participants to verify the accuracy of the reported findings (Morse, 2015). To support transferability, the study provided rich, contextual descriptions, enabling other researchers to determine the relevance of the findings to their settings. Dependability and confirmability were ensured by maintaining a comprehensive audit trail documenting the research procedures, decisions, and reflections, allowing for transparency and potential external evaluation. This section describes how the study was conducted. The subject matters of this section are: (1) the study design; (2) the sample population or subject of the research; (3) data collection techniques and instrument development; (4) data analysis techniques. Please use descriptive paragraphs. Use these questions as a guideline to write the method: (1) Is the design suitable for answering the question?; (2) Is there sufficient information present to replicate the research?; (3) Does the article identify the procedures followed?; (4) Are these ordered meaningfully?; (5) If the methods are new, are they explained in detail?; (6) Was the sampling appropriate?; (7) Have the equipment and materials been adequately described?; (8) Is it clear what type of data was recorded?; (9) Have the data been precise in describing measurements?

It is important to note that you do not need too many formulas or tables unless they must be displayed. This section must be written briefly, concisely, clearly, and adequately to be replicated. This section explains the research approach, study subjects, the research procedure's conduct, the use of materials and instruments, data collection, and analysis techniques. These are not theories. In the case of statistical methods, formulas that are generally known should not be written down. The researcher's specific criteria in collecting and analyzing the research data should be thoroughly described. This section should be written not more than 10% (for qualitative research) or 15% (for quantitative analysis) of the body.

RESULTS AND DISCUSSION

Participants Background Profile

This study involved four rural secondary schools in the Chris Hani East District, all offering Life Sciences from Grade 8 to Grade 12. Despite having adequate furniture, the classrooms are overcrowded, limiting individual learner support. The schools struggle with Grade 12 Life Sciences underperformance, consistently scoring below 60%. While some schools face textbook shortages, none have fully functional laboratories, with one having an unequipped lab. Four qualified Life Sciences teachers (TA–TD), aged 25 to 37, participated in the study, two with less than five years and two with more than five years of experience. Their qualifications include bachelor’s degrees in Natural or life sciences, with two also majoring in mathematics. One teacher is male, and three are female. Twelve Grade 10 life sciences learners, aged 14 to 17, were also sampled (eight females and four males), and all participants were assigned pseudonyms for confidentiality.

Theme Presentation

The data collected from teachers and learners in schools A, B, C, and D was presented in three themes: factors contributing to poor performance in life sciences, effects of poor performance in life sciences on learners' learning, and strategies to enhance learner performance in life sciences. All four themes were further divided into sub-themes. A discussion follows the data presentation.

Theme 1: Factors affecting learners' poor performance in life sciences

Sub-theme 1: Inadequate teaching and learning resources

A prominent theme that emerged from the participants’ accounts was the acute shortage of teaching and learning resources, which they perceived as a significant barrier to academic success in Life Sciences. Learners and teachers consistently cited a lack of essential infrastructure, such as laboratories, libraries, and adequate textbooks. These deficiencies limited opportunities for practical engagement and inquiry-based learning and undermined learners' ability to consolidate theoretical concepts through hands-on experience. The lack of laboratories, in particular, was seen as detrimental to comprehending scientific topics that require experimentation and observation. Learners voiced concern over the minimal exposure to practical work, while teachers acknowledged their inability to deliver meaningful investigations due to the lack of functional facilities. In addition, textbook shortages were repeatedly mentioned, with learners highlighting the difficulty of accessing learning materials during and outside class hours. In some cases, the absence of technological tools further limited learners' autonomy and capacity to engage in self-directed learning. Table 1 presents a thematic synthesis of the participants' experiences regarding inadequate teaching and learning resources to encapsulate these concerns.

Table 1. Learners' and Teachers' Perceptions of Inadequate Teaching and Learning Resources

Sub-theme	Narrative Summary	Verbatim Quote	Participant Code	Interpretive Insight
Lack of Laboratories and Practical Exposure	Learners expressed difficulty understanding Life Sciences content due to the absence of laboratory facilities and limited practical engagement.	"My poor performance in Life Sciences is caused by a lack of teaching-learning materials and exposure to practical activities... since my school does not have a laboratory..."	AL3	The absence of a laboratory impedes experiential learning, particularly for subjects that rely on hands-on experimentation.
Teachers' Limitations in Conducting Practical Lessons	Teachers acknowledged the lack of functional laboratories, which hindered their ability to conduct practical sessions.	"My school does not have a functional laboratory or a library. As a result, I cannot conduct practical work with my learners..."	TA	Teachers are restricted in delivering core components of the curriculum due to infrastructural deficits.
Shortage of Textbooks	Learners frequently reported sharing textbooks due to shortages, limiting their ability to engage fully with the subject matter.	"We do not have enough textbooks; we usually share textbooks as life sciences learners."	BL2	Sharing textbooks reduces individual access to learning materials, reducing time for practice and comprehension.
Lack of Technological Tools for Independent Learning	A lack of digital tools and sufficient print resources makes it difficult for learners to study independently or access supplementary materials.	"There is a lack of resources (textbooks and technological tools). We cannot even practice independently or read more..."	CL3	Resource shortages affect learners' ability to develop autonomy and engage in after-school learning.

As reflected in Table 1, the participants identified a range of resource-related challenges that directly impacted teaching and learning processes in Life Sciences. The lack of laboratories and libraries restricted teachers' instructional options and learners' opportunities for scientific exploration. Without access to practical activities, learners could not connect theoretical knowledge with real-world applications, which hindered their understanding of core concepts. In addition, the chronic shortage of textbooks and the absence of technological tools placed further strain on the learning environment. Learners often could not study at their own pace, reinforce classroom learning, or engage in meaningful independent inquiry. These structural limitations highlight systemic inequalities contributing to poor academic performance and suggest an urgent need for resource investment in underserved schools. Overall, these findings illustrate the foundational role of adequate resources in facilitating curriculum delivery, learner motivation, participation, and academic development.

Sub-theme 2: Challenges with English as the medium of instruction

Language emerged as a salient factor influencing learners' academic performance in Life Sciences. For many participants, English—used as the official medium of instruction—is not their home language, nor is it the mother tongue of their teachers. This linguistic mismatch contributes to learners' difficulties in comprehending subject content, particularly in a discipline that relies heavily on complex terminology, conceptual precision, and scientific abstraction. Learners consistently reported that their ability to understand key scientific concepts was compromised due to the language barrier. They expressed that English-based textbooks, assessments, and classroom instruction often posed challenges, leading to frustration and disengagement. Sometimes, learners requested that teachers use their local language, especially during practical or investigative activities, to support a more profound understanding. This theme also revealed that while some teachers attempted to employ code-switching strategies, these efforts were insufficient to ensure learners' independent comprehension. Consequently, students often struggled to apply knowledge or respond to examination questions without direct support. These insights suggest that language difficulties are not merely peripheral, but are central to the learner experience and academic success in science education.

Table 2. Summary of Participant Quotations and Interpretations on Language Challenges

Participant	Quotation	Interpretation
CL1	"The English language used in most life sciences textbooks is challenging to understand. It is better with demonstrations. Sometimes, the class complains to the teacher and asks for explanations in our local language to help us understand the concepts, especially during investigation activities."	The learner finds textbook language inaccessible and depends on visual aids and code-switching for comprehension. This highlights the importance of multimodal and linguistically responsive teaching.
DL2	"Learning in a foreign language is not always easy. Although my life science teacher tried to code-switch between English and IsiXhosa, sometimes it becomes difficult for me when I am alone and try to answer questions."	Although code-switching occurs, learners still struggle independently. This indicates that temporary language support does not necessarily result in autonomous comprehension or academic confidence.

The perspectives shared by learners underscore the persistent gap between language policy and classroom reality. Using English as the sole language of instruction, without adequate linguistic scaffolding, appears to hinder meaningful engagement with the subject matter. Learners require simplified explanations and benefit from culturally and linguistically responsive teaching strategies that acknowledge their multilingual backgrounds. Addressing this challenge demands a rethinking of pedagogical approaches, where language support becomes an integral component of science instruction rather than an auxiliary tool. Without intentional strategies to bridge the linguistic divide, learners may continue to underperform, not due to cognitive limitations, but because of linguistic exclusion from the learning process.

Sub-theme 3: Teachers' competencies and pedagogical strategies

Participants in this study articulated a wide range of experiences concerning their Life Sciences teachers' pedagogical competencies and instructional strategies. While some learners expressed appreciation for teachers who adapted their instructional approaches to enhance learner understanding, others reported frustration with methods they perceived as rigid, rushed, or unresponsive to learners' difficulties. The data reflect a teaching quality and responsiveness continuum within the educational environment. A number of learners positively highlighted efforts by teachers to scaffold learning through simplification of scientific terminology, use of structured notes, and regular formative assessments. These strategies appeared to help learners manage the cognitive demands of the subject and perform better in assessments. On the other hand, some learners described experiences with teachers who relied solely on textbook-based instruction without meaningful explanation or support, which led to confusion and disengagement. To illustrate these divergent experiences, Table 3 presents a thematic synthesis of learners' and one teacher's perspectives, accompanied by direct quotations and interpretive insights.

Table 3. Summary of Learners' Perceptions on Teachers' Pedagogical Competencies and Strategies

Sub-theme	Narrative Summary	Verbatim Quote	Participant Code	Interpretive Insight
Simplification of Scientific Content	Some learners expressed satisfaction with how their teachers simplified scientific terminology, which helped them understand complex concepts more easily.	"Teachers give us simpler notes to help us understand the subject content better, allowing us to grasp concepts more."	AL1	Simplifying content is a scaffolding technique that enhances comprehension of scientific concepts.
Assessment Support and Strategy	Learners appreciated regular formative assessments and guidance on how to answer exam questions, which helped reinforce learning.	"They provided us with mock tests and taught us how to answer questions. The teacher also makes us write class tests almost every week..."	BL2	Continuous assessment builds content mastery and test readiness.
Teacher Confirmation	One teacher confirmed that the instructional strategies used in class contributed to improved	"Some learners improve from the strategies that teachers use. These strategies expose	TC	Pedagogical strategies are acknowledged by educators to support deeper

	understanding and exposure to scientific thinking.	learners to the scientific world…"		conceptual learning.
Lack of Explanation and Engagement	Some learners were critical of teachers who merely read from textbooks without explaining the content or engaging learners in discussion.	"Our teacher just reads from the textbook and does not explain anything properly… I feel lost because I did not get the chance to learn."	AL3	Passive instruction impedes understanding and reduces learning motivation.
Rushed and Superficial Teaching	Learners felt frustrated when teachers skipped content or rushed lessons, which led to confusion and poor conceptual integration.	"Sometimes, the teacher rushes through the lessons… He skips some parts… and I struggle to connect the concepts."	CL2	Inadequate pacing and superficial delivery hinder learners' ability to form meaningful knowledge connections.

As reflected in Table 3, learners' experiences with their Life Sciences teachers ranged from supportive and encouraging to frustrating and disengaging. On the positive end, instructional practices such as simplifying content, providing structured assessments, and offering test-taking strategies were perceived as beneficial in facilitating learners' academic development and conceptual clarity. These methods appeared to create an environment where learners felt supported and better prepared for evaluations. In contrast, the accounts of learners who experienced ineffective teaching practices revealed significant obstacles to learning. These included a lack of explanation, minimal interaction during lessons, and a tendency to rush through or omit parts of the syllabus. Such approaches contributed to learner confusion, limited conceptual understanding, and a diminished sense of preparedness. These findings highlight the importance of what is taught and how it is taught. Learners' perceptions suggest that effective teaching is closely linked to clarity, pacing, relevance, and responsiveness. Ensuring that pedagogical strategies align with learners' needs remains essential for fostering meaningful engagement and academic success in the science classroom.

Sub-theme 4: Lack of support from parents and the local community

A critical issue raised by teachers and learners in this study is the insufficient support parents and the broader community provide in promoting students' academic success, particularly in Life Sciences. When participants were asked about the extent of parental involvement in learners' educational development, responses—especially from educators—revealed a sense of frustration and concern. Teachers overwhelmingly perceived a lack of engagement from parents, which they identified as a significant barrier to learners' consistent academic progress. Several educators reported that many parents do not participate in school activities, rarely monitor their children's academic tasks, and often fail to communicate with the school about academic challenges. This absence of collaboration affects learners' motivation, accountability, and overall performance. The dominant narrative suggests that some parents view education as the exclusive responsibility of the school, thereby abdicating their complementary role in reinforcing learning at home. Interestingly, although most teachers expressed dissatisfaction with parental involvement, learner perspectives on the issue were more nuanced. While some confirmed the lack of home support, others noted instances where their parents were actively involved, assisting with homework and ensuring access to online materials. This divergence highlights the variability of learners' home environments and underscores the importance of context-specific interpretations of "support."

Table 4. Summary of Participant Quotations and Interpretations on Parental and Community Support

Participant	Quotation	Interpretation
TA	"Parents show no interest in supporting their children."	The teacher emphasizes a general perception of indifference among parents, suggesting systemic disengagement that may demoralize learners.
TB	"Many parents do not actively participate in their children's education. They do not attend school meetings or check if their children are doing homework. This lack of support at home makes it difficult for learners to stay motivated and focused on their studies."	This quote identifies the absence of parental accountability as a factor negatively affecting learner motivation and self-regulation.
TD	"Some parents seem to think educating their children is the school's job. They do not follow up on their progress or communicate with us about any challenges. Without that collaboration, it is hard to address issues early, affecting the learners' performance in class."	The teacher expresses concern over a lack of communication, which hinders early intervention and shared responsibility in supporting the learner.
BL3	"Yes, my parents are supportive because they help me with my homework and provide me with internet data so that I can access the learning material."	Contrary to teacher perspectives, this learner reflects a positive experience of parental support, emphasizing access to resources and direct academic assistance.

The findings under this theme reveal a dichotomy between teacher and learner perspectives regarding parental support. While teachers generally lament the lack of engagement, some learners highlight the presence of meaningful support structures at home. This contrast may stem from differing expectations, inconsistencies in support across households, or variations in how support is perceived and enacted.

The lack of systematic parental and community involvement poses a significant challenge to the educational process. Strengthening home-school partnerships and fostering a culture of shared responsibility may be pivotal in improving learner outcomes in science education. Targeted interventions—such as parent training workshops, consistent communication platforms, and community-based educational programs—could bridge this gap and enhance the support ecosystem surrounding learners.

Theme 2: Effects of the failure rate of life sciences on learners

Learners' academic performance in Life Sciences influenced their self-esteem and motivation significantly. The data reveal that consistent underachievement leads to feelings of inadequacy, withdrawal, and diminished confidence. Both learners and teachers acknowledged that poor academic outcomes reflect gaps in content mastery and have deeper emotional and psychological consequences. These include internalized self-doubt, loss of interest, and detachment from peers and academic tasks. One learner candidly described the internal turmoil experienced after underperforming in a subject they were passionate about. Despite dedicating time and effort to studying, the failure to meet personal expectations triggered a crisis of confidence, raising doubts about their general intellectual capacity. Another learner reinforced this notion, explaining how academic failure caused social withdrawal, emotional distress, and strained relationships with both peers and parents. Teachers confirmed that learners with a history of academic underperformance often disengage during class, avoid participation, and exhibit low academic self-efficacy. This disengagement, teachers argued, is a coping mechanism tied to the learners' diminished self-belief and fear of further failure.

Table 5. Summary of Participant Quotations and Interpretations on Self-Esteem and Motivation

Participant	Quotation	Interpretation
CL3	"Life sciences is one of my favourite subjects, but my performance last term affected my feelings. I studied so hard for the test, but I still did not do as well as I hoped. It made me feel like maybe I am not smart enough to understand it. I even doubted whether I could do well in other subjects."	This response reflects how underachievement in a subject the learner enjoys can undermine global self-concept and lead to generalized academic self-doubt.
AL2	"I feel isolated and withdrawn, and I have reduced interaction with my peers, and I experience frustration from parents, leading to tension."	The learner illustrates how academic challenges lead to emotional withdrawal and deteriorating social relationships at home and school.
TA	"Underperforming learners tend not to participate in classroom activities due to low self-esteem."	The teacher notes behavioral indicators of low self-esteem manifesting as reduced classroom participation.
TB	"It causes learners to be less motivated in class, and most of them do not want to participate in class."	The statement reiterates the connection between poor academic results and decreased motivation, confirming that learners' disengagement is not due to apathy but psychological discouragement.

These findings underscore the bidirectional relationship between academic performance and learner psychology. When learners fail to meet personal, parental, or institutional expectations, they often internalize this as a reflection of their abilities, resulting in lowered self-worth. This decline in self-esteem then influences their willingness to engage, creating a feedback loop of failure and disengagement. Significantly, these psychosocial effects extend beyond the classroom. Strained familial relationships and deteriorating peer connections are consequences of learners' internalized failure, further amplifying their sense of isolation and diminishing their overall resilience. Therefore, educators, counselors, and parents must recognize the emotional dimensions of academic struggles and implement supportive interventions that rebuild learner confidence and motivation through positive reinforcement, differentiated support, and consistent encouragement.

Sub-theme 2: Effect on learners' future academic and career aspirations

The second sub-theme that emerged from the data analysis relates to learners' perceptions of how underperformance in Life Sciences impacts their long-term career aspirations and planning. Many participants, particularly learners, expressed a sense of despair and disillusionment regarding their prospects due to their inability to achieve desired outcomes in Life Sciences, an essential gateway subject for many science-related careers. The narratives reflect the profound psychological toll that academic underachievement exerts on students' future orientation, particularly in aspirational and identity-defining pathways such as medicine, nursing, and environmental sciences. Several learners shared how their poor academic performance has caused them to question their lifelong ambitions. The responses indicate academic frustration and a deep-seated fear of future failure, resulting in diminished career motivation. The learners revealed that despite their effort and dedication, the lack of academic success in Life Sciences leads to feelings of helplessness and a loss of self-belief in their capacity to pursue their chosen careers. Teachers also acknowledged this trend and shared their concerns regarding its long-term implications. According to their observations, when learners experience repeated failure in Life Sciences, they begin to adjust or completely abandon their initial career goals, especially those requiring proficiency in biological sciences. This shift is often rooted in declining confidence, not necessarily a lack of interest or effort. The teachers emphasized the need for early intervention and career guidance to prevent learners from prematurely disengaging from their academic goals.

Table 6. Learners' and Teachers' Quotations on Career Aspirations and Perceived Futures

Participant	Quotation	Interpretation
DL1	"I have always wanted to become a doctor, but after failing in life sciences last term, I feel like that dream is slipping away. No matter how hard I study, I cannot understand the work."	The learner articulates a crisis of vocational identity, equating performance in a single subject with the viability of a lifelong career goal.
BL1	"When I struggled with life sciences last term, I felt it affected how I saw myself. I started thinking, 'If I cannot pass this subject, how can I ever succeed in a nursing or environmental science career?'"	This statement highlights how underperformance distorts self-perception and perceived career competence, resulting in fear of future inadequacy.
TD	"Some even tell me that they have changed their career aspirations because they think they are not smart enough to pursue fields like medicine or biology."	The teacher notes that learners internalize academic failure as intellectual inferiority, which leads to downward revision of aspirations.
TC	"I have had learners who initially aimed for careers in health sciences, but after poor grades, they lose interest or shift to fields they perceive as less challenging."	The excerpt underscores a structural consequence of underperformance: reorientation toward less demanding fields, not due to preference, but perceived incapacity.

These responses suggest that academic performance in Life Sciences acts as both a gatekeeper and a psychological filter for learners' plans. Learners' narratives emphasize how underperformance is not experienced in isolation but is perceived as a direct barrier to upward mobility and academic success. Consequently, this may reduce their competitiveness for entry into higher education, particularly in highly selective programs. More critically, the findings reveal the emotional labor students carry in reconciling their aspirations with their academic realities. Without proper academic support, mentoring, and psychological counseling, learners risk reduced access to higher education and a possible withdrawal from school entirely. This highlights the urgent need for schools to implement structured academic counseling, resilience-building programs, and subject-specific scaffolding to empower learners to remain invested in their long-term goals despite short-term setbacks.

Theme 3: Strategies to improve learners' performance in life sciences

Sub-theme 1: Employing Effective teaching methods and resources

To address learners' underperformance in Life Sciences, both teachers and learners provided valuable insights into effective teaching strategies and resource needs. Teachers emphasized the importance of employing interactive teaching approaches and integrating technology into instruction to enhance student engagement and conceptual understanding. They also pointed to the significance of simplifying complex terminology and facilitating peer collaboration to support diverse learning needs. From the learners' perspective, the need for contextualized learning through real-life examples, more time for concept consolidation, and practice-based activities emerged strongly. These voices converge on a common understanding: teaching strategies should be student-centered and supported by sufficient educational resources. The following table summarizes the key findings under the sub-theme of employing effective teaching methods and resources.

Table 7. Employing Effective Teaching Methods and Resources

Participant	Quotation	Interpretation
TD	"One strategy I think would work well is incorporating more active learning strategies in the classroom. For example, doing more hands-on activities like experiments and demonstrations. I also believe using technology, like interactive apps and videos, could engage learners more and make the subject less intimidating."	The teacher advocates for interactive and technology-integrated instruction to enhance learner engagement and conceptual clarity, especially for students who find Life Sciences challenging.
TC	"Many of my learners struggle with scientific terminology, so I think spending more time on vocabulary and breaking down complex concepts into simpler ones could make a big difference. Another strategy is giving learners more opportunities for peer teaching or group work."	The teacher emphasizes the importance of scaffolding through vocabulary support and peer collaboration, suggesting that simplifying content and facilitating social learning enhances comprehension.
BL3	"My teacher could help us by using more real-life examples in class. When learning about ecosystems, it would be easier to understand if they show us videos or even bring in specimens we can see or touch. Also, I feel like group discussions would help because sometimes my friends explain things in a way that's easier to understand."	The learner values contextualized and multimodal instruction, stressing the usefulness of sensory experiences and peer explanations to bridge understanding gaps.
CL2	"Our teachers give us notes, but I think it would be better to give us more practice questions, especially the difficult ones in exams. Also, I wish they could slow down when they teach. Sometimes, I do not understand a topic, and we move to the next one without fully understanding the first one."	The learner identifies pacing and insufficient practice as barriers to learning, advocating for mastery-based instruction and greater exposure to exam-level content.

The data presented in the table reflect a precise alignment between teachers' pedagogical intentions and learners' expressed needs. Interactive methods, such as group work, contextual examples, and multimodal instruction, resonate strongly with learners and are endorsed by teachers seeking to address learning gaps. Notably, both groups emphasize the value of adequate technological, human, or material resources to support effective learning environments. These findings suggest that a shift toward learner-centered pedagogy, complemented by improved access to teaching resources, may foster greater learner confidence, deeper understanding, and improved academic outcomes in Life Sciences. Incorporating such strategies into curriculum delivery may be critical in mitigating persistent underperformance.

Sub-theme 2: Use of technology and digital tools to improve learning

Integrating digital tools in science education has become increasingly crucial in enhancing learner engagement, comprehension, and academic achievement. In the context of Grade 10 life sciences, participants acknowledged the transformative potential of technology when employed meaningfully within instructional practices. The learners' responses reflect a strong preference for multimodal and interactive forms of instruction, indicating that traditional methods such as textbook-based learning may no longer suffice to meet their cognitive and motivational needs. Moreover, learners and teachers highlighted the growing relevance of digital literacy and accessibility. Learners noted that animations, simulations, and online resources helped them better grasp abstract scientific processes that are otherwise difficult to understand through static texts. On the other hand, teachers emphasized the promise of educational technologies—such as virtual dissections and real-time assessment tools—but also voiced concerns about infrastructural limitations, unequal access to digital resources, and the need for professional development. To capture the depth of these experiences and perceptions, the following table presents key quotations from learners and teachers, accompanied by interpretive analysis.

Table 8. Participant Perspectives on the Use of Technology in Life Sciences Education

Participant	Quotation	Interpretation
AL1	"I think if teachers could use more videos and animations during lessons, it would help us understand difficult topics like the circulatory system or how the human body works. […] if we have computer labs to practice quizzes or use apps for revision, we will do better in exams."	The learner emphasizes the pedagogical value of visual and interactive content in simplifying abstract scientific concepts, highlighting technology's motivational and performance-enhancing effects.
BL3	"I wish they could give us links to online resources, like interactive websites or virtual labs […]. Some of us do not have Wi-Fi at home, so if they could request the Department of Basic Education to provide our school with computers and internet […] it would help."	The learner draws attention to the digital divide and the need for institutional support to ensure equitable access to digital learning tools and platforms.
TC	"If I have the means, I will use simulations and virtual dissections to explain processes like mitosis. However, my school does not have access to the internet, and not all my learners have access to devices or reliable internet outside the classroom."	The teacher recognizes digital simulations' pedagogical potential while acknowledging infrastructural and socio-economic constraints that hinder equitable implementation.
TD	"Platforms like Jove science education videos make learning more engaging […] However, to improve their performance, we need professional development programs for teachers to use these tools effectively."	The teacher underscores the dual need for digital resources and continuous teacher training to optimize educational technology integration in science classrooms.

These responses collectively reveal that while there is both enthusiasm and perceived efficacy in adopting digital tools for life sciences education, systemic barriers remain a significant hindrance. The lack of digital infrastructure, unequal access to the internet, and insufficient teacher training undermine the full realization of technology-enhanced learning. Therefore, any strategy to improve academic performance through digital means must be holistic, involving not only the provision of devices and internet access but also investment in teacher professional development and curriculum alignment with technological affordances.

Theme 4: Uneven implementation of 21st-century teaching innovations in life sciences classrooms

Recent educational reforms in South Africa have emphasized incorporating 21st-century teaching innovations—such as mobile learning applications, digital simulations, instructional YouTube videos, and tablet-assisted learning—into life sciences classrooms to enhance learner engagement and comprehension. These tools are envisioned as "wings" that can elevate the learning experience, particularly in rural schools where resource constraints often hinder traditional methods of instruction. However, findings from participant interviews suggest that although these innovations have been introduced, their integration into daily classroom practice remains irregular and fraught with logistical and infrastructural barriers. Teachers reported participating in professional development workshops facilitated by the Department of Basic Education (DBE) and receiving a limited number of tablets for instructional use. Nonetheless, challenges such as electricity outages, limited device availability, lack of Wi-Fi access, and high data costs often render these technologies impractical for sustained use. Learners also shared their experiences with sporadic exposure to digital tools, emphasizing both the pedagogical benefits and the frustration stemming from inconsistent access. The table below provides a synthesis of key statements from teachers and learners, along with interpretive commentary highlighting the intersection of educational innovation and systemic inequality in rural life sciences classrooms.

Table 9. Perspectives on 21st-Century Teaching Innovations in Rural Life Sciences Classrooms

Participant	Quotation	Interpretation
TD	"We received training to use tablets with some science apps, but the devices are few and often not charged due to power issues."	The teacher expresses enthusiasm for digital integration but is constrained by infrastructural deficits such as limited devices and unreliable electricity.
TB	"I sometimes download YouTube videos at home and show them in class. It helps a lot, but it is difficult when there is no electricity."	Despite limited institutional support, the teacher makes personal efforts to introduce multimedia resources, highlighting both dedication and systemic gaps.
BL2	"We watched a video about the digestive system on Madam B's phone. It helped me understand better than the textbook. However, she said she cannot always do it because of battery and data."	Learners recognize the effectiveness of video-based learning while acknowledging teachers' resource limitations that restrict its consistent use.
CL1	"We tried using a life sciences quiz app for grade 10s. Learners were excited, but the school does not have Wi-Fi, and many do not have smartphones. So it did not last long."	The learner highlights enthusiasm for gamified learning but underscores the digital divide that undermines long-term engagement and equity.
DL3	"I saw a simulation on a teacher's laptop about photosynthesis. It made it easier, but we did not get to do it again. I think we only used it once that term."	Learner testimony illustrates how powerful digital simulations can be, yet their isolated use reveals the limitations of unsustainable implementation.

These accounts reveal a paradox: while teachers and learners recognize the transformative potential of digital innovations in enhancing science learning, their deployment is patchy and unsustained due to structural inequities. The availability of electricity, digital devices, and stable internet access continues to shape who benefits from these innovations and to what extent. Teachers' willingness to use personal resources to bridge these gaps reflects commendable agency and exposes the limitations of relying on individual efforts without systemic reform. To harness the full potential of 21st-century teaching tools in improving life sciences performance, there is a pressing need for targeted policy interventions. These should include infrastructure upgrades (e.g., solar energy solutions, school-based Wi-Fi), equitable distribution of digital devices, and ongoing technical support and training. Without addressing these foundational issues, the "wings" of innovation meant to uplift science education risk being clipped by enduring disparities that characterize rural schooling contexts.

Discussion

The findings of this study revealed critical challenges in life sciences education. The lack of adequate teaching and learning resources emerged as a significant barrier to attaining scientific knowledge and skills in life sciences. Without sufficient resources, students in under-resourced schools struggle to engage with the curriculum, especially in practical and inquiry-based components of the subject. This finding aligns with the observations of Mlachila and Moeletsi (2019) and Adebayo et al. (2020), who highlight the disparity in resource allocation between affluent and low-income communities. Schools in wealthier areas typically have better facilities, including laboratories and digital tools, which provide a conducive learning environment. In contrast, students in under-resourced schools face challenges that compromise their learning experiences and outcomes. This inequity exacerbates the performance gap, underscoring the need for targeted interventions to improve resource availability in rural schools.

Language emerged as another critical factor influencing learners' performance in life sciences. Learners in rural areas, where English is often not their first language, face significant barriers in comprehending complex scientific concepts. As a linguistically diverse country, South Africa's educational system frequently requires learners to engage with content in a second or third language. Msimanga et al. (2017) emphasise that the language of instruction can significantly hinder learners' ability to grasp scientific knowledge, particularly when technical terminology is involved. The findings highlight the importance of incorporating strategies to address this challenge, such as bilingual teaching methods or supplementary language support, to bridge the gap in understanding and improve academic performance.

Teacher competency and pedagogical strategies were also identified as pivotal in shaping learner performance. The findings resonate with the literature indicating that many life sciences teachers in South Africa lack the necessary training in both subject content and pedagogy (Maharajh et al., 2016). Teachers' struggles with implementing the Curriculum and Assessment Policy Statement (CAPS) were also noted, further hampering their effectiveness in delivering structured and outcomes-based lessons. Maharajh et al. (2016) emphasises the role of professional development programs in equipping teachers with innovative and effective teaching strategies. The study also highlighted a lack of parental involvement, which contributes to poor academic performance in life sciences. The study echoes Mogashana et al. (2023), emphasising the positive impact of active parental engagement on learner performance. Creating stronger home-school partnerships may alleviate some of the stress and low self-esteem learners experience. Encouraging parental involvement, despite socio-economic constraints, can have a transformative effect on students' academic journeys. These findings collectively highlight the interconnected challenges and opportunities within Life sciences education in South Africa.

The second findings reveal that learners' self-esteem is significantly influenced by their academic performance, particularly when they perform poorly. This resonates with research by Msimanga et al. (2017), highlighting the psychological effects of academic underachievement. For learners to develop *wings,* they must see life sciences as meaningful and relevant. Learners who understand how the subject connects to their lives and future careers are more motivated to engage with the curriculum (Mnguni, 2018). The study's findings demonstrate that systemic inequalities often hinder learners' aspirations, but when supported, their confidence and motivation grow, enabling them to envision better futures. The interplay between self-esteem, motivation, and future aspirations underlines the importance of addressing systemic educational barriers.

The third finding indicates that teachers must utilise all the resources that can enhance student engagement and comprehension in life sciences. Effective teaching methods and resources are crucial in enhancing student engagement and comprehension in life sciences. The findings of this study align with existing literature emphasising the importance of active learning strategies. A learner-centred, inquiry-driven curriculum supports the cultivation of these *wings*, enhances engagement and empowers learners to take ownership of their education (Kurt et al., 2024). This finding corroborates the findings by Penn and Ramnarain (2019) and underscores the value of using technology in life sciences, arguing that such technologies offer learners hands-on experiences even without physical resources.

The last finding shows that, 21st-century digital tools are recognised as powerful pedagogical aids in life sciences classrooms. These tools represent the *wings* the capacity for digital innovations to make abstract concepts visible and comprehensible. This aligns with Kurt et al. (2024), who affirm that student-centred approaches, promote deeper understanding and retention of biological concepts. Furthermore, as Penn and Ramnarain (2019) argue, simulations and virtual labs help bridge the gap between theory and practice, especially in under-resourced settings. However, the findings also uncover substantial *roots, de*ep systemic constraints that prevent the full realization of these wings. Teachers report power outages, data shortages, and limited access to devices, which undermine even the most enthusiastic efforts to integrate technology. Learners' disappointment over the unsustained digital tools points to the inconsistency and fragility of innovation in these rural classrooms. This duality is further elaborated by Mokhtar et al. (2023), who emphasize that while technology can enhance 21st-century skills, its effectiveness is contingent on accessibility, sustainability, and teacher readiness. Teachers using their data and devices to compensate for school shortages demonstrate extraordinary dedication, but such efforts are unsustainable and inequitable, reinforcing the digital divide. Clark et al. (2023) propose that digital pedagogies, when systemically supported, can transform the teaching of life sciences. The use of technology also intersects with inquiry-based learning, which Syahdi et al. (2023) identify as a catalyst for developing both scientific thinking and 21st-century competencies. The *wings* of innovation (teacher motivation, learner enthusiasm, and pedagogical potential) are weighed down by the *roots* of systemic neglect (poor infrastructure, unreliable electricity, lack of devices, and high data costs). While the seeds of 21st-century science education are planted, they struggle to flourish without equitable resources and institutional support.

CONCLUSION

The study focuses on the factors affecting the performance of Grade 10 life sciences learners in schools. This study used the social constructivism theory through an interpretivist qualitative approach involving purposeful sampling of four schools, four teachers, and twelve learners; the study identified key challenges affecting Grade 10 learners' academic performance in the subject. The findings revealed four overarching themes: factors affecting learner performance, the effect of these factors on learners' self-esteem, motivation, and future career aspirations, strategies to improve their performance and uneven implementation of 21st-century teaching innovations in life sciences classrooms. The thematic analysis of interview data has highlighted the complexity of the educational environment in the district, where issues such as inadequate teaching and learning resources, language barriers, and teacher competencies were found to play a critical role in hindering learners' academic success. These findings align with existing literature that emphasises the disparities in resources and educational quality between urban and rural areas, particularly in subjects that require practical and hands-on learning, such as Life Sciences (Mlachila & Moeletsi, 2019; Adebayo et al., 2020). The lack of proper infrastructure, such as laboratories and access to digital tools, continues to present a significant barrier to effective teaching and learning in these schools. Furthermore, the study found that these challenges negatively affected learners' self-esteem, motivation, and aspirations for future careers in science-related fields. This finding highlights the importance of addressing the underlying factors affecting performance to ensure learners remain motivated and interested in future careers in life sciences. Finally, the study identified several strategies that could help improve Grade 10 learners' performance in life sciences.

Limitations

While this study has provided valuable insights, it is essential to acknowledge its limitations, including the small sample size and the focus on a single district. Future research could benefit from a broader sample size and a longitudinal approach to better understand the long-term impact of these factors on learner performance. Despite these limitations, the study contributes to the growing body of literature on factors influencing academic performance in rural South African schools. It provides practical recommendations for improving life sciences education in the region.

Recommendations

Based on the findings of this study, several recommendations can be made to improve learners' performance in life sciences. First and foremost, it is recommended that the Department of Education should prioritize providing adequate teaching and learning resources, particularly in under-resourced schools. This includes ensuring that schools have well-equipped science laboratories, digital tools, and access to interactive learning platforms. Such resources will facilitate practical engagement in life sciences, essential for developing scientific knowledge and skills. Given the language barriers faced by many learners, it is recommended that the Department of Education implements language support programs in schools, particularly in rural areas. Bilingual teaching strategies and additional language assistance should be integrated into the curriculum to help learners better understand complex scientific concepts in life sciences.

Secondly, it is recommended that teachers should strive to incorporate more interactive and digital learning tools into their lessons, such as simulations, videos, and online resources, which can help clarify complex scientific processes. These tools can complement traditional teaching methods and provide learners with a more engaging and practical understanding of the subject matter. Teachers should adopt differentiated teaching strategies accommodating learners' diverse linguistic and academic abilities. This could involve simplifying scientific language, using visual aids, and providing additional support to learners who struggle with the language of instruction and the content. Encouraging peer tutoring and collaborative learning can also help address gaps in understanding. Teachers should actively work to boost learners' self-esteem and motivation by providing positive reinforcement and setting realistic academic goals.

Thirdly, learners are encouraged to actively participate in class and use available resources to enhance their understanding of Life Sciences. Seeking help from teachers when faced with challenges and forming study groups with peers can also facilitate better understanding and academic improvement. Learners should try to improve their language skills by reading scientific texts in both their home language and the medium of instruction. Also, engaging in extra-curricular activities, such as language clubs or science fairs, can further enhance their language proficiency and scientific knowledge.

Lastly, parents should actively engage with their children's education by communicating with teachers and attending school meetings. Supporting homework and project work at home and encouraging learners to take an interest in life sciences will show learners that their education is valued and foster a positive attitude toward learning. Parents should create an environment conducive to learning by providing a quiet space for study and ensuring that their children have access to necessary learning resources.

Future research could focus on the impact of integrating digital tools and resources into life sciences education in rural schools. Future research could explore how virtual labs, interactive simulations, and educational tools can improve learners' understanding of complex biological concepts. This would include investigating whether these tools can mitigate the impact of resource shortages in under-resourced schools. Furthermore, examining how teachers can be trained to incorporate these digital tools into their pedagogical strategies effectively would provide valuable insights for future teacher development programs.

REFERENCES

Adebayo, K., Nzimande, N., & Grace, N. (2020). Availability of educational resources and student academic performances in South Africa. *Universal Journal of Educational Research, 8*(8), pp. 3768-3781. https://doi.org/10.13189/ujer.2020.080858

Al-Bahrani, M., Al-Lawati, S., Shindi, Y., & Bakkar, B. (2020). Career aspiration and related contextual variables. *International Journal of Adolescence and Youth, 25(*1), 703-711. https://doi.org/10.1080/02673843.2020.1730201

Babbie, E.R., (2020). *The practice of social research.* Cengage Au.

Bakokonyane, K. (2022). Influence of headship instructional leadership proficiencies on academic performance: the case of rural primary schools of Kweneng region in Botswana. *International Journal of Educational Management, 36*(4), 541-551. https://doi.org/10.1108/ijem-09-2021-0383

Boateng, S., & Maliwa, B. (2024). In-Depth Analysis of Contributing Factors Impacting Grade 12 Learners' Performance in Life Sciences "Investigation Questions": A South African Case Study. *International Journal of Learning, Teaching and Educational Research, 23*(2), pp.227-247. *https://doi.org/10.26803/ijlter.23.2.11*

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative research in sport, exercise and health, 11*(4), pp.589–597. https://doi.org/10.1080/2159676x.2019.1628806

Buma, A. M., & Nyamupangedengu, E. (2020). Investigating teacher talk moves in lessons on basic genetics concepts in a teacher education classroom. African *Journal of Research in Mathematics, Science and Technology Education, 24*(1), 92-104. https://doi.org/10.1080/18117295.2020.1731647

Clark, S., Wertzberger, E., & Darvishinia, N. (2023). Rethinking rural educational contexts as sites for teacher education to innovate teaching and learning.. https://doi.org/10.36315/2023v2end035

Cohen, L., Manion, L. & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.

Creswell, J.W. & Creswell, J.D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Department of Basic Education (DBE), 2011. *Curriculum and Assessment Policy Statement Grades 10-12 Life Sciences*. Pretoria, Department of Basic Education.

De Silva, A., Khatibi, A., & Azam, S. F. (2018). What factors affect secondary school students' performance in science in the developing countries? A conceptual model for an exploration. *European Journal of Education Studies*. https://doi.org/10.5281/zenodo.1239967

De Villiers, M. R. (2005). Three approaches as pillars for interpretive information systems research: development research, action research and grounded theory. In *Proceedings of the 2005 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries* (pp. 142-151).

Dhurumraj, T., & Moola, Z. (2023). Exploring teacher improvisation and its influence on learner performance in an under-resourced Grade 11 Life Science class. *International Journal of Research in Business and Social Science*, *12*(2), 384-392.

Etikan, I., & Bala, K. (2017). Sampling and sampling methods. *Biometrics & Biostatistics International Journal*, *5*(6), 00149.

Hudson, A. K., Moore, K. A., Han, B., Koh, P. W., Binks-Cantrell, E., & Joshi, R. M. (2021). Elementary teachers' knowledge of foundational literacy skills: a critical piece of the puzzle in reading science. R*eading Research Quarterly, 56(*S1). https://doi.org/10.1002/rrq.408

Kumar, R., (2019). Research methodology: A step-by-step guide for beginners (5th ed.). Sage Publications.

Kurt, Y., Doğanay, B., Soyer, S., & Şahin, M. B. (2024). The Effect of Student-Centered Teaching Methods and Techniques on Academic Achievement in Life Sciences Teaching: A Meta-Analysis Study. *International Journal of Scholars in Education*, *7*(1), 57-67.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.

Lehesvuori, S., Ramnarain, U. & Viiri, J. (2017). Challenging transmission modes of teaching in science classrooms: enhancing learner-centredness through dialogicity. *Research in Science Education, 48*(5), pp. 1049-1069.

Lin, J. W., Yen, M. H., Liang, J., Chiu, M. H., & Guo, C. J. (2016). Examining the factors that influence students' science learning processes and their learning outcomes: 30 years of conceptual change research. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(9), 2617-2646.

Lincoln, Y.S. & Guba, E.G., (1985). *Naturalistic inquiry*. Sage Publications.

Maharajh, L., Nkosi, T. & Mkhize, M. (2016). Teachers' experiences of the implementation of the curriculum and assessment policy statement (CAPS) in three primary schools in KwaZulu-Natal. *Africa's Public Service Delivery and Performance Review, 4*(3), pp. 371. https://doi.org/10.4102/apsdpr.v4i3.120

Makhene, A. (2022). Use of foundational knowledge as a basis to facilitate critical thinking: nurse educators' perceptions. *Nursing Research and Practice, 2022*, 1-7. https://doi.org/10.1155/2022/3736322

Merriam, S.B. & Tisdell, E.J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Mlachila, M., & Moeletsi, T. (2019). Struggling to make the grade: A review of the causes and consequences of the weak outcomes of South Africa's education system. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.3367432

Mnguni, L. (2018). The curriculum ideology recommended by novice teachers for life sciences in South Africa. *EURASIA Journal of Mathematics, Science and Technology Education, 14*(7). https://doi.org/10.29333/ejmste/91663

Mogashana, D., Basitere, M., & Ivala, E. (2023). Harnessing student agency for easier transition and success: the role of life coaching. *Journal of Student Affairs in Africa , 11*(1). https://doi.org/10.24085/jsaa.v11i1.4206

Mokhtar, K., Zerhane, R., Hammoumi, S., Mostafa, A., Kaddam, M., Drissi, M., ... & Janati-Idrissi, R. (2023). Pedagogical innovation and the development of 21st century skills and sustainable development in the teaching and learning of life and earth sciences in morocco. E3s Web of Conferences, 412, 01022. https://doi.org/10.1051/e3sconf/202341201022

Msimanga, A., Denley, P., & Gumede, N. (2017). The pedagogical role of language in science teaching and learning in South Africa: a review of research 1990–2015. *African Journal of Research in Mathematics, Science and Technology Education, 21*(3), 245-255. https://doi.org/10.1080/18117295.2017.1367874

Munda, S. W., Tanui, E. K., & Kaberia, L. (2000). Relationship between selected educational facilities and students academic performance in Secondary Schools in Bungoma District Kenya. *Kenya Journal of Education Planning, Economics and Management, Eldoview Graphics, Kakamega, Kenya*.

Munje, D. P. N., & Mncube, P. V. (2018). The lack of parent involvement as hindrance in selected public primary schools in South Africa: the voices of educators. *Perspectives in Education, 36*(1). https://doi.org/10.18820/2519593x/pie.v36i1.6

Muwanga-Zake, J. W. F. (2008). Framing professional development in information and communications technologies: university perspectives. Journal of Information Technology Education: Research, 7, 285-298. https://doi.org/10.28945/190

OECD (2018) Preparing our youth for an inclusive and sustainable world: The OECD PISA global competence framework. Paris: OECD (accessed 20 May 2020).

OECD (2019) PISA 2018 Assessment and Analytical Framework. Paris, France: OECD. Available at: https://read.oecd-ilibrary.org/education/pisa-2018-assessment-and-analytical-framework_ b25efab8-en#page1

Penn, M. and Ramnarain, U. (2019). A comparative analysis of virtual and traditional laboratory chemistry learning. *Perspectives in Education, 37*(2), 80-97. https://doi.org/10.18820/2519593x/pie.v37i2.6

Soyikwa, L., & Boateng, S. (2024). Teaching physical sciences in South African rural high schools: Learner and teacher views about the challenges. *Issues in Educational Research*, *34*(4), 1573-1595.

Spaull, N. (2015). Schooling in South Africa: How low-quality education becomes a poverty trap. *South African Child Gauge*, *12*(1), 34–41.

Syahdi, N., Nilyani, K., Anjani, H. R., Asrizal, A., & Mufit, F. (2023). Meta-analysis of the influence of science teaching materials based on inquiry models on 21st century skills. Jurnal Penelitian Pembelajaran Fisika, 9(2), 148. https://doi.org/10.24036/jppf.v9i2.123833

UNESCO (2020) Global Education Monitoring Report 2020: Inclusion and Education– All Means All. Paris, France: UNESCO. Available at: file:///Users/dcobb/Downloads/373718eng.pdf (accessed 20 November 2024).

Vygotsky, L. S. (1978) . *Mind in society: The development of higher psychological processes*, Cambridge, MA: Harvard University Press.

Wertsch, J. V. (2018). Vygotsky's classic. *Pacing and Clinical Electrophysiology*, *41*(1), 87-89.

Zhou, S. and Landa, N. (2019). Translanguaging as foundational pedagogy: disrupting hegemonies for academic access in multilingual spaces. Alternation Interdisciplinary *Journal for the Study of the Arts and Humanities in Southern Africa, 26*(2). https://doi.org/10.29086/2519-5476/2019/v26n2a13