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Résumé de l'article

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Abstract

This study explored the pedagogical strategies employed by grade 12, life-sciences teachers in township schools to teach complex concepts, such as genetics and meiosis, using improvised teaching resources. Resource constraints in South African township schools often limit learners' access to traditional teaching materials and technologies. In response, this research examined how teachers adapt and innovate their methods to effectively convey abstract life-sciences concepts. An embedded mixed-methods design was utilized, with a purposive sample of four life-sciences teachers from diverse township schools, selected to reflect varied teaching experiences and resource availability. Data was collected through interviews and classroom observations, offering insights into their instructional practices. Thematic analysis of interview data and systematic observation of classroom activities revealed a range of creative and adaptive pedagogical approaches. Instructors commonly adopted collaborative, learner-centred, and inquiry-based teaching methods. They employed creative strategies, including designing hands-on activities, using analogies, and incorporating real-life examples to enhance learners' understanding. Collaboration among teachers and the use of community resources also emerged as key strategies for enriching the learning experience. The findings underscore the resilience and ingenuity of grade 12, life-

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Introduction

In the realm of education, the quality of teaching is pivotal for the success of learners, irrespective of their socio-economic backgrounds. Township schools in South Africa, like many similar educational institutions around the world, often face resource constraints that can pose significant challenges for teachers in delivering effective and engaging lessons (Webb, 2023). In the context of life sciences, a critical subject that lays the foundation for understanding complex biological processes, such as meiosis and genetics, teachers in township schools are often required to navigate a landscape where traditional teaching resources may be scarce or outdated. This paper delves into the realm of pedagogical practices employed by grade 12, life-sciences teachers in township schools, when they are compelled to rely on improvised resources to teach the intricate topics of meiosis and genetics. Pedagogical practices refer to the strategies, methods, and approaches that teachers use to facilitate learning and deliver instruction effectively. These practices are informed by educational theories, subject matter, and the needs of learners. They encompass a wide range of techniques designed to promote engagement, understanding, and knowledge retention. Meiosis, the cell division process responsible for genetic variation, and genetics, the study of inheritance, are fundamental concepts in the life-sciences curriculum. Proficiency in these subjects is not only essential for academic success, but also for nurturing a generation of scientifically literate individuals who can contribute to societal development and make informed decisions regarding reproduction issues.

Understanding the concepts of genetics and meiosis has proven to be a formidable challenge for many learners in South Africa. The abstract nature of scientific knowledge presents a barrier to grasping these concepts (Chekour et al., 2018). Numerous scholars concur that the root of this challenge lies in the difficulties encountered when attempting to achieve the objectives of laboratory experiments (Hofstein, 2017). Additionally, the scarcity of essential teaching resources and facilities, particularly in underprivileged township schools, compounds this issue. Govender and Hugo (2020) contend that South African learners consistently underperform in international assessments, such as the Trends in International Mathematics and Science Study (TIMSS), Progress in International Reading Literacy Study (PIRLS), as well as in the matriculation examination.

The life-sciences subject offered during the Further Education and Training (FET) phase poses a significant challenge for students, as they often struggle to grasp and interpret abstract concepts outlined in the curriculum. These complex ideas encompass topics like meiosis and genetics, falling under Strand 1: Life at the Molecular, Cellular, and Tissue Level, as specified by the Department of Basic Education (2011). According to the 2021 National Senior Certificate report, the pass rates for life sciences have fluctuated in recent years. In 2018, the overall pass rate stood at 76.3%, as reported by the Department of Basic Education in 2020. The following year, 2021, saw a decline of 4%, with the pass rate dropping to 72.3%. Furthermore, in 2020, there was an additional decrease of 1.3%, resulting in a pass rate of 71.0%, as indicated by the Department of Basic Education in the same year. Finally, in 2021, there was a noticeable improvement, with the pass rate rising to 82.1%, marking an approximate increase of 11.1%.

The aim of this research is to explore the innovative teaching approaches, resourcefulness, and adaptability demonstrated by teachers in township schools, as they navigate the challenges of limited resources. The significance of teaching approaches lies in their ability to shape the learning environment, influence student engagement, and impact educational outcomes (Wang et al., 2022). Effective teaching strategies are essential for fostering meaningful learning experiences, developing critical skills, and addressing diverse learner needs (Kim et al., 2019). There has been research which investigated how teachers conduct lessons on basic genetics concepts in a teacher-education classroom (Buma & Nyamupangedengu, 2020), so by examining teachers’ strategies and experiences, this study sought to shed light on how these teachers effectively explain complex biological concepts to their learners, and foster an environment that promotes active learning, critical thinking, and scientific inquiry. Through a comprehensive investigation of classroom observations and interviews, the essence of the pedagogical practices that enable teachers to overcome resource limitations and inspire a passion for life sciences among their learners was captured. Ultimately, this research provides valuable insights for improving science education in underprivileged communities and offers a foundation for educational policy reforms that empower teachers with the tools and support that they need to nurture the next generation of scientists, thinkers, and leaders in township schools and beyond.

The Nature of Improvised Teaching Resources

The persistent issue of declining learner performance in South African science education has garnered significant attention (Dhurumraj & Moola, 2023). As noted by Chekour et al. (2018), this challenge often stems from the inherently abstract nature of scientific knowledge, which hinders learners' grasp of scientific concepts. Other scholars have postulated that learners' struggles in science can be attributed to their conceptions about the teaching and learning processes (Taber, 2017) and the limited ability of teachers to develop and employ effective pedagogical approaches (Chekour et al., 2015; Heering & Höttecke, 2014). Contemporary educational standards have highlighted the difficulty in achieving the objectives of scientific experiments in laboratories, particularly in South African schools, where access to adequate teaching resources and facilities is often inequitable (Hofstein, 2017).

Ramnarain and Mamutse (2016) observed that South African township schools continue to be inadequately resourced, lacking the essential facilities for conducting scientific practical work. For instance, Folorunso (2014) has pointed out the scarcity of suitable instructional resources for effective biology teaching in schools. Furthermore, there is a substantial disparity in resources between public and private schools (Amnesty International, 2020), making it difficult for teachers to effectively teach certain subjects, including biology (herein referred to as life sciences), which heavily relies on practical work and experiments. Okori and Jerry (2017) list various essential teaching resources, including microscopes, laboratory equipment, and educational materials, as critical for teaching biology. The absence of these resources poses a significant hurdle to achieving educational objectives, as emphasized by Ezechi (2019).

Ibitoye and Fape (2007) argue that poor achievement in biology can be attributed either to the inadequate use of instructional resources, or the poor state/lack of infrastructure facilities. Similarly, Okebukola (2014) asserts that the subpar state of laboratory facilities and insufficient utilization of instructional materials hinder learners' achievement in this subject. Availability of essential resources is recognized as a fundamental requirement for providing quality education to all learners (Ramothwala & Ramaila, 2020). Addressing these challenges calls for curriculum reforms that prioritize the development of effective pedagogical approaches and a shift from traditional knowledge transmission to more innovative methods, particularly the use of improvised teaching resources (Fayolle & Verzat, 2009). Such resources offer potential solutions to the performance issues in science subjects, as proposed by Ubawuike (2018), who suggests that improvisation can enhance conceptual understanding of scientific topics.

Ramaila (2022) found that the use of improvised teaching resources aims to optimize academic performance. Improvisation is defined as the creation and utilization of materials obtained from the local environment, allowing to produce unavailable equipment using accessible and cost-effective means for effective teaching (Nwosu et al., 2013). They serve as a cost-effective alternative to standard laboratory apparatuses required in science classrooms (Dhurumraj & Moola, 2023). Achimungu and Muftawu (2019) categorize improvisation as substitution, which involves using cost-effective materials in place of standardized laboratory equipment, and as construction, which entails creating new materials from scratch. Improvised teaching resources play a vital role in enhancing learners' understanding of challenging concepts, particularly those requiring skills in application, synthesis, evaluation, and higher-order cognitive processes, such as complex problem-solving and reasoning. These concepts are often considered conceptually difficult, especially in schools facing severe resource constraints.

Understanding pedagogical practices

At the core of every classroom is a vibrant fusion of methods, strategies, and approaches that shape the art and science of teaching. These are collectively referred to as pedagogical practices. At its core, pedagogy embodies the deliberate techniques teachers use to nurture knowledge, understanding, and skills in learners (Hegna & Ørbæk, 2021). From orchestrating engaging lessons to employing innovative tools, pedagogical practices are the catalysts that drive effective learning (Chigbu et al., 2023). Pedagogy, however, is not one-size-fits-all. It is shaped by guiding principles that ensure its relevance and effectiveness in diverse educational settings (Bondie et al., 2019). A cornerstone of pedagogy is the commitment to student-centred learning. This principle shifts the focus from what the teacher delivers to how the student learns, fostering active participation, inquiry, and collaboration. Alongside this, the principle of inclusivity and diversity ensures that every learner feels seen and valued, acknowledging differences in culture, language, and abilities.

Moreover, the constructivist approach—rooted in the belief that learners actively construct knowledge—encourages exploration, experimentation, and the development of critical thinking (Chand, 2024). Differentiated instruction complements this by tailoring teaching methods to individual needs, ensuring that all students are supported, to achieve their potential (Langelaan et al., 2024). Other guiding principles include the strategic integration of technology, which equips learners with essential digital skills, and reflective practice, which calls on teachers to continually assess and refine their methods. The impact of learning and applying these pedagogical principles cannot be overstated. For students, they translate into enhanced engagement and deeper understanding. Learners thrive in environments where they are active participants, and when their diverse needs are met with thoughtful strategies (Damyanov, 2024). Such practices foster not only academic achievement, but also the development of 21st-century skills—critical thinking, communication, and collaboration—that are crucial for success in a fast-changing world. Teachers, too, reap significant benefits from mastering pedagogical practices. They gain a toolkit for navigating the complexities of modern classrooms and a reflective mindset that promotes continuous professional growth. By honing their craft, teachers create classrooms that are more than places of instruction; they become communities where curiosity is ignited, challenges are embraced, and lifelong learning is instilled.

In summary, pedagogical practices are the foundation of transformative education. Rooted in thoughtful principles and delivering profound benefits, they ensure that both teaching and learning are meaningful, impactful, and deeply rewarding.

Pedagogical Practices Adopted by Science Teachers

A substantial body of literature has explored the teaching strategies employed in context-based science courses, with their impact on learning and motivation (Bennett & Holman, 2002). Researchers widely agree that teaching strategies play a pivotal role in guiding educational processes, ultimately leading to meaningful educational outcomes. Recent trends in academic research indicate that issues of poor academic performance in schools are not solely rooted in the subject matter itself but are also intricately linked to teaching practices (Ma et al., 2017). Consequently, contemporary research endeavours often focus on the development of pedagogical approaches to enhance the quality of science instruction and increase learners' motivation (Chekour et al., 2018; Heering & Höttecke, 2013). As articulated by Ramnarain and Fortus (2013), teachers employ various pedagogical strategies to translate their subject-content knowledge into a form readily comprehensible to their learners.

Furthermore, the provision of contextually relevant science education equips learners with knowledge, skills, and values that are directly applicable to their lives (Mavuru & Ramnarain, 2020). This underscores the importance of teachers possessing a particular form of pedagogical knowledge (PK) to effectively convey complex content knowledge to learners. Specifically, teachers should possess robust pedagogical content knowledge (PCK), as articulated by Shulman (1986). Hashweh (2005) suggests that PCK is topic-specific, with each topic requiring a unique teaching approach. Mavhunga (2014) argues that PCK varies significantly among topics and should be assessed at a topic-specific level. However, teachers' PCK cannot yield its full potential without access to adequate teaching resources and facilities, as emphasized by Ogunode et al. (2022). These resources and instructional materials, coupled with teacher expertise, are critical determinants of curriculum success.

Some researchers argue that working in socio-economically challenged communities presents additional difficulties, including inadequate initial teacher preparation, limited ongoing professional development opportunities, subpar school infrastructure that contributes to poor teacher performance, and an increased need for continuous support and teacher development through effective instructional leadership (Spaull, 2013). It therefore requires that teacher development programs empower educators with adaptable teaching approaches that are suitable for use in schools, regardless of their socio-economic contexts. Goldhaber et al. (2013) assert that formal teacher-education programs face the challenge of delivering ineffective instruction on educational theories, as there is insufficient evidence to suggest that teachers with theoretical knowledge are more effective than those without it. Consequently, there is a pressing need for practical pedagogical innovations that prioritize the development of teaching approaches conducive to meaningful teaching and learning of the life sciences.

Contextualized learning as a theoretical framework

Contextualized learning is an educational approach that emphasizes the importance of relating learning content to real-world situations, environments, or problems that learners are likely to encounter (Gebre & Polman, 2020). As a theoretical framework, contextualized learning challenges traditional, abstract forms of instruction that may feel disconnected from students' lived experiences and practical applications. By integrating real-life contexts into teaching and learning processes, this framework aims to make learning more meaningful, relevant, and engaging for students. At its core, contextualized learning recognizes that knowledge is not just something to be memorized or learned in isolation (Perin, 2011). Instead, it is something that becomes more valuable and enduring when it is connected to real-world contexts and practical use. This approach encourages students to see the direct relevance of their education in everyday life, particularly in professional, social, and cultural settings. For example, in a mathematics classroom, contextualized learning might involve using problems that relate to financial budgeting, architecture, or environmental conservation, all of which require applying mathematical concepts in a meaningful way (Yee & Bostic, 2014).

The theoretical underpinnings of contextualized learning are influenced by several prominent educational theories. One of the most persuasive is constructivism, particularly the work of Jean Piaget and Lev Vygotsky. Constructivist theory emphasizes the active role of learners in constructing knowledge through interactions with their environments. Contextualized learning aligns with this theory, by suggesting that learning is more effective when students are actively engaged with content that is embedded in real-life experiences. Vygotsky's concept of the zone of proximal development further supports contextualized learning by emphasizing the importance of scaffolding learners' interactions with the social and cultural context in which they live. Another key influence is situated learning theory, developed by Jean Lave and Etienne Wenger, which argues that learning occurs most effectively when it is situated within a context that is meaningful to the learner. According to this theory, learners do not simply acquire knowledge in a vacuum but rather learn through participation in authentic activities that mirror real-world tasks. In this way, learning becomes an integrated part of social practices, rather than a detached, isolated process.

Contextualized learning also draws from experiential learning theory, as articulated by Kolb (1984). Kolb's model highlights the importance of experience in the learning process, where knowledge is constructed through cycles of concrete experiences, reflective observations, abstract conceptualizations, and active experimentations. In the context of contextualized learning, students are encouraged to engage with the material in practical, hands-on ways that promote deep reflection and application (Perin, 2011). As a theoretical framework, contextualized learning offers several advantages. First, it fosters a more comprehensive understanding, because it connects academic content to students' real-world experiences, making learning more relevant. This relevance often leads to increased motivation and engagement, as students see the direct impact of their education on their personal and professional lives. Additionally, it promotes the development of critical thinking and problem-solving skills, since students are encouraged to apply knowledge to novel, complex situations that require thoughtful decision-making. Contextualized learning also supports inclusive education, by addressing the diverse backgrounds, experiences, and needs of learners. By recognizing the unique contexts from which students come, teachers can differentiate instruction in ways that make learning more accessible and meaningful for all students, including those from underrepresented or marginalized groups.

In summary, contextualized learning as a theoretical framework advocates for an approach to education that bridges the gap between academic learning and real-world application. It draws on constructivist, situated, and experiential learning theories to encourage active, meaningful learning experiences that are closely connected to students' everyday lives. By making education relevant and practical, contextualized learning enhances student engagement, supports critical thinking, and fosters a deeper understanding of content. It is a powerful framework for creating an inclusive, dynamic, and engaging learning environment that prepares students for success in an ever-changing world.

Purpose of the Study

The primary aim of this study is to explore and gain insight into the pedagogical practices employed by grade 12, life-sciences teachers when teaching complex topics, such as meiosis and genetics, with improvised or limited resources. This investigation specifically addresses the research question: What pedagogical practices do grade 12, life-sciences teachers use when teaching meiosis and genetics with improvised resources in township schools?

Methodology

The methodology employed in this study is outlined below.

Research design

A generic, qualitative approach was most suitable for this study, because it aims to explore and understand the pedagogical practices of teachers in a specific context. This type of research is a descriptive methodology aimed at understanding how individuals make meaning of a phenomenon or a situation, based on 'what will work best' in finding answers for the questions under investigation. This method can stand alone as a researcher's articulated approach (Merriam, 2009).

Selection of participants

This study involved a deliberate selection of grade 12, life-sciences teachers (n = 4) from four different township schools. They were specifically chosen from underperforming areas situated in Soweto, South Africa. The four schools selected for this study are part of a broader group of underperforming schools in this township. However, these institutions were chosen based on specific criteria related to their academic performances in life sciences, particularly in the context of teaching complex topics, such as meiosis and genetics, with limited resources. While there are other underperforming schools in this region, these ones were selected to ensure a focused and meaningful analysis within the scope of this study. A school can be considered of poor quality based on several factors, including low-academic performance (e.g., poor exam results or low pass rates), inadequate resources, lack of trained or qualified teachers, and challenges related to student engagement and retention. For this research, the focus was on schools with consistently low-academic achievement, specifically in life sciences, despite the efforts to improve teaching and learning conditions. The Soweto area was chosen for this study due to its unique socio-economic and educational context. It has a diverse student population, with many schools facing challenges, such as under-resourced classrooms and high levels of poverty. By focusing on Soweto, this inquiry aims to gain insight into the pedagogical practices used by teachers in one of South Africa's most historically marginalized areas. This location was selected to explore how teachers navigate resource limitations in a context where educational inequalities are most pronounced.

The application of purposive sampling was employed to ensure that only teachers possessing the requisite qualities were included, thereby ensuring that the data collected would be directly pertinent to addressing the research questions. Purposive sampling was chosen, because it entails the deliberate selection of participants based on the specific qualities that they possess (Etikan et al., 2015). This research study consciously opted for teachers from diverse township schools, with the aim of gaining a broader spectrum of insights, knowledge, and valuable data derived from their experiences in teaching genetics and meiosis in these situations. This decision was made to ensure that the study's participant pool was sufficiently diverse to capture a wide range of experiences, while avoiding unnecessary repetition (O'reilly & Parker, 2013).

Furthermore, this investigation focused on township schools, as they often lack essential teaching resources, resulting in learners' underperformance in critical subjects, such as the life sciences. All the participating teachers had over five years of experience in teaching grade 12, life sciences. Among them, three possessed a four-year bachelor's degree in education obtained from South African universities, while one teacher held an honour's degree in science teaching. It is evident from this information that the selected participants were highly experienced professionals with a wealth of insights and expertise in teaching this subject matter. This factor was deemed essential for the study, as well-qualified and experienced participants were expected to provide valuable and meaningful data that could potentially inform pedagogical reforms aimed at enhancing the quality of teaching and learning genetics and meiosis in township schools.

Data collection

In collecting the qualitative data, classroom-lesson observations were made, followed by the administration of interviews with the participants.

Lesson observations To explore the pedagogical practices employed by grade 12, life-sciences teachers when utilizing improvised resources for teaching meiosis and genetics, classroom lesson observations were made. An observation tool was devised to evaluate how teachers made use of improvised teaching resources and the overall impact of these on the teaching and learning of meiosis and genetics within the chosen township schools. As stated by Shah and Harthi (2014), classroom lesson observations are an integral component of summative assessment of a lesson, and involve systematic scrutiny of events and interactions that occur during classroom instruction. They are regarded as a valuable tool for comprehending classroom dynamics and achieving high standards of effective teaching methodologies. Each teacher was observed, while teaching genetics or meiosis concepts, using the designated improvised teaching resources, which involved a specific teaching approach. A specialized observation checklist, created by one of the researchers, was used to investigate the characteristics of the improvised teaching resources and the pedagogical practices employed by teachers when they were teaching meiosis and genetics. Jilcha (2019) highlights that observational research is known for its strong validity, because it allows the researcher to gather in-depth information about specific behaviours. During the observations, the researcher assessed the appropriateness of the teaching approaches used by the teachers, and the ways in which these approaches or teaching tools effectively conveyed the content to the learners. Teachers were guided regarding the teaching approaches that they should adopt, enabling the researcher to identify suitable teaching approaches for them, when utilizing improvised educational resources for instruction of meiosis and genetics.

To effectively observe the teaching approach, resourcefulness, and adaptability demonstrated by the teacher, according to the research objectives, a multi-faceted approach was employed. It involved a combination of direct classroom observations, interactions with the teacher, student feedback, and an analysis of instructional materials. All these components helped to provide a comprehensive understanding of each of the teachers' methods, along with their abilities to manage complex teaching scenarios, particularly in under-resourced settings.

Observing the teaching approach

The first step was to observe how the teacher organized and delivered the lesson. This included paying close attention to the instructional methods used to teach complex topics, such as meiosis and genetics. A key aspect to focus on was the teacher's ability to present abstract scientific concepts in ways that students could easily comprehend. For instance, the teacher might have broken down difficult topics into smaller, more manageable parts, or used analogies to make the content more relatable. During the observation, it was important to assess how the teacher engaged students, prompting them to think critically and participate actively. The teacher's use of questioning techniques to gauge understanding and promote discussion was also a focal point, as this helped to create an interactive and learner-centered environment.

Assessing resourcefulness

Resourcefulness was observed by examining how the teacher adapted to the limitations of the available resources. In schools with limited materials, teachers often had to be creative in utilizing what was at hand. This might have included using everyday objects to illustrate biological processes or making visual aids to explain complex scientific concepts. The teacher's ability to improvise and make the best use of the resources at hand was a strong indicator of their ingenuity. During the observation, notes were taken on how the teacher navigated these challenges by employing alternative strategies, or materials, to ensure that the lesson was both engaging and effective.

Evaluating adaptability

Adaptability referred to how the teacher adjusted the teaching methods in response to students' needs, or unexpected classroom challenges. Throughout the lesson, the teacher's ability to modify the approach, based on student feedback, or in reaction to unanticipated issues, such as student disengagement, lack of understanding, or technical problems, was observed. For example, if a particular teaching strategy was not yielding the expected results, the teacher might have quickly shifted to a different approach. In addition, real-time adjustments to the lesson were made to accommodate the class's learning pace or address any difficulties that the students were encountering. A teacher's flexibility in these moments demonstrates adaptability and commitment to meeting the diverse needs of all the students.

Teacher interviews and self-reflection

In addition to classroom observations, interviews with the teachers provided valuable insight into their pedagogical decisions. Through one-on-one discussions, the teachers reflected on their own practices, explaining why they used certain strategies, and how they overcame challenges related to resources. Questions were directed at understanding the teachers' thought processes behind adapting lessons, managing classroom dynamics, and fostering an environment conducive to learning, despite limitations.

Gathering student feedback

Another important aspect of evaluating the teaching approach, resourcefulness, and adaptability was gathering feedback from students. This was done through surveys, focus groups, or informal discussions that allowed students to express their views on the teaching strategies, the effectiveness of the lessons, and how well they were able to engage with complex topics. Student feedback provided indirect evidence of how the teachers' resourcefulness and adaptability impacted their learning experiences.

Analyzing Lesson Plans and Materials

Lastly, reviewing the teachers' lesson plans and instructional materials offered insights into their planning processes. Effective teachers, particularly in resource-limited settings, often modify or adapt lesson content to suit their students' needs. By examining the materials used during the lesson, and comparing them to the original lesson plan, the alignment between the teachers' pedagogical approaches and the available resources was assessed.

In summary, observing the teachers' approaches, resourcefulness, and adaptability involved a combination of direct observation, teacher reflections, student feedback, and an analysis of instructional planning. Through these methods, the study gained a deeper understanding of how these instructors navigated the challenges of teaching complex subjects in under-resourced classrooms, ensuring that students received a high-quality education, despite the constraints.

Semi Structured Interviews Each teacher was then interviewed individually using a semi-structured interview schedule. The interviews were meant to elicit more comprehensive insights and conduct an in-depth analysis of the research topic (Showkat & Parveen, 2017). Interviews are particularly well-suited for qualitative studies aimed at exploring participants' experiences, beliefs, or identities, as they provide the researcher with valuable, in-depth information (Mann, 2011). In the context of this study, semi-structured interviews enabled the use of a predetermined topic schedule, while allowing for unanticipated responses, and the emergence of unforeseen issues (Tod, 2006). Furthermore, Jilcha (2019) notes that semi-structured interviews are typically conducted in face-to-face settings, enabling the researcher to uncover new insights, pose probing questions, and examine phenomena from various perspectives. This approach is particularly appropriate for this study, since it seeks to gain a comprehensive understanding of teaching approaches, behaviours, and actions (pedagogical methods) employed by teachers when instructing abstract life- sciences topics.

Data analysis

In this study, a thematic data analysis model was used to examine the pedagogical approaches of teachers utilizing improvised teaching resources to teach genetics and meiosis. Thematic analysis, as described by Braun and Clarke (2013), offers flexibility and can be adapted to various research perspectives. This investigation employed a hybrid coding approach, combining both inductive and deductive coding methods. Deductive coding involved the creation of a priori codes based on research objectives, questions, and specific interview inquiries, following Crabtree and Miller's (1999) approach. Simultaneously, posteriori codes were generated through an examination of the collected data, drawing from Charmaz (2006) and Boyatzis (1998), allowing for the emergence of new themes during the coding process. This coding method was suitable for the study, as it allowed for the exploration of teaching approaches that aligned with the research goals. The data analysis process involved organizing interview transcripts to identify potential themes. Additionally, an observational checklist was used to evaluate various aspects of the lessons, including how teachers employed improvised teaching resources and learner behaviour. The checklist aimed to investigate the pedagogical practices of grade 12, life-sciences teachers when teaching genetics and meiosis. This comprehensive tactic provided insights into the diverse teaching methods used by teachers.

Findings Emanating from Lesson Observations

The analysis of observational data led to the identification of several recurring themes: 1) collaborative learning; 2) use of information and communication technology (ICT); 3) inquiry-based learning approaches; 4) utilization of locally produced resources; and 5) learner-centred teaching approaches. In the first school (School 1) that was observed, the teacher organized the learners into groups, with each group representing a specific blood group in humans. This instructional approach indicated that collaborative learning was employed by the teacher to facilitate comprehension of a sub-concept within the genetics topic. Similarly, in another school (School 2), learners were grouped, and each was provided with dough and other materials to create chromosomes, simulating processes that occur during meiosis. School 3 saw learners working in groups, utilizing locally-produced resources, like bricks and stones, to construct a cell, along with its components, collaboratively. In School 4, learners worked in pairs, illustrating the use of collaborative learning approaches by teachers to help learners make sense of complex life-sciences topics.

Moreover, three out of the four observed schools incorporated ICT into their teaching approaches to enhance the understanding of various life-sciences concepts. These schools utilized technological resources, such as data projectors, laptops, video animations, and PowerPoint presentations to present content to the learners, emphasizing the use of technology as an instructional tool for facilitating meaningful comprehension. Throughout all the observed lessons, most teachers made extensive use of locally available teaching resources, including cardboard boxes, dough, bricks, plastic bottles, and more. This demonstrated the teachers' reliance on improvised teaching resources as substitutes for conventional science equipment, particularly in situations where there were shortages of teaching materials in the schools.

Furthermore, three of the four schools visited faced significant resource constraints, prompting teachers to opt for cost-effective improvised teaching resources when teaching life-sciences concepts. This pedagogical approach encouraged teachers to use teaching resources and materials that were readily accessible to learners, aiding in their understanding of abstract subject matter. All the observed teachers employed inquiry-based learning in their instruction of genetics and meiosis. They consistently encouraged learners to ask questions, fostering an active engagement of inquiry, through prompts, such as, "What do you guys think?" and "What is your opinion?" These types of questions facilitated learner-driven inquiry and contributed to a more comprehensive understanding of genetics and meiosis.

Findings emanating from semi-structured interviews

The results are organized based on the themes that surfaced during the analysis of interview data. They include collaborative learning approaches, the incorporation of ICT as a teaching method, the utilization of improvised teaching resources, and the implementation of inquiry-based learning.

Theme 1: Collaborative learning approaches The teachers employed a collaborative learning approach by creating situations in which learners could work together in groups during the instruction of genetics and meiosis. This instructional strategy is evident in the following teacher responses.

> *The learners work in groups, for instance, we have created chat groups on WhatsApp, where learners work together, helping each other when they are not together in school. But I won't lie, sometimes these learners can be chaotic, especially in those groups. They sometimes can misbehave, if ever they are left unsupervised. Technology becomes interesting if it is used collaboratively, so that even those that [sic] do not know how to use it, are assisted by the ones who know. (*Agnes Teacher 2*)*

> *One of the strategies that I have adopted, from when I was doing my schools [sic] experience, is collaborative teaching strategies, especially what my [sic] used to call the jigsaw method. I always use this method, and I find it useful, because when learners work together, even the ones that [sic] do not understand the content, end up being assisted by the others. But then again, you cannot only use one method, [so,] sometimes [I] tell them to go and research at home. For instance, in genetics, I sometimes tell them to [do] research on genetically-modified foods/ organisms. If learners do research by themselves, they learn more*. (Rachel Teacher 3)

Theme 2: Integration of ICT as a teaching approach The teachers incorporated technology into their instruction of meiosis and genetics. This teaching approach is evident in the following responses.

> *Ok, so, I always prefer using materials and tools that they are used to and are familiar with. For instance, I always use social platforms, such as WhatsApp, Google, and YouTube. These platforms are useful, because learners are stimulated by technology. They know technology more than us, so I usually use technology. Sometimes, I even take videos and communicate with them, which makes it easier for me to teach*. (Agnes)

> *We have created chat groups on WhatsApp, where learners work together, helping each other when they are not together in school. Technology becomes interesting if it is used collaboratively, so that even those that [sic] do not know how to use it, are assisted by the ones who [do] know*. (John)
> *In everything I do, there is always the use of technology…they even call me, 'the modern teacher,' at my school, so I'm very technological. I use projectors, animations, [and] videos. I even joined a special cause [sic] [class] on coding, which taught me more on how to make use of technology…. technology is the new now.* (Patricia)

These responses indicate that the teachers were willing to leverage the capabilities of ICT to simplify complex life-sciences concepts, like genetics and meiosis. Arnseth and Hatlevik (2012) contend that the integration of ICT tools into the learning process creates a dynamic and engaging teaching-learning environment. Pedagogical approaches enhanced by technology enhance the quality, accessibility, and cost-effectiveness of instructional delivery to learners (Albirini, 2006).

Theme 3: The use of improvised teaching resources Most teachers reported challenges associated with the accessibility of teaching materials, primarily because township schools often lack adequate resources. These feelings are evident in the following excerpts.

> *Life sciences is very challenging, especially to learners who are in the humanities stream. The language used in life sciences is one of the major challenges, since learners often fail to understand the language.* (Peter)

> *There are many challenges that we face in our schools. Things like resources for teaching, and most especially, you find that sometimes the textbook says [to] use this resource, which you do not have at school. An example is the practical [experiment] for extracting DNA. You find that we do not have the necessary resources to teach, or conduct, such practical's, [sic] you see. One other thing, the learners in our school don't listen. Some of them come to school to disrupt lessons. Even if you have prepared lessons, they end up not going accordingly*. (Agnes)

> *Learners seriously have a challenge with the understanding of life sciences…I think that it should only be for sciences learners, because it's very difficult for general (Humanities) learners. The terminology is difficult, and some topics, such as genetics and evolution, are very challenging for learners.* (Patricia)

> *For me, I would say, since this is still a new school, I don't have much of a problem with administrative issues. However, since it is new, I always have to outsource resources from other schools, because we don't have some resources to teach. But slowly, the new principal is trying her best to improve the school. She is trying. We are very under-resourced in this school. I mean, as you can see, we are teaching in these shacks. There are no resources. Sometimes, we cannot even make copies, because of [the lack of] ink, papers, load shedding, etc.…It's a challenge for us here.* (John)

Theme 4: Inquiry-based learning The teachers leaned towards employing inquiry-based learning to foster meaningful engagement with the content. The utilization of this technique is evident in the following responses.

> *I basically teach, assess, evaluate, and remediate. That's my strategy…in my assessment, I always ensure that I use past exam papers and not the textbook, and in those papers, I allow them to engage with the content by themselves. [When]do[ing] activities and answer[ing] concepts, especially in genetics, I use inquiry as a teaching strategy.* (Rachel)

> *Some of the things, such as beakers…we sometimes use transparent plastic cups to put solutions [in], etc…,like we did this other day, when we were doing food tests with my grade s [sic]…I literally had to use paper cups, because there were no beakers available for all learners within groups. Also, when I allow them to use these resources, explore by*

themselves. I will then allow them to ask questions [and] draw conclusions…that's what science is about. They need to formulate [a] hypothesis and come up with informed conclusions (laughs). I'm also a physical sciences teacher. (Peter)

So, let's say I do not have a teaching resource, I will make sure that I find other alternatives to teach the concept. Let's say [that] I need to extract DNA from grapes. If I do not have the grapes, I will always go for an alternative……We have very good facilitator who always gives us alternatives. This other year, she gave us handouts with flaps and folds, and learners had to fold them and make the structure of the ear. This activity was very informative to learners, because they were engaged. I'm telling you; they were asking questions and very engaged. (John)

Discussion

Teaching resources

The results of this study unveiled several methods that teachers can employ when utilizing improvised teaching resources to instruct genetics and meiosis in township schools. The teaching methods employed by life-sciences teachers, when utilizing improvised teaching resources for instructing genetics and meiosis in township schools, encompassed collaborative-learning approaches, learner-centred strategies, constructivist approaches, inquiry-based methodologies, and the integration of ICT tools. Furthermore, teachers incorporated technology-enhanced pedagogical methods when employing improvised resources for instructing genetics and meiosis in township schools. These improvised teaching resources encompassed items such as card boxes, charts, dough, and strawberries, among others. Notably, learners who were taught with improvised teaching resources outperformed those who were instructed using conventional teacher-centred approaches. As highlighted by Ramnarain and Mamutse (2016), there is a pressing need for adequate scientific resources in South African public schools to facilitate scientific investigations by teachers. This need is particularly acute in under-resourced schools, where material deficiencies often lead to the adoption of behavioural pedagogical approaches, contrasting with the constructivist paradigm, which is preferred, for promoting learners' scientific inquiry (Dhurumraj & Moola, 2023).

Teaching approaches

The interconnection between teaching approaches that are employed by teachers, when utilizing improvised resources for teaching genetics and meiosis in township schools and constructivism, is visually represented in Figure 1 below.

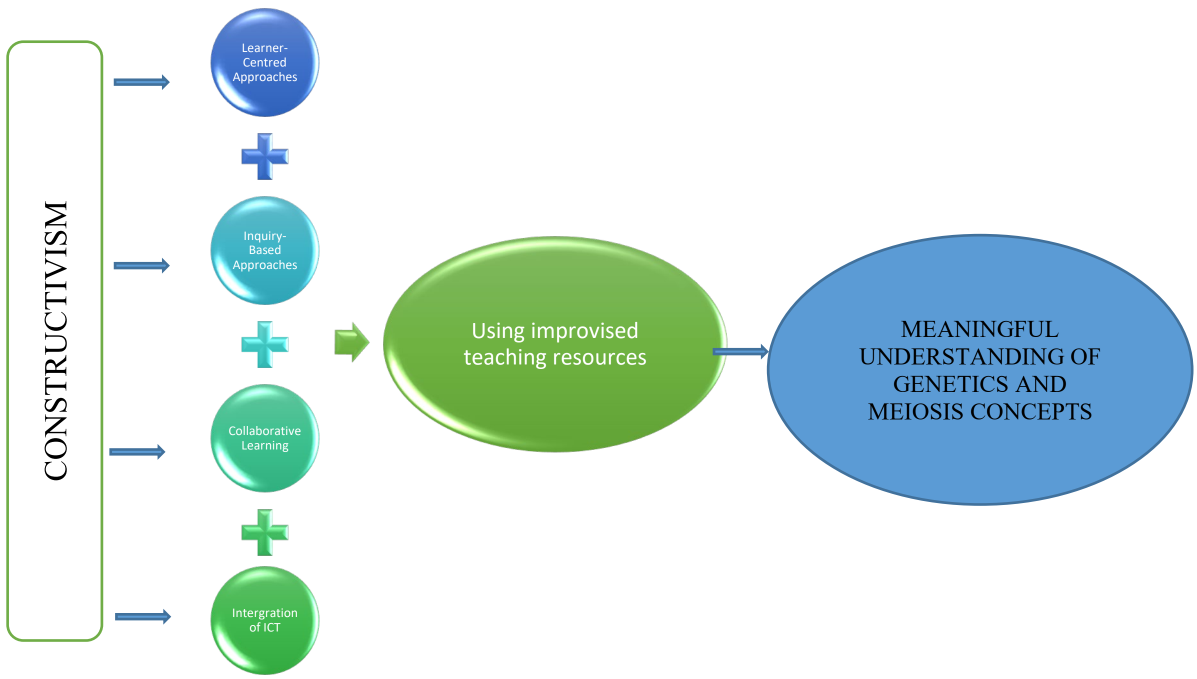

Figure 1: The link between teaching approaches adopted by teachers and constructivism

The visual representation above reaffirms the consistent utilization of learner-centred approaches, inquiry-based approaches, and collaborative learning approaches by life sciences teachers. Nevertheless, it is essential to complement these teaching strategies with the integration of ICT to enhance constructivist learning. Figure 2, which follows, illustrates the connection between learner-centred approaches and constructivism.

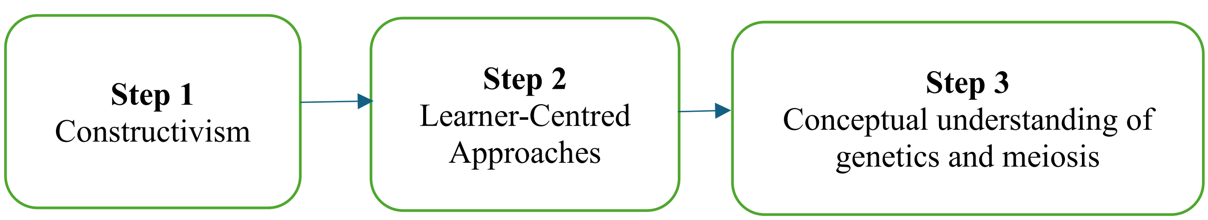

Figure 2: The link between learner-centred approaches and constructivism

Constructivism is widely recognized as an epistemological perspective, as well as a theory of learning and knowledge acquisition, providing insights into the nature of knowledge and the processes through which individuals learn. According to this theory, genuine understanding is built upon learners' prior experiences and existing background knowledge. In contrast, learner-centred teaching represents a pedagogical approach that places significance on learners' ideas and viewpoints, engages them in critical thinking, and considers their needs and beliefs (Pierce & Kalkman, 2003). Tudor (1993) similarly emphasized that learner-centred teaching approaches are fundamentally rooted in the idea that learning activities become more meaningful when learners, rather than the teacher, have a say in determining the conceptual and linguistic content of those activities.

Therefore, it is imperative for teachers to conduct learner-centred teaching approaches when utilizing improvised resources for teaching genetics and meiosis. This approach allows learners to fully realize the pedagogical advantages of constructivism, as these theories posit that individuals construct their own understanding, or knowledge, by actively engaging with their existing beliefs, and the ideas, events, and activities that they encounter (Ültanır, 2012). Consequently, by granting learners the opportunity to construct their understanding, they are more likely to effectively engage with abstract concepts, like genetics and meiosis. This approach becomes particularly valuable in under-resourced township schools, where access to suitable teaching resources for certain topics is limited. In such circumstances, teachers must creatively develop and adopt appropriate, improvised resources for teaching these subjects.

When employing improvised teaching resources, it is essential for teachers to adopt learner-centred teaching approaches, as a constructive strategy, for simplifying intricate life-sciences concepts. As defined by Ibrahim et al. (2018), the utilization of improvised teaching resources involves adapting and utilizing local materials when there is a scarcity, or absence, of manufactured learning supplies. This implies that teachers find locally-produced materials that learners are largely familiar with, as they are readily available within their local surroundings. Consequently, teachers should empower their students to independently employ these resources to construct their own knowledge. When implemented effectively, this approach has the potential to facilitate a profound conceptual grasp of complex subjects, such as genetics and meiosis.

The connection between inquiry-based teaching approaches and constructivism is visually represented in Figure 3 below.

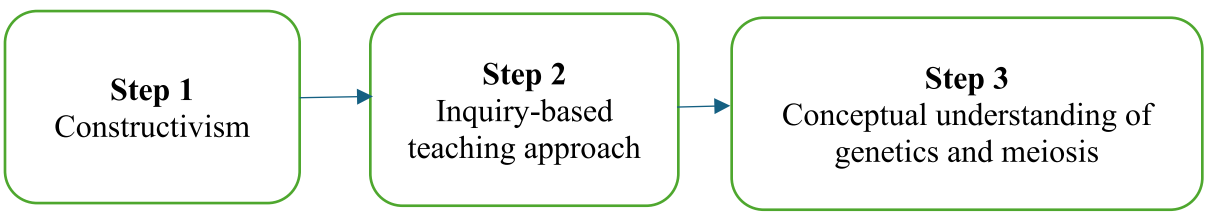

Figure 3: The link between inquiry-based teaching approaches and constructivism

The study brought to light a significant emphasis on inquiry-based teaching approaches, which are closely aligned with constructivist theories. Inquiry-based learning can be defined as active engagement by learners in the process of formulating investigative questions, designing and executing investigations, drawing conclusions from the results, and effectively communicating their findings (Mkimbili, 2018). These actions and activities empower learners to grasp abstract concepts more effectively, because through the act of asking questions, conducting investigations, drawing conclusions, and communicating their findings, they tend to take ownership of the knowledge that they have actively constructed. When learners are actively engaged in inquiry-based teaching, their critical-thinking abilities, individual needs, and interests are considered during the planning and implementation of instruction (Vavrus et al., 2013). Consequently, these activities enable learners to become active builders of knowledge, ultimately fostering a profound understanding of abstract subjects, such as genetics and meiosis.

This approach is particularly crucial in situations where teachers rely on improvised resources to elucidate abstract scientific concepts. These learning materials serve as valuable supplements to authentic scientific equipment, especially in schools that lack access to the necessary scientific apparatuses. In fact, as suggested by Ezechi (2019), created teaching supplies function as alternative resources that can effectively substitute for the actual equipment, which may often be unavailable. The connection between collaborative learning approaches and constructivism is illustrated in Figure 4 below.

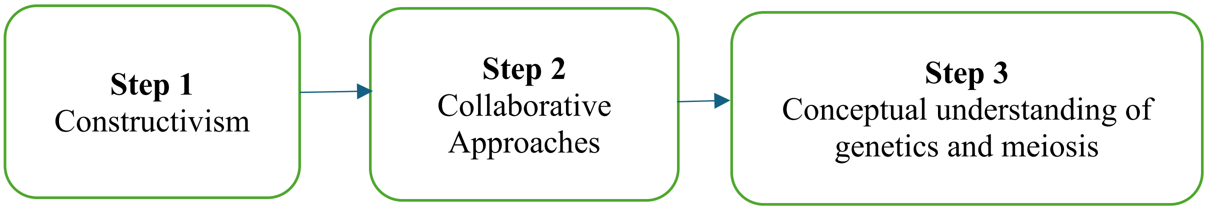

Figure 4: The link between collaborative learning approaches and constructivism

Collaboration has emerged as a fundamental skill in the 21st century, driven by the growing societal need to address critical issues collectively (Austin, 2000). This shift places greater emphasis on collaborative group efforts over individual endeavours and emphasizes the importance of community over independence (Leonard & Leonard, 2001). Numerous researchers have underscored the significance of collaborative learning as a pivotal approach for effective teaching and learning in the 21st century. It is also one of the teaching methods employed by teachers when using improvised resources to teach genetics and meiosis. As pointed out by Srinivas (2011), collaborative learning provides students with opportunities to engage in meaningful conversations with their peers, present and defend ideas, exchange diverse perspectives, challenge existing beliefs, and actively participate in the learning process. Through these interactions, learners construct knowledge and ideas, facilitating conceptual changes and the elimination of misconceptions. Therefore, this study acknowledges collaborative learning as a central approach to constructivist learning, capable of fostering a deep understanding of genetics and meiosis. Collaborative learning can be utilized by teachers when using improvised teaching resources to teach genetics and meiosis. This is because improvised teaching resources must be identified by teachers and adapted to align with the specific learning objectives of the topics being taught. This approach acknowledges the practical challenge of creating customized resources for each individual learner in the classroom.

In the next section, the key elements related to ICT integration, teaching resources, and teacher adaptation, as they pertain to the research objectives of understanding how grade 12, life-sciences teachers navigate teaching complex topics, like genetics and meiosis, under resource constraints, will be addressed.

Explanation of ICT integration

To find an explanation of ICT integration, it is helpful to refer to Figure 1, which provides a visual representation of how information and communication technology (ICT) tools are incorporated into the teaching of complex subjects. This integration is often depicted through models that demonstrate its role in facilitating engagement, improving the accessibility of learning materials, and promoting interactive learning. Figure 1 outlines various ICT tools, such as online simulations, digital resources, educational apps, and virtual-learning environments that can enhance students' understanding of topics, like genetics and meiosis. The explanation in the figure will likely show how these technologies allow teachers to provide visualizations, simulations, and interactive exercises that support abstract scientific concepts. ICT integration also enables teachers to extend learning beyond the classroom, promoting independent learning and providing opportunities for real-time feedback.

Explanation of teaching resources

The explanation of teaching resources can be found in various parts of the study, particularly those focused on the strategies used by teachers in resource-limited settings. Teaching resources refer to the materials and tools teachers utilize to support their instruction and aid student learning. These resources can be physical or digital, ranging from textbooks and worksheets to online videos and interactive tools. In schools with limited resources, teachers often must be creative in utilizing everyday objects, makeshift visual aids, or repurposed materials to illustrate complex concepts like genetics and meiosis. For example, teachers might use objects like paper cutouts, string, or local plants to demonstrate processes, such as cell division. In addition, teachers may rely on free, or low-cost, online resources, such as videos or interactive simulations, to create a more dynamic learning environment. The ability to improvise and adapt supplies to meet the needs of students is a crucial component of effective teaching in under-resourced settings.

Explanation of teacher adaptation

Teacher adaptation refers to how instructors modify their teaching methods and strategies in response to the varying needs of their students, the availability of resources, and the challenges that they face in the classroom. According to the research objectives, teacher adaptation is a critical aspect of effective teaching in resource-limited environments. The research highlights how teachers adjust their instructional approaches to ensure that students grasp complex scientific topics, such as genetics and meiosis, despite the lack of sufficient resources. This form of adaptation can take several forms, including altering lesson plans to accommodate available supplies, shifting instructional strategies based on student engagement and understanding, and improvising when certain materials are unavailable. Teacher adaptation is often an ongoing, dynamic process, where educators continuously assess student needs and make real-time adjustments to their teaching methods. The study's focus on adaptation examines the teachers' ability to remain flexible and responsive, fostering an environment where students can still achieve success, even when faced with resource constraints. This form of adaptability demonstrates the teacher's commitment to student-centred learning and the effective management of classroom challenges.

In summary, understanding ICT integration, teaching resources, and teacher adaptation is essential for evaluating how grade 12, life-sciences teachers manage the teaching of complex topics under constrained conditions. These elements play a significant role in supporting student engagement, promoting resourceful teaching practices, and ensuring that lessons are adapted to meet the needs of learners, even in challenging school environments. Through this discussion, the study aims to provide a comprehensive understanding of how teachers navigate these areas to create effective learning experiences.

Implications for Science Teaching and Learning

This study highlights the severe resource constraints faced by schools in township areas, particularly in subjects like life sciences. While the learning approach adopted by teachers is theoretically designed to improve student learning outcomes, the persistent lag in academic performance raises critical questions. Why are these schools still underperforming, despite the use of appropriate teaching strategies? Is the approach unsuitable for the students' backgrounds, or is there a more fundamental issue at play? The answer may lie in the availability and quality of learning supplies. Although teachers are often resourceful and employ creative methods to overcome these challenges, the lack of proper learning materials remains a significant obstacle. This shortage limits their ability to fully implement teaching approaches that could otherwise enhance student understanding and achievement. Teachers in township schools must often adapt their lessons to compensate for the absence of textbooks, laboratory equipment, or digital tools, but even the most adaptable teaching methods are hindered when the necessary resources are simply unavailable. This situation underscores the urgent need for increased funding and resource allocation to township schools. It is essential that educational policymakers prioritize addressing the disparities in resources between township schools and more privileged institutions. Without equitable access to quality instructional materials, even the best teaching approaches will struggle to produce the desired student learning outcomes.

This study's findings call attention to the significant educational inequities that exist between schools in under-resourced communities and those in more affluent areas. Policymakers and educational leaders must take these disparities into account when designing strategies to improve educational quality. By ensuring that teachers in underprivileged schools have access to the necessary resources and support, they can be empowered to use their adaptability to its fullest potential. Addressing these disparities should be a top priority for those working to foster equity in education and improve learning outcomes for all students, particularly those in underserved areas.

Teachers in township schools may benefit from specialized training and support to help them make the most of limited resources. Professional development programs can focus on pedagogical practices that are effective in resource-constrained environments. This study highlights the importance of community involvement in improving the educational outcomes of township schools. Community support and partnerships can help supplement the resources available to these schools. This paper suggests the need for curriculum adaptation to suit the specific context of township schools. Curricular materials and teaching methods may need to be tailored to make the best use of available teaching tools. Policymakers can use the research findings to inform decisions about resource allocation, teacher training programs, and other policies aimed at improving education in township schools. The study's implications extend beyond South Africa and can be relevant to addressing educational disparities in other parts of the world where underprivileged schools face similar challenges. This research could inspire further studies to examine the pedagogical practices in resource-constrained settings, potentially leading to the development of best practices and innovative teaching methods for such environments.

In summary, this paper highlights the challenges and opportunities associated with teaching life sciences in township schools with limited resources. Its implications can inform educational policies, teacher training, and efforts to improve the quality of education in underserved communities.

Limitations of the Study

This study provides valuable insights into how teachers in resource-constrained environments adapt their teaching methods to overcome the challenges posed by a lack of materials. However, like any research, the study has several limitations that must be acknowledged, to provide a clearer understanding of the scope and the context of the findings. Firstly, sample size is a key limitation. The study focused on a small number of grade 12, life-sciences teachers (n = 4) from four township schools in the Soweto area of South Africa. While this allows for in-depth qualitative insights, the limited sample size may not be fully representative of the broader population of township schools.

Thus, the findings may not be generalizable to all schools in similar resource-poor environments across the country.

Secondly, geographic limitation affects the applicability of the study's results. By selecting teachers exclusively from the Soweto area, the study is geographically constrained, potentially overlooking regional variations in teaching practices and resource availability. Different areas may face different educational challenges, or have different levels of community and governmental support, which could influence how teachers approach the teaching of complex topics, like meiosis and genetics.

A third limitation is the focus on a specific subject area. While the study provides rich data on how teachers approach teaching meiosis and genetics using improvised resources, it does not address how these strategies may apply to other subjects or topics within the life-sciences curriculum. The unique nature of teaching genetics and meiosis, with its complex scientific concepts, may require specific pedagogical adaptations that may not necessarily apply to other subject areas.

Another limitation is the teachers' self-reports during interviews and reflections. While these interviews provide valuable insight into their perceptions and practices, there may be a degree of subjectivity or bias in the responses. Teachers might present an idealized version of their teaching methods or omit certain challenges that they face. This limitation is common in qualitative research but highlights the need for triangulation with other data sources, such as student feedback or additional classroom observations.

Additionally, the absence of longitudinal data is another limitation. The study is cross-sectional, capturing a snapshot of how teachers implement their pedagogical strategies and resources at a particular point in time. This limits the ability to assess how these strategies evolve, or impact students' long-term learning outcomes. A longitudinal approach could provide more comprehensive insights into the sustained effectiveness of the teaching methods employed.

Lastly, observer bias may have affected the data collection process. The presence of the researcher in the classroom during observations could influence the teachers' behaviours or the students' responses, potentially leading to Hawthorne effects, where the observed subjects alter their usual practices, due to being aware of the study. Efforts to minimize such bias through non-intrusive observation and maintaining a neutral stance are essential, but some level of bias may still be unavoidable.

In summary, while this study provides significant insights into the pedagogical strategies used by teachers in township schools to teach meiosis and genetics with lacking resources, these limitations must be considered. Future research could address these shortcomings by expanding the sample size, including a wider geographical area, exploring other academic subjects, incorporating longitudinal data, and ensuring a more comprehensive method of data triangulation.

Recommendations

There is a need for increased funding and resources for township schools, including textbooks, laboratory equipment, and teaching materials specifically designed for teaching life sciences. Adequate resources can significantly enhance the quality of education. Provision of ongoing professional development and training opportunities for teachers is required to improve their pedagogical skills, especially when working with improvised resources. Training can help teachers develop innovative teaching strategies and adapt to changing classroom dynamics. It is imperative to foster community involvement in education, by promoting partnerships between schools and local communities. Engaged communities can provide additional resources, mentorship, and support for teachers and learners. Teachers should be implored to develop formative assessment tools and feedback mechanisms to track student progress and adjust teaching strategies accordingly. Continuous assessment can help to identify areas where additional support is needed.

Conclusion

In the realm of education, resource constraints often pose significant challenges to teachers, especially those in township schools. This study has delved into the pedagogical practices of grade 12, life-sciences teachers when they are tasked with teaching complex topics, like meiosis and genetics, while relying on improvised teaching materials in such settings. Through a comprehensive exploration of their experiences, practices, and the unique challenges that they face, several key insights have emerged. This study's findings reveal that teachers in township schools demonstrate remarkable resourcefulness, creativity, and dedication in adapting their teaching methods to overcome resource limitations. They employ innovative strategies, drawing upon the limited materials at their disposal, to engage and inspire their learners. These teachers are not merely conveying information; they are cultivating a deep understanding of life sciences and instilling a passion for learning.

However, while this study highlights these commendable efforts, it also underscores the pressing need for comprehensive support mechanisms. Township schools and their teachers continue to grapple with resource disparities, inadequate infrastructure, and evolving learner needs. The challenges are manifold, from a shortage of textbooks and laboratory equipment to varying levels of learner preparedness. It is evident that there is no one-size-fits-all solution to address the resource constraints faced by township schools. Instead, a multi-pronged approach is needed. In closing, this study serves as a testament to the resilience and commitment of grade 12, life sciences teachers in township schools. They are educators, who, against all odds, are shaping the future of their learners, nurturing a generation of scientifically literate individuals who can contribute meaningfully to society. By recognizing their challenges and strengths, and by taking concerted action to support them, key educational stakeholders can work towards a more equitable and inclusive educational landscape for all learners, regardless of their circumstances.

Author Bio

Sam Ramaila is a professor in the Department of Mathematics, Science and Technology Education at the University of Johannesburg in South Africa. He currently serves as the chairperson of the Physics for Development, Education and Outreach Division of the South African Institute of Physics (SAIP). In addition, he spearheaded the Review of Undergraduate Physics Education in Public Higher-Educational Institutions Project on behalf of SAIP. The project culminated in the development of the Strategy for the Enhancement of Physics Training in South Africa. His research interests broadly lie in the science education domain, and include inquiry-based learning, teacher education, computational thinking, and nature of science. He published several articles in high-impact international journals. Professor Ramaila is passionate about promoting the benefits of science and its importance in society, as evidenced by his active involvement in diverse and impactful educational and scientific activities in schools and universities in South Africa.

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