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Case Study

The Importance of Teaching Resources on Physical Sciences Learners' Academic Achievement in Rural Schools: A Case of South Africa

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Abstract: The purpose of the article is to explore the importance of teaching resources on the academic achievement of physical science learners in selected rural secondary schools. Qualitative research was undertaken and data were collected from physical sciences teachers, principals and curriculum advisers, through in-depth face-to-face interviews. A multiple-case study design was used and the Activity Theory acts as a theoretical lens, offering a broad approach to analysing the availability of instructional resources and the context of teaching and learning in rural secondary schools. The study revealed three important aspects: resource availability, the quality of textbooks and the value of information, communication and technology (ICT). The availability and quality of resources were found to impact the effectiveness of science teaching in rural schools significantly. The resources make it possible for learners to do practical work, which could contribute to comprehension and possibly improve learner's performance. It is therefore recommended that the Department of Basic Education should address interlocking frameworks for change that include, providing Curriculum Assessment Policy Statements (CAPS) aligned textbooks, well-equipped laboratories, use of ICT and develop teachers' skills and knowledge in rural secondary schools.

***Keywords*:** academic achievement, physical sciences learning, rural schools, teaching resources, case study

1. Introduction

Poor academic achievement in science is not only limited to South African schools, but is a global cause for concern (Howie, 2003; Jetty, 2014). For instance, in the developing countries, rural schools in Nigeria (Yoldere & Adamu, 2014) and Zimbabwe (Nyoni et al., 2017) still lag behind in science achievement. Therefore, the problem is not a new phenomenon in South Africa. Research findings over the past years provide some evidence as to the positive effects of resources on academic achievement (Adeniran, 2020; Smart et al., 2020). Studies have suggested that a shortage of resources, inadequate teacher preparation, a narrow focus on content coverage and poor discipline in schools potentially impede teachers' work and invariably affect learner's academic achievement (Adeniran, 2020; Makgato, 2007). Dhurumraj (2013) refers to teachers' poor understanding of the syllabus and their negative attitudes; whereas Makgato and Mji (2006) mention outdated teaching practices and a lack of content knowledge to enhance and enrich learning. Thus, a narrow focus on the use of the interdisciplinary teaching approach, self-directed student activities, inquiry and problem-based learning approaches is argued to affect students to answer complex scientific questions and not allow them to take ownership of their own learning (Cone et al., 1998; You, 2017). On the other hand, teachers

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are often comfortable with the use of teacher-centred methods instead of guiding learners through the activity-based methods (Labouta et al., 2022). These authors suggest that teachers should act as facilitators of students learning.

Numerous research efforts focus on poor achievement, yet irrespective of these research endeavours, Bloch (2009) and Du Plessis and Mestry (2019) point out that high failure rates in the physical sciences remain a perennial problem, especially in rural secondary schools. The South African Department of Basic Education (DBE) (2011) concurs that a central feature emerging from rural secondary schools is low academic achievement in the physical sciences, which continues to pose a major challenge. The result is that fewer learners pursue scientific careers, which negatively affects the number of scientific professionals (Adeniran, 2020; Cameron, 2009) forming part of the workforce. This has culminated in a shortage of engineers, skilled artisans, technicians, doctors and technologists. Efforts to improve scholastic achievement in the physical sciences appear to be inadequate, as examination results remain unsatisfactory.

Basically, the lack of resources in rural schools according to Halsey (2011) and Smart et al., (2020) has been linked to academic performance deficits. In this context, the diversity of the students' science backgrounds and socio-economic backgrounds has also created some challenges and tensions in science teaching, which affect integration and exchange of science concepts (Brune et al., 2006; Sabelli et al., 2005), and students fail to have enough time to align their interests and to understand the English language that is used for communication and answering science questions (Labouta et al., 2022). Therefore, this article hopes to identify and analyse how the availability of resources if any affects learners' academic achievement in physical sciences, particularly in rural schools.

2. The perspective of science education in rural schools

The rural education in South Africa is historically linked to the legacy of apartheid and the segregated education system that was implemented at that time (Hlalele, 2012). The schools experience teacher shortages in science subjects, large classes and high dropout rates (Amnesty International South Africa, 2020; Parker et al., 2020), and some schools continue to be dysfunctional, insufficiently resourced and inevitably require teachers' ICT knowledge, skills and positive attitudes (Adedoyin & Soykan, 2020). As a result, rural schools continue to struggle with necessary resources (Donachie, 2017), academic performance evidently remains poor (Maringe et al., 2015), there is little or no access to information and communication technology (ICT) (Dlodlo, 2010; Netschivhumbe & Mudau, 2021), and teachers experience inflexible curriculum and fail to implementing experimental teaching methods (Carrell et al., 2020).

In this context, science learners' academic performance is placed at risk, with an ever-widening learning outcomes gap between rural and urban learners (Lamkin, 2016), and rural schools often are not able to offer learners with enough resources (Oakes & Maday, 2009; Jimmerson, 2005). Thus, the lack of equipment prevents teaching with an emphasis on practical activities. Active learning, which creates an environment that respects students' voices, collaboration and effective communication with peers is lacking (Labouta et al., 2022). Liu (2021) recognised that interaction, collaboration and communication lead to better outcomes. For one thing, increased collaboration between schools has helped to provide resources at a lower cost. The DBE (2011) reiterates that the majority of rural schools in South Africa have a serious problem with regard to well-resourced laboratories and ICT use to promote effective science teaching and learning. This means without resources the teaching of science remains theoretical without practical applications of scientific concepts beyond the classroom and experience to facilitate of scientific knowledge.

According to Adeniran (2020), limited access to resources may restrict students' exposure to science practical activities. The availability of resources has a profound impact on science teaching and learning (Tobin, 1990). To ensure effective science teaching, it is essential to invest in a variety of resources, including hands-on materials, ICT, textbooks, professional development, and facilities (Ali-Rweide, 2019; Smart et al., 2020). Labouta et al. (2022) argue that student assessment based on the process of scientific reasoning provides a safe learning environment in which the students are encouraged to explore their ideas. Thus, formative student assessment encourages the students to take learning opportunities seriously. This holistic approach helps create a dynamic and engaging learning environment for students, fostering a deeper understanding and appreciation of science. Besides, options should exist to address the gaps facing rural schools. Though government provides educational resources to schools, there is often uneven distribution and rural schools are victims as these resources do not get to them (Legari, 2004). This suggests that rural schools do not enjoy the resources (textbooks, experienced teachers, ICT infrastructure and laboratories) that are necessary for science teaching and learning (Smart et al., 2020).

2.1 *Research problem*

The history of the South African education system shows the inequalities that existed and were characterised by unequal resource allocation, especially in rural schools (Amnesty International South Africa, 2020). As a result, the imbalances of the past in terms of resources still have a silent but crippling effect on the science learner achievement in rural secondary schools (Parker et al., 2020), and the students' science backgrounds and socio-economic backgrounds have also created some challenges and tensions in science teaching (Brune et al., 2006). To make Physical Sciences more attractive, improve learning results and increase the motivation, interest and attitude of students towards the study of science, resources should be availed in rural secondary schools (Adedoyin & Soykan, 2020). Access to resources can enrich science teaching and learning by providing students with real-world experiences and exposure to diverse scientific disciplines (Alebous, 2021). Possible causes for poor learner academic achievement in this domain-especially in rural secondary schools in South Africa-require further research. Therefore, the purpose of this article is to determine the effect teaching resources have on learners' academic performance in physical sciences in rural secondary schools. The study was guided by the following research question:

"How do available teaching resources influence science teaching to enhance learners' academic performance in rural Limpopo secondary schools?"

2.2 *Study significance*

The experiences of science teachers and other stakeholders in contexts where resources are limited are valuable to inform the current and developing knowledge base in this area of research. The study may assist in filling some of the gaps in knowledge which relate specifically to classrooms with limited science resources. Furthermore, understanding the value that resources offer to science teaching and learning will allow us to make a significant contribution to the current policy debate in South African schools. It is important to understand the links between the complex issues faced by teachers which determine how they are able to use science resources when teaching. This information may be relevant to the Department of Basic Education (DBE) in terms of future investments in rural secondary schools. The results will provide some clues for South Africa, that is where class sizes are large and resources limited. It allows reaching a simplified strategy which leads to an easy understanding of how teaching resources enhance learners' academic performance in rural schools.

2.3 *Limitations of the study*

The study was limited to Limpopo province and focused on selected rural secondary schools. Since this research study was conducted in five schools of the Capricorn District and has been chosen purposefully, generalisability of the findings is limited. The study was only applicable to Physical Sciences teaching. Due to reason of time limitations, only five Physical Science teachers, five school principals and two Curriculum Advisers took part in the research study about the importance of resources in science teaching and learners' academic performance.

2.4 *Theoretical framework*

The framework used to guide the research forms the basis of the Cultural-Historical Activity Theory (CHAT), which interrogates the process of social transformation and includes the structuring of the social world in its analysis, taking into account the nature of social practice. The activity theory is a powerful sociocultural and socio-historical lens enabling one to analyse human activity (Engestrom, 1987), and focuses on the interaction of human activity and consciousness (the human mind) within its environmental context (Engestrom, 1987; Vygotsky, 1978). Yamagata-Lynch (2010) refers to Vygotsky's (1978) basic mediated action as a means of interpersonal communication through interaction among subjects (in this research, the learners), using mediating resources (tools and artefacts) with an object that can be the goal or motive in mind (improvement of academic achievement) while developing new signs to make meaning of the world (Kozulini & Gindis, 2007). The rules include a process-focused assessment (focusing on the process and the scientific reasoning of the students but not the outcomes) and a safe learning environment when carrying out experiments (Labouta et al., 2022). Thus, the activity theory has a focus on the dynamics of identity formation, examining how the social organisation of students' everyday practices supports and constrains their cognitive and social development (Gutierréz, 2008; Valencia et al., 2009).

A fundamental assumption of the activity theory is that learning and doing are inseparable. Thus, conscious learning emerges from activity, not as a precursor to it (Jonassen & Rohrer-Murphy, 1999; Leont'ev, 1974). In this regard, instructional resources such as signs, artefacts, tools or instruments of mediation aim to improve the teaching and learning process (Kozulini & Gindis, 2007). CHAT states that the resources (instruments/tools/artefacts) comprise anything used in the transformation process, including material tools which aid in the transformation of the environment (Engestrom, 1987). Basically, a learner's new capacities can only be developed in the zone of proximal development (ZPD) through the use of appropriate resources that incorporate active, experiential and group-based learning-situated activities with an adult or more capable peer (Scribner, 1997). According to CHAT, a child's intellectual development ought to be examined during problem-solving activities in laboratory settings, to investigate the interactions that take place involving the individual (Leont'ev, 1974). Therefore, interaction among science learners can be assisted by resources (cultural tools and artefacts) in the classroom.

Ideally, the interactions in which learners engage allow opportunities for mediated action that contribute to the social formation of their consciousness (Wertsch, 1998). Thus, learners are not passive participants waiting for the environment to instigate meaning-making processes for them, but through interactions, they make meaning of the world (Scribner, 1997). The resources (cultural tools and artefacts such as instructional materials and learning aids) facilitate interactions between the teacher and learner, and physical sciences. In this context, the small class size is a key feature that allows for effective group and class discussions essential for the success of science projects by the students (Labouta et al., 2022). However, resources that function as tools or artefacts are not merely handed to the subject, but are invented, applied, interrogated and used during activities. The use of resources (artefacts-symbolic and physical tools), thus plays an important role in forming learners' perceptions, clarifying their understanding of complex concepts and illuminating their thinking and learning (Alebous, 2021). In this regard, limited resources can hinder the ability to conduct experiments, reducing the practical and interactive elements of science teaching and learning (Kozulini & Gindis, 2007). Therefore, the activity theory provides an instrumental lens for analysing science learning processes by focusing on the activities in which students are engaged and the relationships among collaborating individuals as shown in Figure 1 below (Engestrom, 1987; Jonassen & Rohrer-Murphy, 1999).

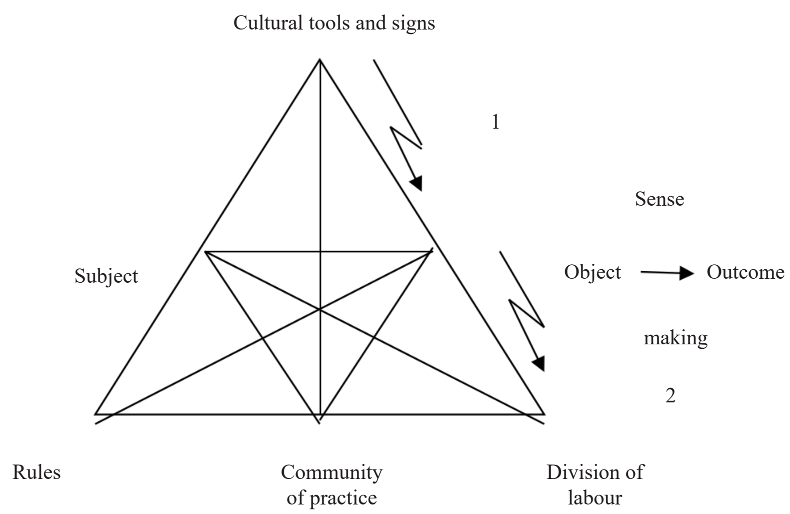

Figure 1. The activity system (Engestrom, 1987)

2.5 *Teaching resources and learners' academic achievement*

Verspoor (2001) states that resources are critical to learning and the intended CAPS curriculum cannot be easily implemented without them. Similarly, CHAT proposes mediated action to explain the link between signs and human understanding through interaction with resources (artefacts, tools) and other people, to ensure that everybody comprehends what is conveyed and can accommodate new meanings (Yamagata-Lynch, 2010). According to a United Nations Educational, Scientific and Cultural Organization (UNESCO) (2010) study, individual schools with similar resources and teaching-learning conditions delivered very different results when their learners were tested. In spite of the deplorable conditions in some schools, the learners did relatively well, while in other schools the results were poor, even though the required resources were available. Yet resources such as those needed for practical work were found to support learning and motivate engagement during classroom interaction.

The importance of providing adequate learning and teaching materials (including textbooks, teachers' guides and supplementary materials) to support educational development and quality upgrading has been recognised by governments throughout the developing world (Du Plessis & Mestry, 2019). Substantial research evidence shows that textbooks are among the most important resources that have a demonstrable influence: for example, a study in sub-Saharan Africa linked poor performance in science to a lack of textbooks (Mudulia, 2012). This supports the findings of Schiefelbein and Simmons (1981), who indicate that there is a correlation between the availability of textbooks and learner achievement. Well-designed textbooks and supplementary materials can serve as valuable resources for both teachers and students (Mason & Kimmons, 2018; Smart et al., 2020). The textbooks provide structured content, explanations, and exercises that support the curriculum. Outdated or inadequate textbooks can hinder learning, as students may be exposed to inaccurate information or miss out on recent scientific discoveries. However, a UNESCO (2010) study deduced that the influence of a specific input or process factor on results is never direct or linear: an increase in the number of textbooks per learner, for example, may not directly lead to an improvement in examination results. In this respect, Legotlo et al. (2002) found that the learner-textbook ratio is 10:1 in most schools in South Africa, which is considered the main cause of underachievement. This coincides with the views of Lewin and Stuart (2003), who maintain that the impact of textbooks is greatest in the poorest countries where teacher quality may be low, and where facilities and resources are scarce and generally of poor quality. Notably, not all secondary schools are equipped with sufficient textbooks and some learners are not given textbooks to take home, which affects them when doing homework.

Unfortunately, in some rural schools, science is not taught through doing, due to the absence of experimental objects (Wachira, 2005; Ali-Rweide, 2019). Makgato and Mji (2006) and Howie (2003) have shown that a lack of resources is a common problem in most public schools in South Africa. These studies revealed that besides textbooks, public secondary schools have a serious shortage of physical facilities such as laboratories and science equipment. Mudulia (2012) argues that when the delivery or acquisition of science equipment and supplies is delayed, teachers cannot be expected to do their work properly, which could lead to poor performance on the part of learners. This implies that learners' performance in science could be linked to the inadequacy of resources. Well-maintained laboratories and science facilities create a conducive learning environment (Netschivhumbe & Mudau, 2021). Thus, practical laboratory work is considered central to any science teaching, because learners then experience science through various forms of carefully designed practical tasks (Lowe et al., 2013; Smart et al., 2020). The value ascribed to practical activities has led to the development of science kits and mobile laboratories, because many rural schools lack laboratory facilities and apparatus. If practical work is neglected the Physical Sciences remain theoretical, and learners are denied an opportunity to enhance their understanding and their application of theoretical knowledge (Makgato & Mji, 2006). According to CHAT, a learner's intellectual development ought to be examined during problem-solving activities in the laboratory setting. Access to well-equipped laboratories, science kits, and hands-on materials enhances the learning experience (Alebous, 2021). Practical experiments and demonstrations help students understand abstract scientific concepts by providing tangible, real-world examples. The availability of laboratories in schools is a key component in the provision of quality teaching (Du Plessis & Mestry, 2019; UNESCO, 2012), and Africa-based research has revealed that schools in rural areas which offer science subjects face great challenges due to the unavailability of such facilities (Zvavahera, 2015). Although not a guarantee, an increase in virtual laboratories could supplement practical work and make up for shortages in resources.

It is important to note that one of the specific aims of Physical Sciences is to promote knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and ICT knowledge (DBE, 2011; McGee et al., 2018). The incorporation of ICT could facilitate the transfer of knowledge and skills to learners, and allow for the presentation of content in a simple, meaningful way (Michaelsen, 2021). Thus, ICT plays a significant role in transforming science teaching and learning. Integration of ICT in teaching science can enhance the effectiveness of instruction, engage students, and provide access to a wealth of resources. According to Badri et al. (2014) ICT allows the use of interactive simulations and virtual laboratories that enable students to explore and experiment with scientific concepts in a virtual environment. Online simulations that illustrate chemical reactions and physics principles can be used to conduct experiments in real-life. Furthermore, ICT provides access to a wide range of multimedia resources, including videos, animations, and interactive presentations which can help in visualizing complex scientific phenomena and making abstract concepts more tangible (Mason & Kimmons, 2018). It facilitates online research, enabling students to access scientific databases, journals, and educational websites, supports collaborative learning and allows students to work on projects together, share findings, and engage in discussions. Digital textbooks and e-books are accessible through ICT, providing dynamic and interactive content (De Los Arcos et al., 2016). It allows for updates to reflect the latest scientific knowledge and encourages a more personalized learning experience. The availability of ICT resources, such as computers, interactive simulations, and educational software, can enhance science instruction (Badri et al., 2014). Therefore, lack of access to ICT can impede the integration of modern teaching methods, limiting students' exposure to current scientific advancements and academic achievement.

The investments of teachers in the use of resources strongly influence the experiences of students. Contrary to expectations, Hattingh et al. (2007) determined that the availability of resources did not necessarily guarantee their use, and that the competence, creativity and initiative of teachers play a more important role. Mudau (2013) argues that teachers' practices that fail to create meaningful learning, resolve misconceptions, develop inquiry as well as problem solving skills, which can negatively influence learner academic performance. Teachers may make false claims that they do not teach the practical component of the Physical Sciences due to a shortage of apparatus, when in fact they do not know how to use the equipment which is available in their schools. As a result, practical work is avoided and apparatus is left unused in storerooms. Thus, learner performance is not solely dependent on the availability of resources but also on the effective use of the available resources by teachers. This implies that there may be a need to train teachers to improve their skills in using apparatus during experiments, or to improvise if resources are not readily available (Michaelsen, 2021). Adequate resources for teacher training and professional development enable educators to stay updated on the latest pedagogical approaches, curriculum changes, and scientific advancements (Ali-Rweide, 2019). By prioritizing professional development, the school can refine teachers ICT proficiency and improve self-efficacy (Badri et al., 2014). This, in turn, positively influences their teaching methods and effectiveness.

From the preceding discussion it is apparent that, although not a guarantee, resources could engender greater learner engagement and academic achievement. Consequently, learners could develop more advanced skills as they access and exploit the multiple resources available to them (Badri et al., 2014; Smart et al., 2020). The lack of resources could cause a decrease in students' motivation, interest and attitude towards science (Adeniran, 2020). Adequate space and safety measures contribute to effective science teaching and learning. In this context, poor infrastructure, including outdated facilities and inadequate safety measures, can pose challenges to conducting experiments and may compromise the overall quality of science teaching and learning (Netschivhumbe & Mudau, 2021). Virtual labs and simulations allow students to explore scientific phenomena that may be difficult or expensive to replicate in a traditional classroom. Essentially, the correct use of ICT resources can have a major influence on the learning experiences of a learner and the understanding of scientific concepts. In sum, regardless of whether sufficient resources would have the effect of improving academic achievement, their inclusion would enrich any teaching-learning situation in science classrooms.

3. Methods

The qualitative research approach used in this study aims to discover underlying motives and desires by using, amongst others, in-depth interviews. A further interpretation is that qualitative research is concerned with the subjective assessment of attitudes, opinions and behaviours (Morse, 2001). A multiple-case study research methodology was applied. The school was the unit of sampling used. A multiple-case study is a type of case study research that involves selecting and analysing two or more cases that share some common characteristics or features, but also differ in some aspects (Yin, 2018). These cases were chosen based on different criteria, such as performance and resources. The study was interested in getting the views of five teachers, five principals and two curriculum advisors about the importance of resources in teaching science in rural schools. Purposive sampling was used to collect data. According to Creswell (2013) and Merriam (1998), purposeful sampling is based on the assumption that the researcher wants to discover, understand and gain insight; therefore, the researcher must select a sample from which the relevant data can be obtained. In other words, the sample was chosen because the participants were knowledgeable of, and informative about Physical sciences which the researcher was investigating. Five schools were purposefully selected. Physical sciences teachers at the five schools automatically comprised members of the sample, as did the five principals responsible for managing and leading those schools. As there are only two curriculum advisers in that particular circuit office, both were included in the study. The sampled schools differed in various ways from one another, as some were well-resourced while others were not. Contextual factors linked to the teaching and learning of the physical sciences (environment) in which the participants operated also differed, with variations in terms of the qualifications of the teachers, principals and curriculum advisers. These differences between the participants ensured the collection of rich data.

Permission was granted from the Department of Basic Education, University of South Africa (UNISA), school principals and Circuit manager. Before the interviews were held, the teachers and Curriculum Advisers gave written consent to take part in the interviews. Participation was voluntary, and teachers, principals and curriculum advisers could withdraw from the interview at any time without penalty. Ethics approval was obtained from the Ethics Committee of University of South Africa (UNISA). The protocol number is 24 October/31070647/MC. The interviews were audio-recorded and handwritten notes were made to report non-verbal cues and to supplement the recorded data.

For the purpose of data analysis, the researcher gathered responses from participants through field notes, tape recordings and jottings. Complete reading and listening of the text and audio were done which enhanced easy coding of the text. The data was categorised through mind-maps by which respective themes were derived for further interpretation (Hycner, 1985). Participants were given the scripts to read through after the coding to verify if they had not been misinterpreted. This was done to ensure that responses provided by the participant were valid and the data gathered were reliable respectively (Patton, 2015).

4. Discussions and findings

Research question: "How do available teaching resources influence science teaching to enhance learners' academic performance in rural Limpopo secondary schools?"

In presenting the findings, codes were used to refer to participants, for example Teacher 1, Principal 1 and Curriculum Adviser 1.

Table 1. Description of summary codes or organising themes for the resulting thematic networks

Themes
1. Availability of resources
2. Availability of textbooks
3. ICT use

4.1 *Availability of resources*

The first theme that emerged from the data was the availability of resources (see Table 1). Teacher 3 remarked that 'if l had an overhead projector, for example, it is easier to teach with an overhead projector with our big classes. Also, textbooks, like now l do not have Curriculum Assessment Policy Statement (CAPS)-aligned textbooks until now, even in Grade 12'. When probed, Teacher 3 mentioned that,

> If each learner has a textbook that can supplement teaching and learning in the absence of the educator, plus when the classroom activities have got to be written, there is point of reference that is … let us go to page 111 or 84. If they do not have textbooks, it becomes laborious and there are some diagrams you cannot draw without using a projector or textbook.

If the materials are not available, learners cannot benefit from doing textbook-based homework, nor does it assist them in working on their own. Textbooks provide exercises, and learners should be able to jot down their own notes using the textbooks. The shortage of textbooks has cost implications for schools, because educators have to photocopy materials (Du Plessis & Mestry, 2019).

Teacher 1 mentioned: 'We need practical work, but even a basic kit is not available and this is affecting learners' performance seriously because some of the activities need [a] hands-on approach and then in the absence of the resources [that] is a setback'. Teacher 2 was the only one who stated: 'We have a new laboratory; it has all the apparatus and chemicals and other resources'. When probed, Teacher 2 pointed out that, resources such as laboratories help to expose learners to reality, as they use all their senses. Teacher 4 responded that they need a number of items, 'like first textbooks, secondly the learning spaces … accommodation where they sit, then we need a laboratory for experiments'. Teacher 4 added that if a laboratory were available, abstract concepts could easily be explained while learners did experiments in class.

Teacher 5 stated:

> We are facing a lot of challenges in terms of apparatus and chemicals. As an educator l will be very happy to have these. More importantly, physical science is a subject that the learner has to discover on his own, so we need apparatus and chemicals to do experiments. I am teaching physical sciences as if I am teaching history. If a teacher wants to teach about double bonds in organic compounds, he needs bromine solution to test the presence of ethane, but it is not available in our schools.

The principals participating in this study acknowledged that the shortage of textbooks places immense strain on the school and on educators, who have to photocopy the materials the learners might need. Also, in their view, the absence of equipped laboratories in schools leads to the memorisation of theory, rather than comprehension being gained through practical activities-something which might adversely affect learners once they attend tertiary institutions. This was substantiated by Principal 5, who said:

> As one of the practical subjects, physical sciences need to be taught in a laboratory; hence in most cases if there are no laboratories in schools, learners will resort to theory [rather] than practice. If these learners, complete grade 12 they may experience problems when they use the resources for the first time at tertiary level, hence the laboratory can facilitate teaching and learning in the classroom (Netschivhumbe & Mudau, 2021).

In support, Principal 1 indicated: ''If we have a laboratory, it will be easy for the teacher or learner to do experiments".

Both curriculum advisers who were interviewed were convinced that the lack of resources contributed to the learners' poor performance in this subject. The advisers were of the opinion that as it is learners need to work on their own to perform well in the physical sciences, and that practical (laboratory) work will assist learners to do better. Curriculum adviser 1 conceded that the lack of resources is a major concern, especially when it comes to practical work in a laboratory. Curriculum 2 mentioned, 'Physical science involves experimentation which is difficult if resources are scanty. The lack of resources could lead to forced development and misconceptions in science'.

According to CHAT, the use of resources thus plays an important role in forming learners' perceptions and clarifying their understanding of complex concepts through hands-on activities. Alebous (2021) mention that the way in which learners engage in activities in laboratories influences what and how they learn. Therefore, access to well-equipped laboratories could improve examination results by promoting learners' practical exposure to theoretical concepts. Laboratory work is important (Du Plessis & Mestry, 2019), because in physical sciences there is a need to do experiments as part of learners' assessment, in addition to helping learners understand through doing. Resources such as laboratories help to expose learners to the real world, and allow them to use all their senses. If resources for practical activities are not available (even basic science kits); the learning could be hampered. Physical sciences should encourage and develop discovery skills, consequently, resources with which to do experiments, are essential.

4.2 *Availability of textbooks*

A second theme that was identified relates to the quality of textbooks. Teacher 5 complained: 'The textbooks we use do not have a lot of questions for learners to practise, or worked-out examples for learners to do on their own'. It was also pointed out that when learners only hear something, they easily forget, but if they see and work out problems, they remember the work. 'Textbooks assist learners to work on their own, but they are not ideal' (Teacher 2). Teacher 1 stated: 'I don't have textbooks for a start, but even the ones we have are not good and then there [are] no resources for practical activities'. Textbooks are important because they supplement teaching and learning in the absence of an educator, and serve as a point of reference during classroom activities. The principals pointed out that textbooks can only affect learner performance if they contain the relevant information, but more importantly if they are used properly. The curriculum advisers considered textbook selection a concern: 'Our teachers choose textbooks without knowing [their] content' (Curriculum adviser 2). Curriculum adviser 1 indicated that teachers in schools just select any textbook because they may not know which books are 'good textbooks' during the textbook requisition process.

CHAT, sees basic mediated action as an interpersonal communication through interaction among learners using resources. The findings indicate that the lack of quality textbooks is a serious issue. To support the finding that many of the textbooks currently in use lack examination-related questions and examples for learners to practise, Adeniran (2020) suggest that textbooks are a critical ingredient of learning, as the intended curriculum cannot be easily implemented without them. Besides the shortage of physical sciences resources, the quality of textbooks provided by the DBE, appears to be inadequate. In this regard, Badri et al. (2014) and Smart et al. (2020) found a positive link between the availability of quality textbooks and learner achievement.

4.3 *Information, communication and technology (ICT) use*

The use of ICT was the third theme identified during the data analysis. Although the main concern was that most teachers do not use textbooks that align with the new curriculum, the teachers lamented the fact that at school there are no internet facilities which learners can access. As Teacher 2 mentioned: 'Maybe we need internet which can be accessible to the learners and where they have problems and [can] check and find answers. Other apparatus besides the internet, we have access to them'. Teacher 4 stated, 'My students can work on a group project researching science issues using collaborative online platforms'. This was supported by Teacher 1 who indicated, 'ICT enables the use of videos to explain science concepts. E-books with embedded videos, quizzes, and interactive simulations can reinforce learning and gamified apps can be used to teach physics principles through problem-solving'.

The school principals were aware of resource-related challenges, and particularly of the importance of ICTs. Principal 1 indicated: 'If they have computers, they can have exemplar questions and even [the] use of lessons which are taught through television and radio programmes'. Principal 4 indicated that one advantage of ICT is that it allows teachers to do simulations, or they can show videos of aspects that are impossible to convey in class. Ideally, teachers can make video-recordings to use during teaching and learning, for example, demonstrations of how generators work. Four of the principals indicated that ICT is essential for learners wishing to access exemplar question papers and practise calculations. In addition, the principals pointed out that television and radio programmes that are broadcast during the holidays play an important role in improving learner performance. However, they admitted that many learners in rural areas do not have access to these platforms.

Principal 2 suggested that there are numerous educational apps and games that are designed to reinforce science concepts in a fun and engaging manner. Principal 3 pointed out that ICTs provide information to learners. Principal 5 proposed that ICT could solve the problem of underachievement: 'Most of the things can be done through the use of computers. If learners are taught using computers, some of the things which are not accessible to them, like chemicals ... they see them through simulations and it will be more like they are doing those things'. Principal 5 added that his school 'is presently using [a] sponsorship partnership with African Bank, which comes to our school once a week to do experiments with the learners. They make use of computers in teaching experiments; as a result, our results are improving bit by bit'.

Both curriculum advisers agreed that, ideally, learners should be given an opportunity to access computers. 'ICT could help to solve this problem. Through computer access learners can go onto the internet and view experiments that they cannot do due to a lack of equipment (Curriculum adviser 1). However, the curriculum advisers pointed out that learners are unable to surf the net because they do not have computer skills, and are encouraged to use other devices to search for information. ICTs enhance communication, problem solving, collaboration and innovation. As substantiated by curriculum adviser 2, 'sometimes they are not able to search information from the internet. Our learners are not able to handle computers. Therefore, we encourage them to use their cell phones'.

According to CHAT, appropriate ICTs incorporate active, experiential and group-based learning-situated activities with teachers and more capable peers. ICTs are considered an important resource in physical sciences, because they offer a new medium of creative expression and communication for both teachers and learners. Tools play an important role in human thinking and learning, yet ICT is frequently absent from schools, or insufficiently used in physical sciences. The internet was not accessible to the schools participating in this study, but if computers were available, the teachers could become facilitators and coordinators of learning (Labouta et al., 2022), rather than having to be the centre of knowledge. If ICT is provided, learners should be able to search for information on the internet, where they could access exemplar question papers. Teachers could use the ICT to do simulations, and through videos, provide insight into concepts learners might find difficult to visualise (Michaelsen, 2021). Television and radio programmes that are broadcast during the school holidays might be beneficial, but learners in rural areas (where this study was undertaken) frequently do not have access to such media. Schools could thus possibly acquire those resources to help improve learners' performance. These interactive tools can motivate students and make learning enjoyable (De Los Arcos et al., 2016). However, given teachers' and learners' lack of ICT skills, besides provision, training should be a priority.

CHAT states that resources enhance transformation of the environment. Generally, the schools participating in this study were under-resourced, which contributed to poor learner achievement in physical sciences. According to Ali-Rweide (2019), whatever a teacher achieves with his/her learners would be influenced by the teaching and learning resources available to him/her. Any lack of resources would thus entrench sub-par learner performance.

5. Policy implications

The study revealed that the selected rural schools in this rural district did not have adequate resources for both teachers and students to perform practical activities because science deals with experiments. This adversely affects students' hands-on activities and negatively affect students' learning outcomes. Learners need to do practical work on their own to perform well in physical sciences. As a matter of urgency, apparatus and chemicals are needed to conduct experiments. Laboratory work is important, because experiments not only facilitate comprehension but also form part of learners' assessment. Resources such as laboratories will help to expose learners to real learning situations where they can engage all their senses. If resources for practical activities are not available (even basic science kits), the learners' performance is likely to be hampered. With the introduction of CAPS syllabus common experiments were introduced. This calls for well-equipped laboratories, which many secondary schools lack. From the research results it is evident that better laboratory facilities are required in the schools, so that more practical lessons can be conducted.

The shortage of physical science textbooks was reiterated. Thus, the lack of textbooks was identified as a serious issue in the selected secondary schools. The findings show that textbooks provided by the Department of Education are inadequate, especially for teaching the latest CAPS curriculum. The textbooks that are currently in use do not have examination-related questions or examples for learners to work on and gain practise. The lack of textbooks makes it impossible to give homework or even encourage learners to work autonomously. Also, a shortage of textbooks has cost implications for schools, because educators have to photocopy materials for the learners. In this regard, digital textbooks and e-books can be developed to be used in schools (De Los Arcos et al., 2016).

The findings show that ICT is an important resource in physical science, because it offers a means of creative expression and serves as a research tool for teachers and learners. The use of computers was found to enable teachers to become facilitators and coordinators of learning, rather than being seen as the sole bearers of knowledge. Through ICT learners could access not only exemplar question papers but also allows teachers to do simulations or show videos of things that are impossible to do in class. Television and radio programmes broadcast during the school holidays can assist in improving learner performance, but clearly many rural learners do not have access to these platforms. However, the Internet was not accessible to the schools participating in this study.

Generally, the schools in this study were under-resourced, and that contributed to poor learner achievement in physical sciences. It is hoped that this research will assist in identifying gaps or obstacles to improving learners' academic achievement in the physical sciences, and reignite their desire and confidence to take the subject. The research findings could assist school principals in comprehending the difficulties teachers face with limited resources. This could encourage the former to find ways of providing adequate learning materials and apparatus to assist teachers in their work. Alternatively, it might prompt them to approach sponsors to assist with the acquisition of such resources. Raising awareness about the dire need for resources to teach the physical sciences might encourage the corporate world to contribute to the provision of applicable resources in schools. The research findings could assist in supporting teachers, create an enabling learning environment and strengthening learning and teaching materials to effectively implement science teaching.

6. Recommendations

It is recommended that textbooks be made available to all learners in order to engage in self-activities and self-learning. Thus, adequate new updated textbooks in line with CAPS should be availed by the DBE in the form of digital textbooks and e-books.

Furthermore, the physical science laboratories should be made available with the necessary equipment and chemicals to help learners put the theory to practice. This calls for well-equipped laboratories, which many secondary schools lack.

More importantly, the internet and computers should be made available in rural schools to enable simulations, communication, collaboration and problem-solving during science teaching and learning to improve learner performance. Access to essential resources like science labs, textbooks and computers is a necessity of practical skills and information exchange.

Lastly, it is crucial that teachers develop skills, and knowledge and understand that the pedagogic integration of ICTs into the classroom goes with an understanding of what learning in digital space is. Through training the science teachers have the opportunity to adopt more innovative and engaging science teaching methods.

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Human research and declaration of helsinki

No animals were used for studies that are the basis of this research. All the humans were used in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013 (http://ethics.iit.edu/ecodes/node/3931). Ethics approval was obtained from the Ethics Committee of University of South Africa (UNISA). The protocol number is 24 October/31070647/MC.

Conflict of interest

There is no conflict of interest.

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