

Utilising WhatsApp for Extending Learning Opportunities (ELO) in Physical Sciences amongst Rural Secondary School Teachers in the Vhembe District

by

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Dissertation submitted for the requirements for the degree of

MASTER OF EDUCATION IN PHYSICS EDUCATION

in the

DEPARTMENT OF HUMANITIES, SOCIAL SCIENCES AND EDUCATION

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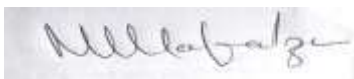
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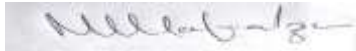


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Supervisor.....Date.....

DECLARATION

I declare that **Utilising WhatsApp for Extending Learning Opportunities in Physical Sciences amongst Rural Secondary School Teachers in the Vhembe District** is my work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references, and that this work has not been submitted before for any other degree at any other institution.



Mulalo Nakisani Mafadza

Date 20/02/2026

DEDICATION

This dissertation is dedicated to my father, 'Mushavhi' Nthatheni Peckson Mafadza. I have come to understand that love knows no boundaries. Even though you are no longer with us, I still love you just as I always have. I have carried you in my spirit throughout my academic journey.

Till we meet again.

ACKNOWLEDGEMENTS

- To Him who is able to do exceedingly, abundantly above all I think or ask, I thank you for the grace that carried me through compiling this dissertation, and the patience that you gave people around me. Truly, your grace is sufficient for me.
- To my mother, Maria Takalani Mafadza, thank you for being my biggest cheerleader. You did not allow me to give up, even when I gave you very good reasons. You are indeed a superstar.
- To my person, muthu wanga, Dakalo Eric Mulaudzi, I have watched you take care of the kids and the chores just so that I could sit and write. I thank you for not standing in the way of my dreams, and for being patient with me even when I had gotten to your last nerve.
- To my kids, Mukovhe, Thama, Ria and Ori. It could not have been easy always hearing that mommy is busy. I thank you for loving me through my busyness.
- To my siblings Hangwani, Elelwani, Dakalo, and Zwivhuya and the rest of my family, I thank you for your love and support.
- This study would not have been possible without the participation of the teachers and learners who took part. I thank you for all your contributions.
- My Supervisor, Dr Maxwell Tsoka, thank you for not giving up on me, and for the patience (even when I did not deserve it), and professionalism in carrying out your role as my supervisor.
- A special mention to Dr SJM Kaheru, the world really needs more people like you who know how to inspire and motivate learners to do better. I would also like to thank Gundo Ndou, Muofhe Rose and Nthulani Lindelani. Thank you for always being there when I needed you. And my friend, Bridget, you are truly a girl's best friend.

ABSTRACT

This study investigated the use of WhatsApp by rural teachers for extending learning opportunities in Physical Sciences as a way of mitigating the challenges that rural schools are grappling with. The study is conceptualised around the constructivist paradigm and employs a qualitative case study design. A non-probability purposive sampling technique was used to select participants for the study, from a population of Physical Sciences teachers and learners in rural secondary schools. Data was collected through the WhatsApp built-in export chat feature and screenshots of the actual conversation within the application. The collected data were coded, organised, and analysed using content analysis. In the rural context, where access to the internet and web-enabled devices may be limited, the findings indicated that teachers conceptualised WhatsApp as a medium for communication and retaining a proxy of virtual social presence. The findings also indicated that WhatsApp was perceived as a pedagogical tool for providing access to digital teaching and learning resources and as an instructional tool for extending learning beyond the rural classroom. The study discovered that WhatsApp has the following affordances for ELO in the rural setting: (i) A networked community of learning, (ii) Accessibility beyond classroom walls, (iii) Low-cost and widely available technology, and (iv) Resource sharing and supplementary support. Nonetheless, the findings also highlighted drawbacks in using WhatsApp for ELO, such as a lack of teacher training in pedagogical use of WhatsApp, increased teacher workload, and irrelevant messages. These findings contribute to the growing body of knowledge on mobile and blended learning in rural contexts. Based on the findings, the study recommends recognising WhatsApp-mediated learning as part of the e-Education strategy. The study further recommends teacher training to enhance the use of WhatsApp and similar technologies for learning. Future research should focus on exploring the pedagogical use of WhatsApp across different learning areas and grades, its impact on policymaking and implementation, as well as its impact on learner performance.

Key Concepts: WhatsApp, Rural schools, Learning, Extended Learning Opportunities (ELO), Physical Sciences

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ACRONYMS

4IR	Fourth Industrial Revolution
CAPS	Curriculum and Assessment Policy Statement
CHAT	Cultural Historical Activity Theory
DBE	Department of Basic Education
DoE	Department of Education
ECC	Ethical Clearance Certificate
ELO	Extended Learning Opportunities
ICT	Information and Communication Technology
L1A	Learner 1 from school A
L2A	Learner 2 from school A
L1B	Learner 1 from school B
L2B	Learner 2 from school B
L1C	Learner 1 from school C
L2C	Learner 2 from school C
MSE	Mathematics and Science education
PDF	Portable Document Format
Q1–Q5	School Quintile 1 to Quintile 5
RQ	Research Question
SMS	Short Message Service
T1	Teacher 1
T2	Teacher 2
T3	Teacher 3
T4	Teacher 4
TIMSS	Trends in International Mathematics and Science Study
Wi-Fi	Wireless Fidelity

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

The emergence and advancement of the Fourth Industrial Revolution (4IR) is driving the adoption and integration of technology within the educational setting to be responsive and relevant to the current digital age. This advancement of technology has given rise to social media platforms that have penetrated and reshaped all aspects of daily life, including the educational landscape. Consequently, a growing trend in the field of educational and academic research concerning mobile and online learning has been the impact of integrating social media applications to supplement teaching and learning practices (Suarez-Lantaron et al. 2022; Ibrahim 2018). Amongst the sizable social media platforms available, WhatsApp, an instant messaging application, has gained vast popularity with the youth (Folasayo & Olajide, 2022; Jere et al., 2019), and has features that make it adaptable for educational purposes (Abualrob & Nazzal, 2019).

The WhatsApp platform is used by teachers and learners to supplement the traditional classroom and provide Extended Learning Opportunities (ELO) (Ibrahim 2018; Jere et al. 2019; Adams 2019). This study views ELO as activities or experiences made available to learners to support learning beyond the confines of the classroom and normal school hours. These auxiliary opportunities are designed to supplement and enhance the formal learning process, providing learners with a broader range of educational experiences and skills. In this study, ELO is applied specifically in rural secondary school settings, where teachers use WhatsApp to engage learners outside formal teaching hours. This may include sharing learning materials, discussing subject content, answering questions, and providing academic support after school, thereby extending Physical Sciences learning beyond the traditional classroom setting. ELO can take various forms, including activities normally performed in classrooms, but now, through a non-formal approach. While some of the modus operandi may change in e-Education platforms, activities may be planned or spontaneous, but they stimulate and promote learning. For example, communication

on WhatsApp may be more flexible and less formal, particularly because it is a social media app, allowing teachers and learners to interact beyond scheduled class times.

WhatsApp is a web-based instant messaging application that was created in 2009 as an alternative to Short Message Service (SMS) (WhatsApp 2023). This application is free and allows users to share and exchange digital content effectively, including texts, pictures, audio clips, videos, and documents, using Wi-Fi or a mobile network connection (WhatsApp 2023). WhatsApp users can interact on both a one-to-one basis and in group chats through messages, voice and video calls (WhatsApp 2023). 93% of South African internet users are WhatsApp subscribers (Statista 2023), which is compatible with most smartphones and can also be operated on a laptop or desktop computer (WhatsApp 2023), making it a versatile application that can span over a diverse population of learners.

Physical Sciences has been perceived by learners as complex and challenging (Klieger & Goldsmith, 2020), as many learners perform poorly in this learning area (TIMSS SA Newsletter, 2023). In South Africa, Physical Sciences is offered as a combination of physics and chemistry (Rajan et al. 2008). The teaching and learning of Physical Sciences is a complex exercise, as it is not only limited to teaching and learning content knowledge, but includes developing scientific skills, acquiring science language, and integrating mathematics as both a language and skill (Rajan et al. 2008). Within WhatsApp groups, teachers can engage learners in solving mathematical questions, which, in turn, helps them understand physical sciences. Further, in this subject, learners are often expected to comprehend and conceptualise abstract phenomena that are not necessarily intuitive to them (Klieger & Goldsmith, 2020). The difficulty in teaching and learning Physical Sciences has been associated with a lack of resources, including basic resources such as human resources, textbooks, equipment, and laboratories, as well as inadequate teaching methods (Abualrob & Nazzal, 2019; Muremela et al., 2021). Studies have shown that WhatsApp can be used to share diverse learning materials (Adams, 2019; Rambe, Chipunza and Ng'ambi, 2020), helping learners access resources that support the development of content knowledge. It can also be used to furnish learners

with videos that complement practical activities in the laboratory (Pratama & Kartikawati, 2017). Such activities may not replace ‘hands-on’ laboratory work, but they can help learners understand how scientific concepts work, thereby building content knowledge. This is disadvantageous because some abstract ideas in science may prove difficult to teach and learn without the aid of resources (Abualrob & Nazzal, 2020).

The occurrence of the COVID-19 virus in 2020 was an eye-opener for educational institutions, and many were forced to consider WhatsApp as a platform to provide opportunities for teaching and learning (Chirinda et al. 2021). Teachers and learners could interact over the platform and engage in academic related activities. The COVID-19 pandemic was accompanied by lockdown restrictions, resulting in the closure of schools (Chirinda et al. 2021). During this period, teaching and learning were disrupted, but ‘privileged’ schools were able to migrate effortlessly to various online learning systems, whereas learning in rural schools came to a complete halt (Chirinda et al. 2021). To find mediums that could facilitate learning and offer a solution to recover the loss of class time and further studies, teachers resorted to using WhatsApp as a teaching and learning space (Chirinda et al. 2021). Currently, some teachers continue using WhatsApp as an educational platform for ELO outside normal school hours.

The interest in this study was brought on by two reasons. Firstly, the ubiquitous nature of technology, and how virtual/digital communicative spaces presented through WhatsApp afford ELO, most especially in the challenging learning area of Physical Sciences. Secondly, the resource-challenged traditional classrooms in rural schools and how WhatsApp is being used to address resource challenges and enhance learning practices. However, this is not without challenges considering the rural context, as some teachers and learners may not have access to WhatsApp either because of internet connectivity or ownership of a smartphone.

Rural schools lack essential resources such as laboratories and textbooks, which are needed to provide rich and meaningful learning of Physical Sciences (Nemadziva et al. 2023; Muremela et al. 2021). Without laboratories, learners cannot perform practical tasks or experiments that are a necessary component of teaching Physical Sciences.

Experiments aid learners in realising scientific concepts (Basic Education 2011). The constraint in resources means that teachers resort to only using the lecture method to teach, which only fosters surface-level learning of scientific concepts (Nemadziva et al. 2023). The lecture method has been found to contribute to learners having misconceptions regarding science, which ultimately leads to poor performance (Nemadziva et al. 2023). Moreover, rural schools in the Vhembe Districts have a shortage of scarce skill teachers, who are qualified and experienced Physical Sciences teachers. Physical Sciences teachers in rural schools are few, have large workloads and must contend with overly populated classrooms (Muremela et al. 2021). This places learners at a disadvantage because teachers may not have sufficient time to identify and address their learners' misconceptions (Adams 2019).

Many studies that have explored the educational use of WhatsApp in various learning areas and across varying academic levels have found WhatsApp to be a potential educational tool for enhancing communication for teaching and learning purposes (Durgungoz & Durgungoz, 2022; Suarez-Lantaron et al., 2022; Abualrob & Nazzal, 2020; Zan, 2019; Cetinkaya, 2017; Pratama & Kartikawati, 2017; Bouhnik & Deshen, 2014). Teaching and learning practices through the WhatsApp platform have the potential to increase academic success by extending exposure to learning content and material (Durgungoz & Durgungoz, 2022; Jere et al., 2019). It potentially encourages student autonomy by encouraging learners to initiate and lead discussions, creating a suitable learning environment, and strengthening student-teacher relationships (Durgungoz & Durgungoz, 2022). Furthermore, the WhatsApp platform has been shown to support ELO by providing a communicative space that encourages content-based discussions and enables teachers to recognise and challenge misconceptions. Teachers can recognise how well learners understand concepts through the answers or questions they post on the group. Teachers can then provide timely feedback, helping learners, and learners do not have to wait to get assistance in the classroom because learning is no longer limited to the classroom (Adams 2019). It also enables teachers to present resources that cater to learners' needs (Adams 2019; Bouhnik & Deshen 2014).

1.2 STATEMENT OF THE PROBLEM

Rural schools are excluded from rich and meaningful science learning experiences by the challenges that have become perennial in these contexts (Adams 2019; Nemadziva et al. 2023). The Trends in International Mathematics and Science Study (TIMSS SA Newsletter 2023) investigated inequalities in science achievement and discovered that rural schools in South Africa were the worst-performing, with the Limpopo province recording the lowest scores. Based on these findings, rural schools have performed worse than their urban or suburban counterparts, especially in science and mathematics (TIMSS SA Newsletter 2023).

Figure 1: Performances distribution curves in Physical Sciences (percentage) Source: DBE 2023

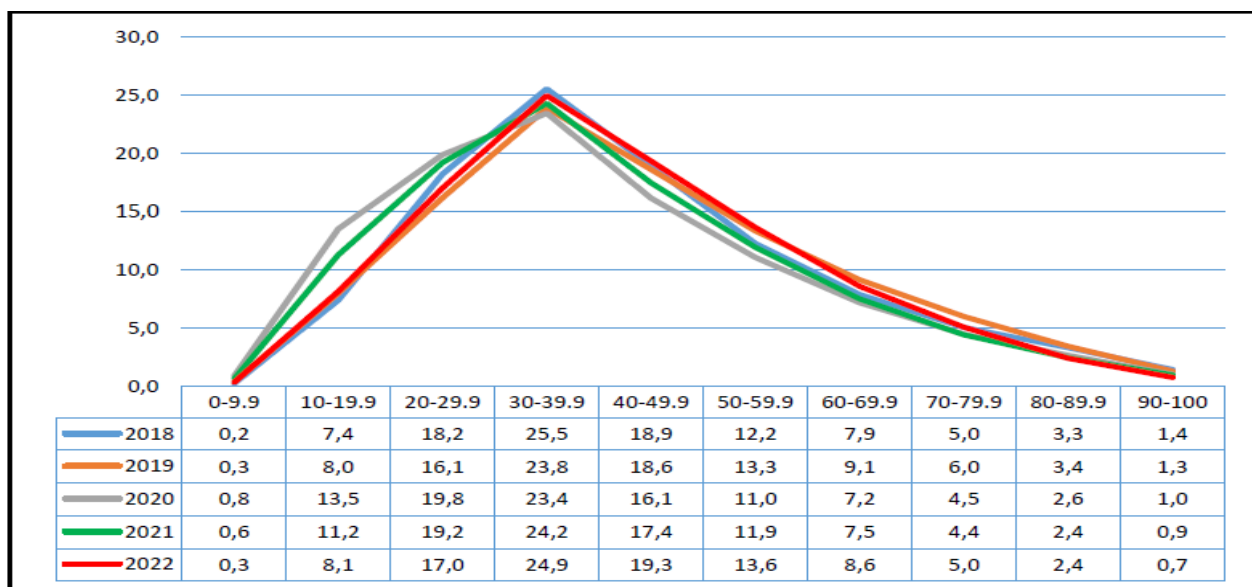


Figure 1 shows Grade 12 results in Physical Sciences, indicating that from 2021 to 2025.

The Diagnostic Report (DBE, 2025) provides additional evidence of poor performance in Physical Sciences. The last five years have witnessed a similar pattern of performance, with most learners performing at 30-39%, which translates into a less-than-satisfactory level 2 pass. This is an elementary achievement, according to the National Policy pertaining to the Programme and Promotion Requirements (Basic Education 2011). Less

than 10% of learners within each year of the five years obtain a combined substantial (60%-69%) meritorious (70% - 80%) and outstanding pass (80% - 100%).

Poor performance in science reduces the pool of learners pursuing science in high school, ultimately reducing the number of learners pursuing science-based careers and degrees in higher institutions of learning. This results in limited science expertise held in the country. Science is a crucial learning area because science and technology are critical drivers of economic advancement and improving health, education, and infrastructure systems (Hlabane 2016; Rajan et al. 2008).

The significant performance gaps that exist between rural and urban schools are due to a lack of access to resources and pedagogical strategies (TIMSS SA Newsletter 2023; Muremela et al. 2021). Using WhatsApp may prove an innovative teaching strategy to address resource challenges and an alternative to traditional teaching methods that negatively affect learner performance (TIMSS SA Newsletter 2023). However, this would depend on whether teachers and learners have access to the application and on how well teachers can use it as a pedagogical tool.

To address these challenges and enhance science education in rural schools, it is crucial to explore alternative approaches that will enhance the teaching and learning of Physical Sciences. With the increasing popularity of social media applications, educational institutions have begun incorporating these platforms for ELO (Jere et al. 2019). Based on the above interest and concerns, this study investigated rural teachers' use of WhatsApp for ELO in Physical Sciences. I suggest that the effective use of WhatsApp for ELO hinges on making sense of the tool and harnessing its affordances.

1.3 AIM OF THE STUDY

The aim of the study is to investigate rural teachers' use of WhatsApp for extending learning opportunities in Physical Sciences as a way of mitigating challenges that rural schools are grappling with.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study are to:

- Describe how rural teachers understand the use of WhatsApp for ELO.
- Examine the affordances of WhatsApp for ELO in rural schools.

1.5 RESEARCH QUESTIONS

- How do rural teachers understand using WhatsApp to provide ELO?
- What affordances does WhatsApp provide for ELO for learners in rural schools?

1.6 DEFINITIONS OF KEY CONCEPTS

The terminologies below are used in this study and are defined to enable the reader to comprehend this study.

1.6.1 WhatsApp

This is a Web-based instant messaging application that can be downloaded and accessed on smartphones and laptops. It operates using an active internet connection, either through Wi-Fi or a mobile data carrier (WhatsApp 2023). This application connects users with other users on the phone contact list. Users can exchange content like text, pictures, video clips, voice notes and file documents (WhatsApp 2023; Bouhnik & Deshen 2014). The current study adopted a similar definition.

1.6.2 Rural Schools

These are government-owned, no-fee-paying public schools located in rural areas, which may be tribal lands or farms, characterised by low population densities and low economic activity (Department of Basic Education 2017). They fall under quintiles 1-3, are

historically disadvantaged and are found in places where basic amenities are often lacking. Moreover, these schools often have resource challenges, fall on the disadvantaged side of the digital divide, and have poor learner performances in mathematics and science. The current study adopted a similar definition.

1.6.3 Physical Sciences

This refers to a learning area in the South African school curriculum which studies phenomena relating to physics and chemistry (Basic Education 2011; Rajan et al. 2008). The current study adopted a similar definition.

1.6.4 Learning

This refers to the processes and activities by which learners organise and acquire knowledge (Ornstein & Hunkins, 2016). These processes and activities facilitate understanding of the Physical Sciences by encouraging learners to interact and engage with the knowledge of scientific concepts and subject matter. Such activities may include discussions, lectures, giving feedback, exchanging pictures, voice notes and videos that teach and expand on scientific concepts. The current study adopted a similar definition.

1.6.5 Extended Learning Opportunities (ELO)

Extended Learning Opportunities are the educational activities and experiences designed to facilitate learning beyond the traditional classroom setting. These opportunities can be planned or spontaneous; they are created outside normal school programmes and hours and are aimed at stimulating and promoting learning. These auxiliary opportunities are intended to supplement and enhance the formal learning process, providing learners with a broader range of educational experiences and skills. ELO can take on various forms encompassing both tangible and intangible elements that can be found within a learning environment. These activities include some of the activities that teachers and learners normally do in classrooms but now in a non-formal manner where some certain rules and methods may be altered. The current study adopted a similar definition.

1.7 SIGNIFICANCES OF THE STUDY

The significance provides the justification for the study, by specify why the study is worthwhile and who the study aims to benefit (Creswell & Creswell 2018). The findings of this study are beneficial to all stakeholders within the educational landscape, which includes and is not limited to education policymakers, School Managerial Teams, E-learning, curriculum advisors, teachers, parents and learners. The findings will give grounds for intervention and the formulation of school guidelines. With the increase in WhatsApp use, policies are needed to regulate its use to avoid unfavourable situations and provide interventions needed to inform pedagogical practices, increasing the effect and optimal use of the application. The findings will also aid future research projects concerned with social media platforms in education, online and mobile learning.

1.8. DELIMITATION OF THE STUDY

The scope and delimitation of the study help the study to define the study's boundaries and coverage (Creswell & Creswell 2018). This study was conducted in the Vhembe District, Limpopo province, on rural teachers who teach Physical Sciences in grades 10 - 12.

1.9 STRUCTURE OF THE RESEARCH PROJECT

Chapter 1: Introduction

This chapter introduces the study, identifies the researcher's interest in investigating the stated research problem, provides background to the problem, the main aim of the study, and the research questions the researcher aims to answer to address the research problem. This section will also include a definition of key terms, the significance of the study, the scope of the study and the limitations under which the study will be carried.

Chapter 2: Literature Review.

This chapter presents the theoretical framework underpinning the study and summarises the scholarly literature read and used to inform the current study, as well as the research gap.

Chapter 3: Research Methodology

In this section, the researcher presents the research paradigm and outlines the strategies used in gathering data, including sampling procedures and data collection methods. Further, it discusses the ethical considerations and quality control measures used to enhance the study. used to carry out the study.

Chapter 4: Presentation, Interpretation and Discussion of Findings

In chapter 4, the study presents the analysed and interpreted findings generated from collected data. These findings are discussed and compared with existing studies.

Chapter 5: Conclusion and Recommendations

This chapter brings the study to a close, presenting the conclusions and recommendations of the study for concerned stakeholders.

References

All the works cited by the researcher will be listed alphabetically using the Harvard style of referencing.

Appendices

All documents used in the process of carrying out this study will be attached to the research report; this section will contain the ethical clearance, informed consent forms, interview guide and the observation checklist used in the process of data collection.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the theoretical framework, which serves as the working model for investigating, analysing, and understanding rural teachers' use of WhatsApp in pedagogical practices. It also reviews and summarises relevant literature on the use of WhatsApp and similar technologies in education with a particular focus on rural contexts.

2.2 THEORETICAL FRAMEWORK

A theoretical framework is a philosophical structure that contains established theories about a research phenomenon.(Cai *et al.*, 2023; Dziak, 2024; USC Libraries, 2025). It combines generalisations, assumptions and ideas made about how things happen and lays a basis for predicting how things are expected to happen in the future. (Dziak, 2024; Kivunja, 2018). Theoretical frameworks aim to provide simplified explanations of how certain aspects work in the world, how these aspects relate to one another, and how to distinguish one aspect from another(Crawford, 2020; Dziak, 2024; Kivunja, 2018). These are not theories from the present researcher but are compiled by experts in the field; however, the researcher selects, customises and embodies these theories to explain their current research problem (Cai *et al.*, 2023).

The field of education is complex and has evolved significantly over time, with multiple theories attempting to explain how we learn (Goldie 2016). In recognising the merits and limitations of various learning theories, this study adopted two theories, namely, the Cultural-Historical Activity Theory (CHAT) and Connectivism, which are integrated to form a comprehensive compounded framework. 'Connect-ivity' is a theoretical framework through which the study is underpinned. A theoretical framework is used in a study to explore a research phenomenon by specifying key concepts that indicate the relationship

between variables and give direction into how the study is carried out (Cohen et al. 2018:69). In this study, a combination of CHAT and Connectivism was used to address the cultural, social, and technological aspects of WhatsApp practices in pursuit of ELO in Physical Sciences.

2.2.1 Cultural Historical Activity Theory (CHAT)

The Cultural Historical Activity Theory (CHAT) is a theoretical framework used to study the dynamics of human activities and practices within a social group setting of a particular cultural context by investigating factors that contribute to these practices. Founded on ideologies presented by the psychologist, Lev Vygotsky (1978), and further developed by his followers, the CHAT model works to expose and provide clarity on dimensions that make up human practices (Igira & Gregory, 2009; Roth & Yew, 2007). According to Foot (2014), CHAT is a philosophical perspective that aims to comprehend mediated actions by humans, considering the social and cultural context through which the action is executed. By examining what may seem like a simplistic act of communication, CHAT presents a lens through which different layers and components involved in WhatsApp activities can be critically analysed. It does so by looking at the roles of the participants (rural teacher and learners), the tools used (e.g., WhatsApp and its functionality), the rules governing the community and the intended learning outcomes.

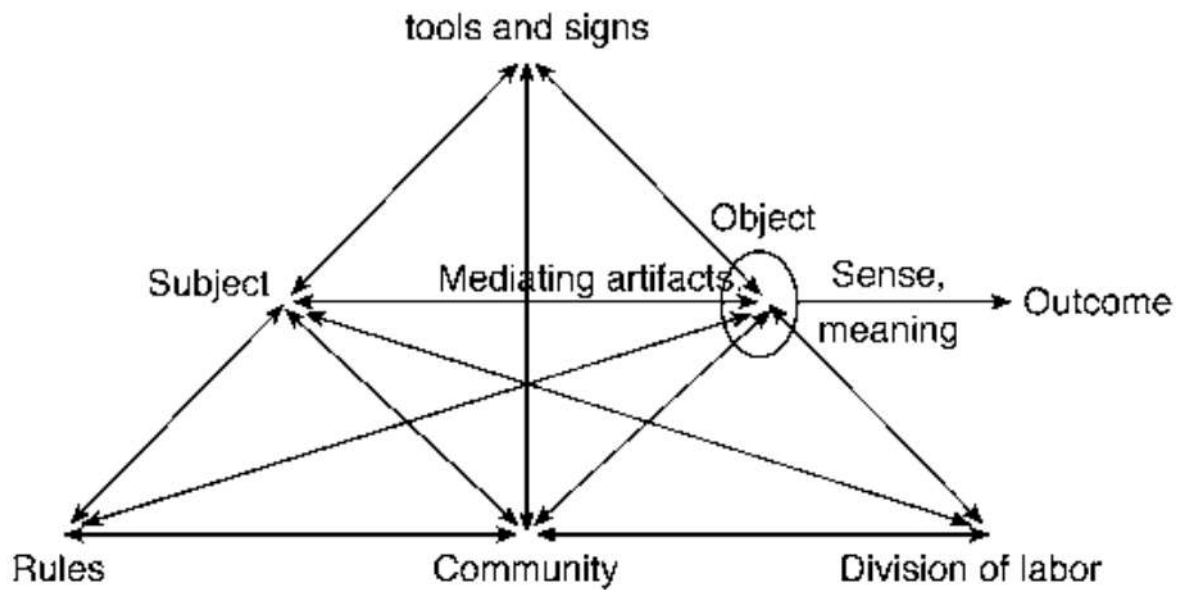


Figure 2: Diagram representation of CHAT.

A practice through the CHAT framework is modelled as a system with the following interlinked components: Subject, Object, Outcome, Community, Tools, as well as the Division of labour and Rules (Batiibwe 2019). These components, although separate, are observed in relation to each other within the activity or practice system and are not to be regarded as independent entities (Foot 2014). When applied to analysing WhatsApp interactions, components of the CHAT framework enable the researcher to view activity beyond a simplistic level by revealing how the social and cultural elements influence the activity system.

Considering that this study is set in a time when technology and, more specifically, social media are an integral aspect of everyday life, influencing everyday practices (Siemens 2017). In this study, technology can be viewed as both a culture and a tool because of how it is valued, and its use has become normalised in society (Siemens 2017; Jahnke 2015), and as a tool, through which practices of teaching and learning can be mediated.

2.2.2 Connectivism

Connectivism, on the other hand, is a learning theory introduced by George Siemens and Stephen Downes in response to understanding learning in a technologically encultured era (Kop & Hill, 2008). Connectivism describes learning as a network phenomenon impacted and influenced by socialisation using various digital media (Siemens 2014). Networks or connections are defined as links that individuals make with each other, the learning community and knowledge. Maintaining and nurturing these networks are necessary for learning. Technology is fundamental in human learning practices, and it enables networks to be formed, nurtured, and maintained (Siemens, 2017).

The roles of teacher and learner in digital learning environments are different from those previously experienced in traditional learning environments. This is because technology allows for learning to be the responsibility of both the teacher and learner.

Connectivism accounts for how WhatsApp may be manipulated to provide ELO. It can specify the roles that the teacher and learner take on in digital learning environments and how individuals connect in a learning community. The tenets of Connectivism account for how technology affects learning practices (Siemens, 2017; Siemens, 2014). In this way, Connectivism complements CHAT by extending the understanding of how humans learn in digital environments.

The CHAT and Connectivism frameworks agree on the social nature of learning, but differ on distributed cognition, conditions of learning, and the role of technology in learning practices.

- Social Nature of learning.

Both theories recognise learning as a social phenomenon and that learning is a consequence of social interactions between subjects or nodes (Batiibwe, 2019; Goldie, 2016; Siemens, 2017). CHAT highlights the social and cultural make-up of the group as

an influencing factor in how learning is pursued (Foot, 2014), while Connectivism focuses on social networking or forming connections between nodes in a group (Siemens, 2017).

- Conditions for learning

Both theories agree that community is significant in human learning (Foot, 2014; Roth & Yew, 2007; Siemens, 2017), humans learn collectively (Foot, 2014) and maintaining these connections is a part of learning (Siemens, 2017).

- Distributed Cognition.

In the CHAT framework, learning is distributed to subjects using various tools that are chosen to fit a purpose. (Foot, 2014), whereas in Connectivism, learning is distributed to the subjects and their technological tools (Siemens, 2017). According to Siemens (2017), learning may reside in non-human appliances and can be accessed when required.

- Role of technology

In the CHAT framework, the role of technology is understood as a tool that could be used by the subjects in executing learning practices. (Foot, 2014). However, the Connectivist theory explicitly recognises and places emphasis on technology being central to learning practices. (Siemens, 2017; Goldie, 2016). It is for this reason that this study synthesises principles from the CHAT and Connectivism to present a comprehensive framework of Connect-ivity.

2.2.3 Connect-ivity

Where technology was once seen as a mere tool, the fusing of the biological and digital worlds (Jahnke 2015) requires a framework that thoroughly acknowledges the significance of technology within human culture and practice. To present a theoretical framework that aids the researcher in answering the set research questions, the study synthesised tenets of both CHAT and Connectivism and presents 'Connect-ivity' as the

theoretical framework to underpin the study. Connect-ivity is aimed at investigating and understanding technology-enabled learning practices by integrating social, cultural and networked dimensions of learning. This calls for technology to be viewed as more than just a mediating tool but as a significant enabler of diverse actions within human practice.

Connectivity combines the strengths of both perspectives. Using the CHAT framework, it highlights the social and cultural dimensions of the WhatsApp activity system. And from Connectivism, the study draws attention to the nature of digital networked learning.

Connect-ivity will be discussed under the following principles:

- Subject and Community

A subject refers to the individual or groups of individuals immersed in the activity (Batiibwe 2019). According to Foot (2014), this is the actor and perpetrator of the activity or practice. The connectivist theory refers to subjects as nodes. This answers the 'Who?' within an activity system. In the digital age, technology is an extension of human learning practice (Jahnke 2015). In answering the 'Who', we cannot ignore or diminish the importance of the 'With what?', the technological aspect that enables the activity. Thus, the individual and the technological platforms co-exist in perpetrating the action.

A community is a collective group of subjects that share a common interest and are situated in a particular social and cultural context (Batiibwe 2019; Foot 2014). A community is the collection of individuals involved in the activity; individuals form a network whereby they are connected through various technological platforms. A community is a network, formed by linking entities known as nodes (Siemens 2017). Nodes may be individuals, learners, and or learner communities (Siemens 2017).

Communities play a vital role in learning, and technology presents platforms where communal learning and practice can be executed. Learning occurs within a community (Kop & Hill 2008), and constructing knowledge is a fluid process, that is, a consequence that happens when nodes link up (Siemens 2017; Kop & Hill 2008). Learning is a

networked phenomenon affected by technology and social factors (Goldie 2016), and nurturing and maintaining networks or connections is needed to facilitate continual learning.

In this study, the subjects or nodes are the participants in the science WhatsApp group, the teacher(s), and the learners. WhatsApp forms a base for the community and connects teacher(s) to the learners. Learning practice in the WhatsApp environment is a communal activity where individuals are supported by their peers and teacher for academic success (Adams 2019; Abualrob & Nazzal 2019; Bouhnik & Deshen 2014).

In the Connectivism theory, learning may reside in non-human devices (Siemens 2017), and knowledge may be stored in digital devices and accessed when needed (Siemens 2014). Technology is basic in learning practices and an enabler of learning communities (Siemens 2017).

The tenet on Subjects and Community will enable the study to specify how WhatsApp enables subjects to connect to each other and the community. It will shed light on how rural teachers understand their WhatsApp teacher-learner community.

- Roles and Rules

This is the 'Who does what and how?'. It specifies the shared responsibility, tasks, and roles that members of the community take up in executing the practice or activity (Batiibwe 2019). Divisions of labour specify who does what and how toward the objective (Foot 2014). Using technology decentralises power from the teacher, who in the traditional setting is a knowledge source, and who is responsible for transmitting knowledge to passive learners (John 2019; Rajan et al. 2008). Learners are actively participating and contributing to learning practices (Jahnke 2015).

Rules are the norms, standards, and expectations that regulate the community and which members of the community ascribe to, these rules may be implicit or explicit (Batiibwe 2019; Foot 2014). In carrying out learning practices, there is a consensus among the

members of the community regarding what is appropriate and acceptable conduct. When humans interact regardless of whether it is a physical or virtual space, expectations and assumptions arise that form social boundaries to which they ascribe (Jahnke, 2015) expectations are built within the community around what is acceptable conduct.

The tenet on rules and roles will be the study to specify the arrangement of how the teacher and learner relate with each other on the WhatsApp platform, what roles and responsibilities each member has in the community, and what rules fashion the community.

- Object, Outcome and Decision-Making

Object refers to the motive or the influence behind the action, the fundamental reasons for embarking on a specific activity or practice (Batiibwe 2019; Foot 2014). This is concerned with answering the ‘Why?’ What purpose is the activity or practice set out to achieve? The aim of this study is to investigate how WhatsApp is used by rural teachers for ELO. The motive behind teachers’ actions is important and will be used to investigate how they make sense of using WhatsApp for ELO.

Outcome refers to the consequence or product of the practice. This component is concerned with specifying the outcome following the activity or practice (Batiibwe 2019). The Connectivism perspective is that the outcome of learning is a dynamic process and the connections that learners have enable them to know more (Siemens 2017). Technology enables learners to always have continual avenues of learning.

Decision-making is a learning process, choosing which knowledge to absorb and which knowledge to abandon (Siemens 2017). In the digital age, knowledge is readily available to consumers and easily accessible through mobile devices. Being able to Judge and make connections between fields, ideas and concepts is a basic skill and a valuable outcome (Siemens 2017; Jahnke 2015). Having easy access to knowledge does not imply learning (Jahnke 2015) but being able to extract relevant and accurate knowledge falls on the decision-making process of the learner (Siemens 2017).

The principles of Objective, outcome and Decision-making will allow the study to specify the objectives held by teachers on executing learning on the WhatsApp platform and what outcomes were obtained as a result. Further what decisions were made in response to the objective and outcomes? It will also shed light on how WhatsApp affords ELO.

- Artefacts/ Tools

These are concrete and abstract resources employed by the subjects and the community to facilitate the outcome (Batiibwe 2019; Foot 2014). Tools may include the language, pedagogical approach, and technological mediums used (Foot 2014). Tools are shaped by the needs, norms, and values of the community and are responsive to the time in which this community exists (Foot 2014). Learners in the WhatsApp group use language that is comfortable to them for learning purposes (Jere et al. 2019) and use various media to facilitate knowledge (Abualrob & Nazzal 2019). Tools are significant because they facilitate learning.

The tenet on tools will allow the study to specify which tools subjects and their communities use to provide ELO on the WhatsApp platform. These may include language and pedagogical tools. This will allow the study to account for the means through which WhatsApp affords ELO.

In conclusion, Connectivity offers a comprehensive understanding of the dynamics of learning influenced by WhatsApp and situated within a historical and cultural context. It does so by looking at the activity system of rural teachers and their participation in a rural learning network.

2.3 EMPIRICAL LITERATURE

This section presents a literature review that summarises previous research and scholarly articles that shed light on the research problem.

2.3.1 Challenges facing rural schools.

Rural schools continue to struggle with the legacy of apartheid three decades after the country gained liberation (Amnesty International 2020). Apartheid was a racially segregating regime that saw black South Africans being offered low-quality life opportunities. (Amnesty International 2020). Currently, rural schools continue to offer subpar education compared to their urban counterparts (Nkambule 2022). Although the extent of this historical injustice may vary across different rural contexts, it suggests that apartheid has had far-reaching implications for present educational outcomes.

Rural schools are in rural areas, and as defined by the Department of Basic Education (2017), these rural areas are farms, traditional areas with low population densities, low levels of economic activity and low levels of infrastructure. Rural communities often grapple with a lack of basic amenities such as clean water, proper sanitation, quality health care and infrastructure (Amnesty International 2020). Rural schools mirror the same set of challenges faced within their communities (Amnesty International 2020). Studies investigating concerns in rural schools document a lack of resources, low learner performance (TIMSS SA Newsletter 2023; Muremela et al. 2021), and negative attitudes towards schooling as prevailing challenges in the rural setting, which can be seen as a trademark of rural schools (Amnesty International 2020). However, it can be argued that a blanket approach cannot be taken to describing the challenges that South African rural schools face. These challenges may not be uniform, considering contextual factors that influence experiences.

In South Africa, schools are classified by quintile levels (Q1- Q5), with Q1 being the least resourced and Q5 being the most resourced and affluent of schools. There is a strong correlation between a school's quintile number and learner performance, as low quintile numbers correlate to low learner performance (TIMSS SA Newsletter 2023; Nemadziva et al. 2023). While the relationship has been widely documented, Jansen and Blank (2015) demonstrate that low-quintile rural schools can produce high learner performance despite resource challenges and factors prevalent in rural contexts. However, it is worth noting that such schools are few and far between. Evidently, high learner performances are often positively skewed in favour of schools with abundant resources (Nemadziva et

al. 2023). The top 200 schools in South Africa, which amount to 3%, can produce distinctions in a challenging learning area like mathematics in comparison to the following 6,600 (97%) schools combined (Amnesty International 2020). Rural schools are mostly government public, no-fee-paying schools (Amnesty International 2020). These schools have seen minimal changes in their state despite being currently ruled by a democratic government, and they continue to be under-resourced and disadvantaged (Amnesty International 2020; Nemadziva et al. 2023). This demonstrates that historical inequalities remain ingrained in the South African educational system, as they continue to affect rural schooling,

2.3.2 Lack of resources

Lack of resources includes a lack of teaching and learning materials, infrastructure, and human resources (Muremela et al. 2021; Nkambule 2022). Lack of resources affects multiple facets of teaching and learning practices. Teachers without the proper and adequate resources are unable to carry out pedagogical actions successfully (Nemadziva et al. 2023). However, it is worth considering the resilience and innovative strategies that are used by teachers in resource-constrained schools, particularly rural schools. These teachers go beyond their employment contractual obligations, such as extending teaching and learning time to achieve educational outcomes. (Jansen and Blank, 2015). But, according to John (2019), rural schools use the traditional teaching method as they tend to focus on explaining concepts and reading from textbooks. The traditional classroom or the lecture method is characterised by lecturing, note-taking, and textbook reading (Rajan et al. 2008; John 2019). It is teacher-centred and a one-way communication path as the teacher is the active participant while learners are passive recipients (John 2019; Rajan et al. 2008). The lack of resources leaves teachers with no other alternative but to use the traditional method of teaching (Nemadziva et al. 2023). Teaching methods may influence learner performance, and the use of traditional teaching methods fosters superficial surface learning in learners. This method only produces memorisation in preparation for examination taking (Jere et al. 2019).

2.3.3 Teachers of rural schools

In rural schools, teacher-related problems stem from a lack of teachers, unqualified teachers, or inadequately qualified teachers (Amnesty International 2020). Due to undesirable working conditions, rural schools face challenges in recruiting and/or retaining adequately trained and qualified teachers (Muremela et al. 2021; Amnesty International 2020). Science teachers in rural schools are few compared to teachers in other learning areas (Chowdhury 2014). Science teachers have heavy workloads and are highly stressed, which negatively impacts the quality of teaching they offer their learners (Muremela et al. 2021; Chowdhury 2014). This suggests that teacher-related challenges are a concern in rural schooling contexts; however, this may not be uniform across South African schools. Furthermore, rural schools often have overcrowded classrooms; in low-population schools, teachers support learners in a multi-grade system (Chowdhury 2014; Nkambule 2022). In the case of overcrowded classrooms, teachers spend all their time from class to class, leaving teachers with minimal time to analyse learners' work, and as such, teachers cannot constructively support learners (Chowdhury 2014; Jere et al. 2019). It implies that time constraints negatively affect the opportunities to provide feedback to learners. Furthermore, Physical Sciences content is dense, and learners must contend with alien and even abstract concepts (Chowdhury 2014). Unfortunately, finding ample opportunities to learn is challenging because of time constraints. According to the Amnesty Report (2020), only 66% of classroom time is spent on actual teaching and learning.

2.3.4 Learners in Rural Schools

Learners in rural schools face a multiplicity of barriers stemming from their schooling experiences and rural backgrounds. There is a clear distinction between learners from rural backgrounds compared to learners from affluent communities; background characteristics influence learner prospects (Nemadziva et al. 2023). Although this may be a generalisation and not indicative of all South African rural learners, Chowdhury (2014) documents that learners in rural schools do not have positive attitudes towards schooling. Many of them are demotivated and do not comprehend the value of attending school (Chowdhury 2014). Some learners do not have transport to use to go to and from school and walk long distances to school, which in turn aids learner absenteeism (Amnesty

International 2020; Nkambule 2022). When they do attend class, the appalling state of the classroom is not conducive to teaching and learning as it fails to stimulate learning and learner participation (Nkambule 2022). This suggests that factors stemming from learners' environment and context influence how learners participate in the educational process.

2.3.5 Physical Sciences in Rural Schools

Physical Sciences is a valuable and worthwhile subject. It has a significant role in the lives of all South African citizens because it is key for driving socio-economic growth through scientific and technological advancements (Basic Education 2011). Physical Sciences are essential for holistic development in learners as it fosters critical thinking and problem-solving skills. It also prepares learning for further education prospects, specialised learning and better employment (Basic Education 2011).

The Physical Sciences learning area in rural schools has been one of great concern due to low learner performance (Muremela et al. 2021). Lack of resources negatively affects the delivery of content and curriculum. This implies that resource challenges may negatively impact the teaching and learning process unless alternative or innovative strategies are employed. Little to no alternatives have been presented to rural schools regarding how they are to reconcile the lack of resources and improve pedagogical practices (Muremela et al. 2021). The dominant method is the lecture method, which is unsympathetic as it does not factor in differentiated learning styles that aid learners to acquire knowledge (Adams 2019). However, this may also stem from teacher training and institutional support of individual schools.

In contrast, Urban schools perform better in the learning area of Physical Sciences than their rural counterparts (TIMSS SA Newsletter 2023). Urban schools are well-resourced (TIMSS SA Newsletter 2023). Abundant resources have been associated with satisfactory results in Physical Sciences (Nemadziva et al. 2023). Moreover, urban schools are more appealing to scarce skills teachers who often leave rural schools for urban schools in pursuit of better teaching prospects (Muremela et al. 2021).

2.3.6 Technology Enriched Learning Environments

Technology has changed how we learn; schools are no longer the source of information they once were (Jahnke 2015). Mobile technologies enable learners to have easy access to knowledge anytime and anywhere (Jahnke 2015). Considering the pervasive nature of technology and social media, educational institutions may need to rethink ideologies surrounding teaching and learning practices in unofficial learning environments such as those presented through the WhatsApp platform. Educational institutions are using pedagogical approaches that are not responsive or relevant in the digital age. (Jahnke, 2015). 'Who we teach has implications for how we teach' (Phakeng 2018). Learners are accustomed to how technology enriches their lives, and they incorporate it into their learning practices (Abualrob & Nazzal, 2019). According to Yildirim and Sensoy (2016), technology offers constructive learning, permanent learning and materialisation of abstract concepts and decentralises power from the teacher to place learning responsibility on the learner.

Even rural schools have embraced WhatsApp as a platform for teaching and learning. It has emerged as a pragmatic solution to longstanding challenges concerning resources, pedagogical approaches, learner support and subject time allocation. (Adams, 2019; Jere et al., 2019; Nduduzo et al., 2023). Studies investigating concerns about rural school education often document that these schools are crippled by resource constraints, which lead to low learner performance (TIMSS SA Newsletter, 2023; Muremela et al., 2021). Despite challenges in the rural context, the adoption of WhatsApp educationally indicates innovation in improving teaching and learning.

Studies highlight the important role of WhatsApp in fostering technology-enriched learning environments. Demonstrating that WhatsApp enables continuous communication between teachers and learners outside formal school schedules, thereby extending instructional time (Jere, Jona and Lukose, 2019; Rambe, Chipunza and Ng'ambi, 2020), even with limited access to formal educational infrastructure, such as libraries or internet connectivity. Rambe, Chipunza and Ng'ambi (2020) found that WhatsApp enabled learners from rural backgrounds to share information and exchange learning resources.

Whereas Jere, Jona and Lukose (2019) indicate that WhatsApp provides an accessible platform for rural learners to engage with content knowledge, ask questions, and receive timely support. Notably, WhatsApp can be used to conduct pedagogical activities in Mathematics and Science education (MSE) (Adams, 2019; Lois and Ibironke, 2022). Teaching and learning of these subjects benefit from the use of ICT because it enhances conceptual understanding, supports learner-centred approaches, fosters collaborative learning, and provides access to varied resources central to Mathematics and Science education (MSE). (Abualrob and Nazzal, 2019; Adams, 2019; Lois and Ibironke, 2022). This suggests that WhatsApp can be adopted to support and enhance the teaching and learning of conceptually challenging learning areas. This is particularly important in rural settings, where mobile technologies help to bridge gaps in access to quality education. However, it cannot be taken for granted that access to such technologies may present challenges for both teachers and learners in rural contexts, particularly because such areas are on the unfortunate side of the digital divide.

2.3.7 The use of WhatsApp for ELO

WhatsApp was founded by Brian Acton and Jan Koum in 2009 (WhatsApp 2023). Technically, it is a messaging and calling digital application that uses mobile data or Wi-Fi connectivity to connect users to each other (WhatsApp, 2023). Some teachers have repurposed and adapted the tool to provide ELO (Jere et al., 2019; Adams, 2019), which suggests that social media applications that are widely used can be adapted to support teaching and learning. In this study, ELO are the educational activities and experiences designed to facilitate learning beyond the traditional classroom setting. These opportunities can be planned or spontaneous; they are created outside normal school programmes and hours and are aimed at stimulating and promoting learning. These auxiliary opportunities are intended to supplement and enhance the formal learning process, providing learners with a broader range of educational experiences and skills. ELO can take on various forms encompassing both tangible and intangible elements that can be found within a learning environment. These activities include some of the activities that teachers and learners normally do in classrooms, but now in a non-formal manner,

where certain rules and methods may be altered. In agreement with the connectivism theory (Siemens, 2004), it suggests that learning is not confined to the formal classrooms alone.

The objectives for how WhatsApp are used to provide ELO can be identified in the literature as activities for:

- **Furthering classroom-based instruction:** This can be completing class activities that could not be completed during the prescribed class time (Jere et al, 2019; Chirinda et al, 2021).
- **Supplementing classroom-based instruction:** These are activities that enrich learning, including providing prescribed learning materials like past examination papers, study guides or textbooks or alternative learning materials such as links to websites and supplementary materials for the purpose of deepening understanding of concepts (Bouhnik & Deshen, 2014; Adams, 2019; Abualrob & Nazzal, 2019; Jere et al., 2019). It can also be through extending contact time with the teacher for purposes of academic assistance (Abualrob & Nazzal, 2020; Jere et al, 2019).
- **Providing meaningful learning experiences:** This includes intangible elements that are valuable and necessary for creating a positive classroom climate. This may be through providing support, peer collaboration, social cohesion and building trust. WhatsApp has multimedia capabilities that allow for varied pedagogical activities and catering to different learning styles for meaningful learning experiences (Bouhnik & Deshen , 2014; Abualrob & Nazzal, 2019).
- **Easy accessibility/availability of the teacher:** A digital learning space overcomes time and space limitations, which means that teachers are available to learners regardless of the time of day or day of the week (WhatsApp, 2023; Adams, 2019; Jahnke, 2015). Teachers engage and supervise the educational process. This gives way to learning opportunities such as academic support, where teachers attended to learners' school and learning-related support outside of the classroom. Because WhatsApp is not restricted to the classroom, teaching and

learning take place anywhere and anytime. Furthermore, it promotes peer collaboration, social cohesion and building trust. WhatsApp has multimedia capabilities that support varied pedagogical activities and cater to different learning styles, fostering meaningful learning experiences (Bouhnik & Deshen, 2014; Abualrob & Nazzal, 2019).

WhatsApp can be manipulated to provide Extended Learning Opportunities, and because it is a web-based application, activities are not bound to a physical location, affording learners the opportunity to learn anywhere and at any time. (WhatsApp, 2023; Adams, 2019; Jahnke, 2015). WhatsApp is low-cost and easily operated, making it accessible to a diverse population of learners, with its multifaceted capabilities making it adaptable to varied pedagogical activities. (WhatsApp, 2023; Adams, 2019; Abualrob & Nazzal, 2019).

The use of WhatsApp for ELO impacts different variables in the process of learning. This section will discuss how the use of WhatsApp counteracts resource challenges, enhances communication, teacher and learner interactions and provides a learning environment. However, accessibility to web-enabled devices and data costs may pose challenges for practice in rural areas.

2.3.8 WhatsApp and Resources

Studies indicate that WhatsApp provides a platform where learners can share and access resources (Bouhnik & Deshen, 2014; Adams, 2019; Abualrob & Nazzal, 2014; Adams, 2019; Abualrob & Nazzal, 2019; Jere et al., 2019). This is significant considering the under-resourced rural setting. Due to its multimedia capabilities, the WhatsApp platform enables teachers to provide versatile resources like pictures, videos, voice notes and document files (Adams 2019). In a learning area like science, resources are vital to produce a successful learning experience (Adams 2019). Some concepts cannot be taught to full capacity without the use of visual aids (Abualrob & Nazzal, 2020). WhatsApp, as a supplementary educational tool, has been found to support the traditional classroom as various media, such as images, are more effective in encouraging learning (Cetinkaya 2017). Teachers can use the platform to provide learners with content materials that will

allow learners to acquire knowledge in the content area (Jere et al. 2019; Adams 2019; Bouhnik & Deshen 2014). In this way, WhatsApp may be used to help mitigate limitations concerning resources in rural classrooms.

A study in Indonesia conducted by Pratama & Kartikawati (2017) that investigated WhatsApp within the electrical engineering course found WhatsApp to be effective in producing the required learning outcomes. The course in electrical engineering requires experimentation and practical activity to accompany theory. Using a videotaped practical activity, the teacher was able to simulate a virtual laboratory where the learners were equally involved through watching and analysing the practical activity, thus counteracting the limitations of laboratory instruments (Pratama & Kartikawati, 2017).

A study carried out in a South African rural school that aimed to evaluate the effectiveness of WhatsApp as an educational tool in assisting the learning of mathematics in grade 12 concluded that the application highly facilitated the learning of mathematics (Jere et al. 2019). A WhatsApp group was created for the purpose of sharing mathematics content, and the teacher was able to distribute resources and study guides that learners could not afford (Jere et al. 2019). Because the content that is to be covered in class is extensive, the teacher was able to send resources that helped learners understand concepts better and cover some of the work that had not been covered in class (Jere et al. 2019). This study concluded that WhatsApp afforded learners the opportunity to deepen their knowledge of concepts that had been covered during class time (Jere et al. 2019). Through the WhatsApp platform, learners can decide the duration spent on a particular topic depending on their degree of understanding and satisfaction (Adams, 2019). It suggests that WhatsApp may be useful in supporting learning outside of formal schooling schedules.

WhatsApp allows teaching and learning practices anywhere and at any time, and it can create a virtual platform transcending space and time, which is a characteristic of modern classrooms (Jahnke 2015; Bouhnik & Deshen 2014; Jere et al. 2019; Adams 2019). Teachers can use the WhatsApp application to extend the contact time that learners have with learning content and knowledge (Jere et al. 2019; Adams 2019). In a study by Adams

2019), a teacher used the application of ELO in science for marginalised learners of a low economic status. Learners used WhatsApp to access the teacher outside of school hours. Learners would ask about concepts that they needed clarification on, and the teacher was able to assist (Adams 2019). The use of WhatsApp could be beneficial to learners who do not possess good study habits. Through the application, the teacher can guide learners in their schoolwork (Adams 2019). Learners in rural areas may not have adequate support from their parents or guardians in completing homework activities, and access to the teacher means that the teacher is further able to provide guidance that will enable the learner to complete school tasks (Jere et al. 2019).

2.3.9 WhatsApp and Communication

A study by Bouhnik & Deshen (2014), which was carried out shortly after WhatsApp's inception, found that WhatsApp was able to improve the quality of communication between the teacher and the learner(s). The application creates a time-efficient environment in which the teacher and learner engage in clear and unobstructed dialogue (Bouhnik & Deshen, 2014). In any learning environment, communication is vital as it is the medium through which teachers and learners share and construct knowledge (Ujakapa et al. 2018). Learners can ask the teacher and seek clarity where they do not understand (Bouhnik & Deshen, 2014). When the teacher is unavailable, learners assist each other in answering questions (Bouhnik & Deshen, 2014). The study highlighted four main objectives behind WhatsApp use in education, which are communicating with students, creating dialogue, nurturing social cohesion among learners, and serving as a learning environment to execute learning practices (Bouhnik & Deshen, 2014). Although this study provides early insights into the educational use of WhatsApp, the findings remain relevant as they are consistent with newer studies. Abualrob and Nazzal (2020) A study that explored the use of WhatsApp in teaching and learning biology and chemistry found that WhatsApp was able to provide a platform that strengthened learner-to-learner as well as teacher-to-learner communicative interactions in a time-efficient environment.

According to Abualrob & Nazzal (2019), WhatsApp provides an inclusive environment where even the learners who are considered shy do not feel isolated and are comfortable

enough to join in learning activities. Learners who are usually considered shy, unconfident, and self-effacing have been found to be open communicators while using WhatsApp (Abualrob & Nazzal, 2019). The WhatsApp environment created a positive learning outlook, and learners feel comfortable enough to raise concerns or questions that they would not have the courage to ask in class. However, even in the case where rural learners may have access to such technology, such outcomes may also be influenced by learners' digital literacy levels. It can be argued that the familiarity with WhatsApp and web-enabled devices, and how the educational use of WhatsApp is implemented, may present varying outcomes.

2.3.10 WhatsApp for Collaboration and Support

Triyanto (2019) states that the benefits of working collaboratively outweigh the benefits of working alone and that teamwork may overcome shortcomings in the traditional classroom setting. Aligning with the constructivist paradigm that learning is induced through collaboration, however, its application in digital learning environments requires consideration. Learners engaged in learning activities through the WhatsApp platform have been found to provide social and academic assistance to each other; learners are encouraged to pursue learning together as they attempt to help each other answer questions posted to a WhatsApp group (Bouhnik & Deshen, 2014; Adams, 2019).

The use of WhatsApp encourages learner participation in knowledge sharing and constructing (Abualrob & Nazzal, 2019). When a question is posted on the group application, it is met with a response from most of the learners within the group. It is further seen that other learners are more likely to respond with their own answers and contribute to an enriching discussion (Abualrob & Nazzal, 2019). This suggests that the educational use of WhatsApp may encourage active learning through participation. By studying the answers given by the individual learners in the group, the teacher is then able to assess conceptual understanding and thus rectify conceptual errors immediately and provide feedback timeously (Bouhnik & Deshen, 2014). Poor performance in science is a result of learners misunderstanding concepts or having incomplete knowledge of concepts

(Basic Education 2020). By being able to recognise learner misconceptions, the teacher can give constructive feedback to learners. Frequent feedback has been shown to improve learning (Alabdulkareem, 2015).

The educational use of the WhatsApp platform has been shown to forge a more personal relationship between teachers and learners (Bouhnik & Deshen, 2014). It allows the teacher to know individual learners' strengths and weaknesses personally and within the learning areas. The WhatsApp group platform may bring about positive emotions around learning (Durgungoz & Durgungoz, 2022). A study by Durgungoz and Durgungoz (2021) has found that WhatsApp cultivated and sustained an environment that promoted learning for secondary school learners in Turkey in the learning area of Mathematics. It increased learner satisfaction and motivation in studying mathematics (Durgungoz & Durgungoz, 2022). WhatsApp has increased in popularity in the educational setting and is being used to mediate learning in various learning areas and across varied levels of learning (Cetinkaya, 2017; Durgungoz & Durgungoz, 2022). Learning takes less effort through WhatsApp, as learners can learn unintentionally by merely reviewing content shared on the WhatsApp exchanges (Cetinkaya, 2017). While these studies demonstrate that WhatsApp may enhance teaching and learning practices, their transferability to South African rural schools warrants investigation.

2.4 RESEARCH GAP

A study conducted on the research trends of WhatsApp in education, which achieved 50 research papers from 2013 to 2017, discovered most studies to have been on languages, especially the use of WhatsApp for the teaching of English and with the bulk of these studies concentrating on higher education, this is because many learners in this sector are considered to have possession of smartphones (Ibrahim 2018). This indicates a research gap at the school level and more specifically in rural contexts. There has been a growing trend of high school teachers using WhatsApp to either supplement or complement the traditional classroom setting. However, scientific evidence is lacking

about WhatsApp being used for executing pedagogical practices and supporting practical activities within the Physical Sciences classroom. According to Ibrahim (2018), who investigated the pedagogical use of WhatsApp in science education, the amount amounted to 6%, showing that this phenomenon is understudied. Moreover, limited research can be found on WhatsApp being used in the rural setting. This demonstrates the need for an investigation into rural science education.

Physical Sciences is a valuable learning area as it has the potential to accelerate the socio-economic growth and provide personnel that can cover the scarce skills shortage in South Africa (Basic Education 2011; Rajan et al. 2008). It is imperative to consider innovative and alternative ways that can be used to address resource challenges that contribute to the continued dissatisfactory learner performances in rural schools.

With the increase in teachers and learners using WhatsApp for educational purposes, existing studies have focused on WhatsApp as a communication tool and a platform for resource sharing. However, there is limited research on rural teachers' experiences with using WhatsApp for ELO and how it helps them overcome challenges in teaching and learning prevalent in their schools. Furthermore, there is a lack of focus on how WhatsApp is currently being used to support pedagogical practices.

2.5 CHAPTER SUMMARY

This chapter presented the theoretical foundations of the study, which are critical for understanding pedagogical use of WhatsApp. It introduced the Connect-ivity framework, a conflation of CHAT and Connectivism, to highlight human-mediated activity in a digitally mediated learning system.

The chapter also presented a literature review, focusing on the context of rural schools and on how WhatsApp has been used to date in the educational setting. It also identifies the research gap and outlines the areas this study aims to cover.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter documents the strategies used to investigate how rural teachers pedagogically use WhatsApp to extend learning opportunities in the Physical Sciences in three selected secondary schools within the Vhembe District. The purpose of this section is to provide a detailed account of how the study was conducted, where, and with whom. The Connect-ivity framework serves as the basis for this study, serving both methodological and analytical purposes. It has implications for the set research objectives and also it has informed the methodological strategies used to collect data.

This study set out to answer the following questions:

RQ 1: How do rural teachers understand the use of WhatsApp to provide ELO?

RQ 2: What affordances does WhatsApp provide for ELO for learners in rural schools?

The research paradigm and methodology used in the study are aligned and relevant to fulfil the above set of questions. This chapter further outlines the analysis process, including how the data was handled and organised, and how the main themes were drawn from the data. The chapter will also cover the ethical considerations and quality control measures used to improve the study's quality.

3.2 RESEARCH PARADIGM

A research paradigm is defined as the philosophical framework composed of abstract tenets used to inform and validate how the research is oriented and the research plan that is put into place (Baker, 2022). It expresses the ideologies connected to how the

researcher perceives reality, influencing what and how the researcher thinks about the world, knowledge and research. Similarly, Creswell & Creswell (2022, pp. 43-44) also define research paradigms as a set of philosophical assumptions made by the researcher concerning research, stating that it embodies the core beliefs and values that the researcher identifies with regarding the status of reality (Creswell & Creswell 2018:43-44). It is a basis for how the researcher sees the world they live in and a way to interpret occurrences or phenomena experienced in their world (Kivunja and Kuyini, 2017). According to Cohen, Manion & Morrison (2018), a research paradigm is the researcher's basic attitudes about reality and knowledge, shaping the way a researcher thinks and sees a research phenomenon. Baker (2022) further defines a paradigm as an intersection of ontology, epistemology and methodology. In addition, they state that a research paradigm guides the researcher on the course of action regarding investigating a research problem and answering research questions.

Clearly articulating the paradigm underpinning the study is significant in assisting the reader to comprehend the assumptions that the researcher brings to the study, and therefore the rationale for the research plan. Research paradigms are central to the planning and decisions the researcher will make concerning the structure of the entire research study (Kivunja and Kuyini, 2017; Baker, 2022; Creswell and David Creswell, 2022). According to Baker (2022), examining a paradigm should be explored in the initial stages of a study, as it has implications for how the researcher frames the study and asks research questions, and ultimately employs the methods deemed relevant to answering them.

This study is conceptualised around the Constructivist research paradigm, which is a philosophical position that describes reality as being socially constructed by individuals through their lived experiences (Mertens, 2015). The study acknowledges that rural teachers and learners see and experience things differently and their experiences shape their outlook (Creswell & Creswell 2018). People develop meanings in their world as they actively seek to understand the world they live and work in (Creswell & Creswell, 2018). Individuals' cultural and historical background and their interaction with others influence

how they experience the world (Creswell & Creswell 2018). Constructivism recognizes the existence of multiple realities, reality as being complex, time-bound, and a consequence of social interactions (Mertens, 2015). Employing the constructivist paradigm is suitable for situating rural teachers' and learners' pedagogical practices on WhatsApp within an appropriate contextual frame. It opposes the traditional and rigid philosophical position asserted by positivists who hold the assumptions that there is only one reality, reality as being absolute and authentic knowledge is objective and gained only through a scientific methodology (observation and experimentation) (Creswell & Creswell 2018). Positivism discounts subjective views, values, and meanings that individuals associate with their experiences (Mertens 2015).

According to Creswell, the constructivist framework considers beliefs, values, and meanings individuals affiliate with their reality, rather than merely gathering facts and giving descriptions of activity (Creswell 2015). It implies that what rural teachers and learners value and believe about the rural context, the pedagogical context, and interaction with WhatsApp, translates into real experiences and practices. It emphasises people as active agents who deliberately seek out and define their own reality, grounded in their lived experiences and the contextual factors that surround them (Cohen et al. 2018; Mertens 2015; Creswell & Creswell 2018).

In the context of this study, constructivism emphasises that knowledge is not fixed but socially constructed through experiences and context. The use of WhatsApp as a pedagogical platform is influenced by teachers' and learners lived experiences and belief systems. In particular, the contextual factors of the rural setting influence how teachers make sense of the WhatsApp platform for ELO.

Constructivism, which is often combined with the philosophy of interpretivism, considers the subjective view of participants and contextual factors responsible for shaping the reality of individuals and asserts that true knowledge is socially constructed (Creswell & Creswell, 2018). This implies that the study captures and accounts for the lived experiences of both teacher and learners. Allowing the study to delve deeper into understanding how rural teachers perceive the WhatsApp platform for ELO.

Further, the constructivist paradigm encompasses Connect-ivity, the theoretical framework underpinning the study. Connect-ivity looks at the intersection of human-mediated activity (Engeström & Sannino, 2021), and the role of digital technology in teaching and learning (Siemens, 2004).

3.3 RESEARCH APPROACH

A Qualitative research approach was used to investigate and gain an in-depth understanding of the rural teachers' use of WhatsApp to provide ELO in Physical Sciences. Teachers and learners were studied in their natural settings, and attempts were made to understand and assign meaning to the practices exhibited by these subjects (Mertens, 2015; Cohen et al., 2018; Creswell & Creswell, 2018). With the rise in WhatsApp use in education, little is known about how rural educators use this platform to provide learners with ELO. A qualitative lens will enable the study to provide a descriptive, detailed, and insightful account (Cohen et al., 2018, p. 287) of how educators make sense of and use WhatsApp to provide ELO, and of the affordances WhatsApp offers in this regard. A qualitative perspective will enable the researcher to examine teachers' perceptions of WhatsApp and its affordances, thereby addressing the research questions.

3.4 METHODOLOGICAL DESIGN

The following section provides the plan, guiding how the study is conducted to answer the research questions.

3.4.1 Case study

This research study employed a case study design. A case study is an intensive, in-depth investigation of a particular setting, focusing on developing a detailed, descriptive narrative of the phenomena (Cohen et al., 2018). According to Mertens (2015), A case study is an investigative approach focusing on a unit, which may be an individual(s), group(s), or an event to present a thorough description of complex phenomena. To gain a comprehensive understanding of how rural teachers understand and make use of

WhatsApp beyond its intended social interaction design as well as its affordance, multiple cases, being four rural teachers, were considered for the study (Cohen et al., 2018; Mertens, 2015).

3.5 POPULATION AND SAMPLING

A population is the complete collection of entities that the researcher wants to understand (Salkind, 2010). A research population is generally an extensive collection of people or objects that are the focus of a scientific inquiry for which the research benefits (Hassan, 2021). To conduct this study on all the rural teachers and learners who use WhatsApp for pedagogical practices is impractical as it would require substantial amount of time and money. It would make the study impossible to conclude particularly considering the timeframe allocated for the degree program. It is therefore more practical to study a smaller group of schools that would be representative of the entire population. Thus, this necessitates investigating a sample group rather than the population.

3.5.1 SAMPLE AND SAMPLING PROCEDURE

A sampling procedure specifies how the sample group will be selected from the population group (Creswell & Cresswell, 2018). Considering the nature of the case study, the sample group will be small, consisting of four rural teachers from three schools within the Vhembe District, Limpopo Province, who use WhatsApp with their learners for ELO in Physical Sciences. Two learners, each from three WhatsApp groups, will be considered for the study. A non-probability purposeful sample will be used.

Non-probability sample

A non-probability, purposive sampling technique will be utilised, in which the researcher selects participants based on certain characteristics or attributes (Creswell & Creswell, 2018). Purposeful sampling allows the researcher to select participants who are relevant and most likely to yield data required to form conclusions about the study (Dawson 2009; Cohen et al. 2018). In a case study, the researcher may select cases that are fit for the

purpose they set out to achieve (Cohen et al., 2018, p. 386). Cases will be selected based on similarity (Cohen et al., 2018).

A non-probability, purposive sample will allow the researcher to intentionally select teachers who are already using WhatsApp for teaching and learning in Physical Sciences in rural schools. This will allow for an in-depth analysis of the WhatsApp groups to be executed, aligning with the case study design. An in-depth investigation requires ample time; purposive sampling will ensure efficient use of time and resources by focusing on only relevant cases to address the research questions. Some of the criteria for choosing the sample group will be:

- A teacher in the Vhembe District who teaches Physical Sciences, grades 10 -12.
- A teacher from a school that falls under quintile 1-3.
- A teacher who is using the WhatsApp platform with their learners for pedagogical activities in Physical Sciences.

Prospective teachers who use WhatsApp from different schools in Vhembe that are known by the researcher were approached and recruited to be participants in the study. Some were recruited through referrals from colleagues who know teachers who are currently using WhatsApp with their learners.

3.6 RESEARCH INSTRUMENTS

The study employed the following data collection methods: Collecting WhatsApp Chat logs and Telephonic interviews with both teachers and learners. The data collection period will run over three months, making this a longitudinal study (Cohen et al. 2018).

3.6.1 Collecting WhatsApp Chat log (Digital Materials)

This nature of social media sites provides opportunities to gather diverse data, such as text, images, videos, documents, and voice notes (Cohen et al., 2018; Creswell & Creswell, 2018). The advantage of WhatsApp is that messages are saved permanently

in chat logs. WhatsApp chat logs were retrieved through the built-in export chat feature, and Screenshots were collected from the WhatsApp group platform. The chat logs were critically reviewed and analysed. Using the Connect-ivity frameworks, the primary goal was to classify messages by sender (teacher or learner), content type, format, and purpose. The chat logs span the group's existence, showing transactions that lasted over a year.

3.6.2 Interviews

Interviews are preferred to elicit certain information about how WhatsApp is understood by rural teachers and learners, avoiding generalisations (Cohen et al., 2018). Using telephonic interviews, the researcher spoke directly with participants and extracted views and opinions (Creswell & Creswell, 2018). Semi-structured interviews yielded insights into the teacher's sense-making and the perceived affordances of WhatsApp. It assisted the study in uncovering perceptions and experiences grounded in the realities of teachers and learners. (Lune & Berg, 2017). The project employed telephonic semi-structured interviews as a complementary method alongside WhatsApp chat logs.

The telephone interviews were audio recorded, with both teachers and learners providing consent. The interviews were conducted in English and Tshivenda, allowing the participants to express their views comfortably. The recordings were transcribed and translated into English. Some words and phrases in Tshivenda lack English equivalents, so they were translated to retain their contextual meaning. The audio recordings were listened to repeatedly, and the transcripts were read repeatedly to gain familiarity with the data and identify ideas related to the research objectives.

3.6.2.1 Interview Schedule

Telephone interviews were conducted with teachers and learners during November and December 2025. Telephone interviews were preferred to avoid disrupting teachers and learners, as during this period, they were either preparing or writing exams. Depending on the participants' availability, interviews were conducted after school hours. learners

were interviewed collectively through a conference call. The primary goal of the in-depth interviews was to assist the researcher in getting additional insight and clarity and to verify data from the WhatsApp Chat logs.

3.7 DATA ANALYSIS AND REPORTING

Data analysis specifies the approach to organising and interpreting the gathered data (Creswell & Cresswell, 2018). The WhatsApp chat logs alone provide extensive data, and when coupled with the interview responses from both teachers and learners, a strategic plan was needed to reduce the data to a manageable size. Content analysis, a method used to summarise and categorise extensive communicative material into meaningful themes, is employed for a specific purpose. It presents the study as a systematic process for handling, examining, and verifying communicative data (Cohen et al. 2018). It also enabled the researcher to code and categorise text into meaningful units of analysis (Cohen et al. 2018). Coding is an exercise the researcher uses to identify themes encountered during the study (Cohen et al. 2018).

The WhatsApp logs collected showed all the message transactions since the group was established. In some groups, data transactions spanned over three years, resulting in a large amount of information. Because of this, initial codes were established that categorised data. Below is a table showing the initial coding process used to reduce data.

Initial codes	Definition	Examples
Direct learning opportunity	Messages and activities that clearly facilitate teaching and learning Physical Sciences	Assigning work Explaining concepts Providing resources Providing feedback

Indirect learning opportunities	Messages that support teaching and learning but do not directly teach physical science concepts	Providing school and learning related information. Motivating and encouraging messages Reminders
Not linked to learning	Messages that have no relation to learning	Social messages Jokes Salutations Personal information
WhatsApp organisational messages	Messages that show management of the group	Adding or removing group members Messages deleted Change profile picture
Miscellaneous	Messages that do not clearly fit into the above categories during the initial coding sweep	Off-topic messages Vulgar

Table 1: initial Codes

The initial sweep enabled the study to identify messages that were not relevant to answering the questions, like the WhatsApp organisational messages (Andreotta et al.

2019). Content analysis can be useful for reducing data by focusing on the context in which the content is created to draw out meaningful interpretations (Roller & Lavrakas, 2015). Relying on the Connect-ivty framework, messages were further broken down into elements such as subject, objective, tools, division of labour rules, and rules outcome (Engeström and Sannino, 2021) and the role of WhatsApp (Siemens, 2004). To understand how teachers use WhatsApp for ELO, the methodology of content analysis will allow WhatsApp transactions to be thoroughly examined and organised into categories relevant to the study.

3.8 DATA ANALYSIS TOOLS

Manual coding was conducted inductively, using content analysis, and meaningful units of text were identified with descriptive codes that capture participants' experiences, intentions, and perceptions. These codes were then compared with those from the WhatsApp chat logs.

To support the coding process, Microsoft Word and Microsoft Excel were used as tracking tools. Microsoft Excel was used to create coding tables and matrices that allowed for tracking of codes, categories and themes across the different data sources. Microsoft Word was used to transcribe and manage data collected from the interviews. Using these tools allowed for the comparison of patterns and themes.

The data in this study was organised and presented in a series of themes related to the research questions. Where necessary, screenshots of the conversations were attached

3.9 ETHICAL CONSIDERATIONS

This addresses ethical codes and guidelines that the researcher aims to abide by. Educational research is concerned about people and collecting data from people (Creswell & Creswell 2018), thus the researcher should expect to be faced with moral dilemmas that need decisive action on what is wrong and what is right (Cohen et al. 2018). Researchers need to protect research participants, build a relationship of trust with them,

promote the integrity of the study, and protect the researcher from cheating as well as inappropriate conduct that affects them and the institution being represented while tackling a new challenging issue (Creswell & Creswell 2018)

The researcher applied and received Ethical Clearance Certificate (ECC) from the University of Venda's Ethics committee and permission from and from the Department of Education. In conducting the study, the researcher observed the standards and guidelines set out by the Ethics Committee which included but were not limited to permission for inclusion as a participant, anonymity, informed consent, respect of participants, plagiarism guidelines and avoiding bringing harm to participants.

3.9.1 Permission for inclusion as a participant

Permission to include as participants was obtained from all teachers and learners before they were considered for involvement in the study. Teachers and learners were provided with clear and detailed information about the research's purpose, what would be expected of them, and the procedure involved. This extended to include informed consent (Creswell & Cresswell, 2018: 329).

3.9.2 Anonymity

Anonymity means that a participant remains unknown and unnamed, but considering the nature of qualitative research, the researcher will know the participants due to interactions that would have been encountered during the study (Lune & Berg, 2017). In qualitative research, anonymity is linked to the confidentiality of participants, and it addresses issues of privacy and protection of participants from harm (Cohen et al. 2018). Web-based research poses the risk of exposing participants to individuals who may prey on them through their personal account details (Cohen et al., 2018).

3.9.3 Confidentiality

This refers to the specification of measures that the researcher takes to avoid linking the findings to a particular individual(s) (Cohen et al. 2018). WhatsApp groups are private,

and details are known only to those participating in the group. To uphold confidentiality, participants will be assigned pseudonyms, and details such as phone numbers that can be found on the WhatsApp platform will be omitted when data are presented (Lune & Berg, 2017).

3.9.4 Respect for Participants

Respect for participants refers to how the researcher should have due regard for the participants' cultures, gender, norms, values and feelings (Mertens 2015; Creswell & Cresswell 2018). In carrying out this study, the researcher interacted with the participants of the study who may have different and even contrary social, cultural and gender orientations from those of the researcher. (Creswell & Cresswell 2018). The researcher guarded against any prejudice or bias and uphold the dignity and integrity of the participants. Although some of the participants may be older than the researcher in age, the researcher respected the participants' viewpoint on all the matters expressed during data collection.

3.9.5 Informed Consent

The aspect of informed consent concerns participants' voluntary participation (Creswell & Cresswell, 2018). Teachers and learners exercise their free will to participate in the study, but this must not be done under any implied deceit by the researcher. To ensure informed consent, the researcher will disclose to participants what the study is about and what will be expected of them. Verbal consent will be required when conducting interviews to ensure their protection and to acknowledge their rights in the study. Because the study will include learners who may be minors, parents or legal guardians will be required to sign consent forms on behalf of the learner (Creswell & Cresswell, 2018).

3.10 TRUSTWORTHINESS IN QUALITATIVE RESEARCH

Measures of quality control in qualitative research are strategies used to ensure an accurate, valid, effective and worthwhile study (Cohen et al. 2018). These are measures

undertaken to ensure that, from data collection through to analysis and interpretation, the findings to be communicated maintain their integrity (Creswell & Cresswell, 2018). Measures of quality controls are actions to ensure that high-quality data are collected in qualitative research (Mertens 2015). The key concepts in measures of quality control in qualitative research are credibility, transferability, dependability and confirmability (Cohen et al. 2018; Mertens 2015).

3.10.1 Credibility

Credibility concerns the truth value in the study (Cohen et al. 2018). This is how accurately the phenomenon is observed and recorded (Mertens 2015). To ensure credibility, the researcher should spend a prolonged amount of time studying the phenomenon (Creswell & Cresswell, 2018). The data collection stage will span over three months, allowing sufficient time for the researcher to investigate the phenomenon. Credibility can also be ensured through triangulation, the use of multiple data collection methods (Creswell & Creswell, 2018; Mertens, 2015). The study used interviews and WhatsApp chat logs for data triangulation, thereby increasing the study's credibility.

3.10.2 Dependability

Dependability refers to the consistency and replicability of a study (Cohen et al. 2018). A different researcher investigating the same phenomenon under the same set of procedures in a similar group must yield the same results (Cohen et al. 2018; Creswell & Cresswell 2018). To ensure dependability, all the steps undertaken to carry out the study were documented for purpose of peer debriefing. Peer debriefing is when a peer audits another researcher's work (Cohen et al. 2018). The advantage of investigating WhatsApp is that permanent records can be kept for re-examining and verifying to ensure consistency. Drafts and documentation to an external researcher that bears no conflict of interest to audit the work. Member checking was also used where the findings obtained were taken back to the participants to ensure the integrity of the data has been maintained (Mertens, 2015; Cohen et al., 2018).

3.10.3 Transferability

Transferability concerns the generalizability of a study's findings (Cohen et al. 2018). This is the extent to which findings from the sample group apply to the study's population (Cohen et al. 2018; Creswell & Creswell 2018). This is an external validity criterion requiring the reader or audience to judge how generalizable the findings are. To ensure this criterion is met, the researcher must provide rich, thick descriptions of the phenomenon under study (Cohen et al. 2018). The findings of the study were presented in themes containing a detailed narrative of the phenomenon under study by providing thick and rich descriptions of the methods used and data collected. Moreover, a multiple case study ensured enhancing the richness of the data and the corroboration of findings.

3.10.4 Confirmability

Confirmability refers to impartiality (Cohen et al. 2018). In a qualitative study, the researcher's own background, interests and bias may skew findings towards a particular end. The researcher must be mindful of their own bias when undertaking research to avoid a misrepresentation of findings (Cohen et al. 2018). According to Creswell & Creswell, (2018), it is not that the researcher's background and interest should be omitted but rather that the researcher should be able to clarify their bias and make meaningful contributions to the study by commenting on how their interpretations of the findings are shaped by their background (Creswell & Creswell 2018). To ensure the impartiality of the study, the researcher reported both negative and positive data (Creswell & Creswell 2018). Additionally, member checking was used where the findings were taken back to the participants for them to confirm the accuracy of the interpretation of results (Creswell & Creswell 2018).

3.11 CHAPTER SUMMARY

This chapter presented the research methodology and design employed for the study. It outlined a qualitative approach and a constructivist paradigm that guided the investigation of teachers' pedagogical use for extending learning opportunities in Physical Sciences. A case study was used to obtain an in-depth understanding of the phenomenon within a rural school context.

The chapter also discussed the sampling procedure and the generation of data from WhatsApp chat logs and telephone interviews and further explained the process for handling and analysing data, supported by manual coding. Ethical considerations and quality control measures were also presented. The next chapter presents and discusses the study's findings.

CHAPTER 4

PRESENTATION, INTERPRETATION AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

Building on the methodology outlined in Chapter 3, this chapter presents the findings and interpretation of the collected data. The primary focus is on understanding rural teachers' sense-making of WhatsApp for ELO and its affordances.

The focus of the data collection process was to answer the following research questions:

RQ 1: How do rural teachers understand the use of WhatsApp to provide ELO?

RQ 2: What affordances does WhatsApp provide for ELO for learners in rural schools?

The study draws on the tenets of the Connect-ivity framework, formed from the conflation of Connectivism and Cultural Historical Activity Theory (CHAT), to analyse and interpret data. The findings are presented through themes that emerged from the data analysis. The aim is to provide insight into how rural teachers use WhatsApp to create ELO in the teaching and learning of Physical Sciences, thereby mitigating the challenges rural schools face.

Research Context

The study was conducted in three rural secondary schools, namely Lwamondo, Ndamuleleni, and Mudinane, located within the Vhembe District. These schools often face resource challenges, including poor internet access and a shortage of teaching and learning materials. Consequently, these challenges affect how teaching and learning take place.

Among the three WhatsApp groups investigated in this study, four Physical Sciences teachers and their learners used WhatsApp to support learning outside the classroom. The WhatsApp groups existed prior to conducting the study. The following table gives an overview of the teachers that participated in the study.

Participant profiles

Table 2: Teacher Profiles

Teacher Profiles					
Schools	Participant ID	Age	Gender	Teaching experience	Educational qualifications
School A	T1	55	Female	20	Diploma in Education BED specialising in Physical Sciences
	T2	26	Female	2	Degree in Chemical Engineering PGCE Hons in Curriculum Studies
School B	T3	41	Male	4	BED specialising in Mathematics and Physical Sciences
School C	T4	31	Male	4	BED specialising in Mathematics and Physical Sciences

The table above provides details about the four teachers who participated in the study. The table includes their ages, gender, years of teaching experience and their educational qualifications. At School A (Lwamondo Secondary School), T1 and T2 are in the same WhatsApp group. All the teachers are qualified to teach Physical Sciences, with teaching experiences ranging from 2 to 20 years. The teachers are of varying genders and ages,

ranging from 26 to 55. The tables demonstrated that the study employed a diverse sample of teachers, thereby enhancing the credibility and trustworthiness of the findings.

School A is a high-enrolment school with a learner count of 1871, whereas schools B and C have 850 and 523 learners respectively. The following table provides an overview of the learners who participated in the study.

Table 3: Learner Profiles

Learner Profiles				
Schools	Participant ID	Age	Gender	Grade
School A	L1A	18	Male	12
	L2A	18	Female	12
School B	L1B	18	Male	12
	L2B	18	Female	12
School C	L3A	18	Female	12
	L3B	17	Female	12

Table 4.2 presents the details of the 6 learners involved in the study. These are learners who take Physical Sciences as a learning area and are part of the WhatsApp group. The learners' ages ranged between 17 and 18 years, and there is diversity in the genders represented. All the learners were in grade 12.

In the WhatsApp group of school A, there were a total of three teachers and 109 learners. The third teacher in the group is the Departmental Head for Mathematics and Physical Sciences at the school. However, only two teachers (T1 and T2) took part in this study. This group spanned over three years. It was established when learners were admitted to grade 10 in 2023 and continued until 2025, when the learners were completing grade 12.

The WhatsApp group for school B, Mudinane Secondary School, had 1 teacher and 10 learners. The group was created in 2024, when the learners were in 11th grade, and continued through 2025, when the learners were completing grade 12.

The WhatsApp group for school C, Nndamuleleni Secondary School, had one teacher and 37 learners. The group was created in 2025 when they were in grade 12.

The study acknowledges that not all learners from the three rural schools had access to WhatsApp. The study captured the experiences of only those learners who had access, which aligned with the research objectives.

Before commencing data collection, a formal pilot study was not conducted. However, the researcher ensured rigour by carefully designing the interview questions and aligning them with the research questions. The questions were also reviewed with the supervisor and improved where necessary. This helped ensure the questions were clear and suitable for the study.

4.2 RESEARCH QUESTION 1

How do rural teachers understand using WhatsApp to provide ELO?

The Connect-ivity framework was drawn upon to answer this question, particularly in relation to the subject. Within this framework, teachers' understanding and the use of WhatsApp are influenced by the limitations of the rural classroom, their interactions with technology, their professional obligations to learners, and their intentions to achieve better learning outcomes in the physical science classroom. The analysis of the teacher interviews revealed a relatively simple and unsophisticated sense-making pattern regarding the use of WhatsApp. Teachers predominantly conceptualised WhatsApp through a *tool-and-medium lens*, viewing it primarily as a convenient communication platform and pedagogical resource. This unsophisticated sense-making became evident in their limited way of using WhatsApp for curriculum delivery, utilising limited WhatsApp function and mainly used the application for sending messages to learners. The flow

diagram below was carefully curated to represent teachers' sense-making processes regarding the use of WhatsApp to support Extended Learning Opportunities.

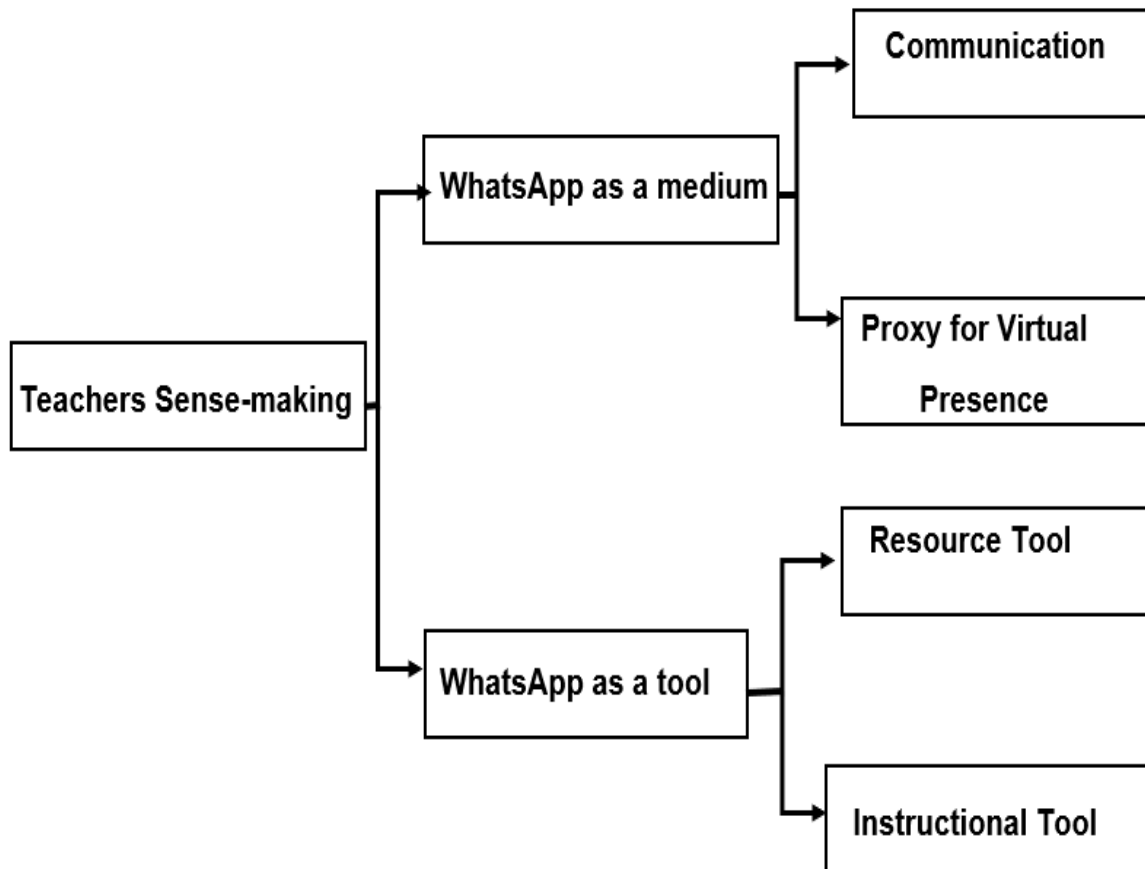


Figure 3: Teachers' sense-making of WhatsApp.

WhatsApp as a communication tool

The study discovered that rural teachers (T1 and T3) perceived WhatsApp as a communication medium for interacting with learners. Within this framing, WhatsApp served as a convenient link connecting the teacher, positioned as a central node, to learners, enabling the transmission of information and coordination of learning-related activities. This is a fitting theme because it shows that teachers have understood WhatsApp through its basic functionality, which is for communication and interaction purposes, before it can be a learning platform. By 'medium,' I mean a platform where the teacher can interact with learners virtually to promote learning. This definition aligns with the view of Lubis et al. (2023) who view educational media as anything that can channel and convey messages from sources such as people, materials, equipment, or activities to create conditions for recipients (learners) to successfully complete the learning process.

This theme shows how rural teachers use WhatsApp to connect with and interact with learners outside the school, seeking to create opportunities and conditions for learning beyond the classroom. Teachers reported using WhatsApp to send messages related to teaching and learning in Physical Sciences, such as reminders about tests and class dates, and to clarify topics and instructions for completing tasks. This has helped learners by allowing them to stay up to date with schoolwork and receive academic support when they are not in school, especially when they encounter content they do not understand. Teachers have indicated that WhatsApp has made it simple for learners to ask questions and receive clarification, reducing uncertainty and delays in the learning process. In this way, WhatsApp supports continuous engagement among teachers, learners, and learning content, extending learning beyond normal school time. The following excerpt by T1 describes how she uses WhatsApp.

T 1 I recall that we started using a WhatsApp group during the COVID-19 pandemic. When learners were at home, we used

WhatsApp to talk with them about their schoolwork and give them information about class schedules and arrangements.

The purpose of this WhatsApp group is to facilitate better communication with learners and to share important information.

It is so easy through WhatsApp because.....

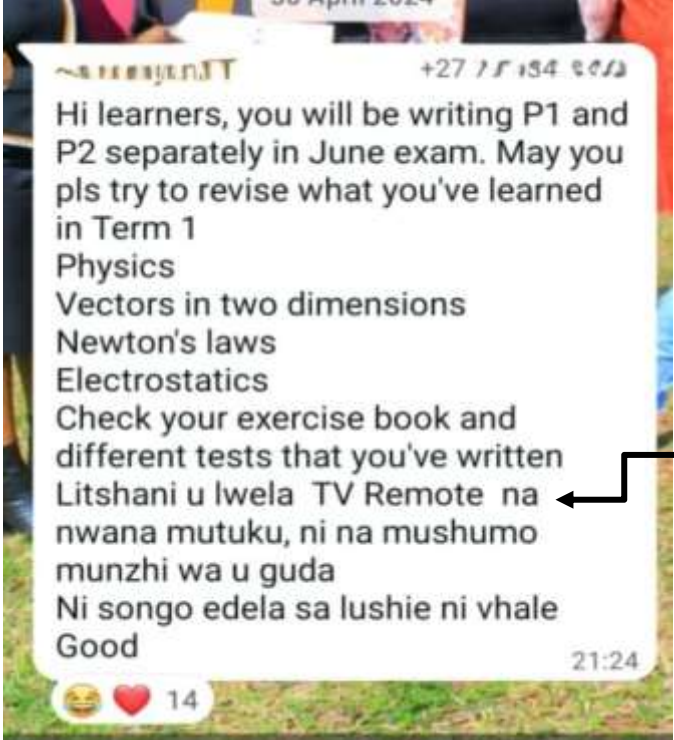
Until now, we have been using WhatsApp.

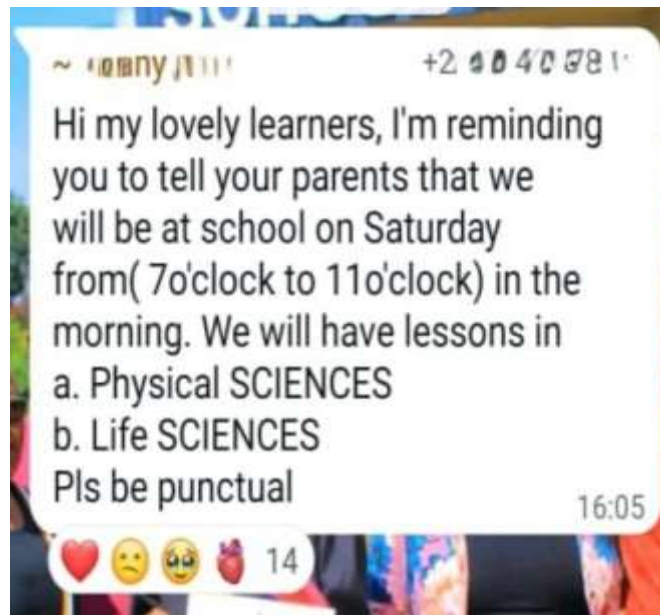
T1's account shows that the WhatsApp group with her learners was initially established in response to the COVID-19 pandemic. This was when schooling was suspended, and learners were learning from home. WhatsApp was used when teachers and learners needed to connect and continue interacting with each other for the purposes of learning remotely (Chirinda, Ndlovu and Spangenberg, 2021). Primarily being a communication application, it was seen as an effective communication medium between both teachers and learners as they are already using WhatsApp in their personal capacity. In the excerpt below, T1 explains that both she and her learners are familiar with the application.

T 1 I already use WhatsApp when I speak with my family. My learners also have WhatsApp, and learners who do not have their own phones use their parents' phones to access WhatsApp. Most of the learners have the application, and so it makes it easy to communicate with them.

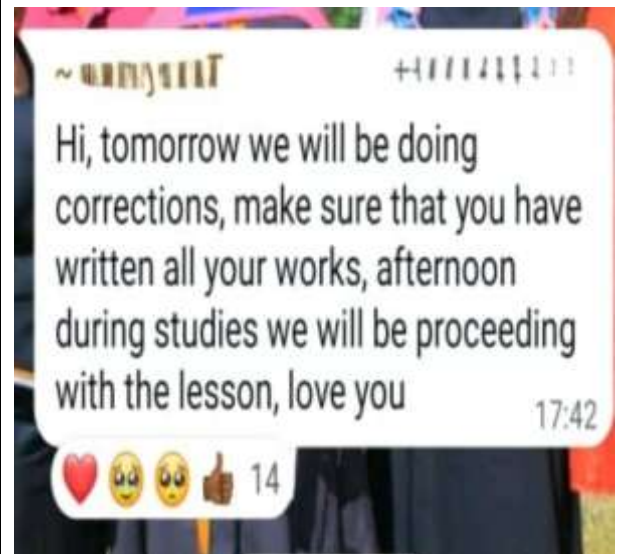
T1 states that both she and her learners have access to WhatsApp and are already familiar with it. This indicates that it is easier to embrace, posing minimal challenges to adoption in the educational setting. Familiarity with the tools makes using WhatsApp for

learning-related communication a practical option. Through the group platform, the teacher shared information on schoolwork, class schedules and arrangements. This was so learners could stay informed and engaged even when they were not physically at school. T1 still uses WhatsApp for sharing information and schoolwork with learners. The following screenshots show how T1 currently uses WhatsApp.

 Screenshot 1	Do not fight for the TV remote with your younger siblings; you have a lot of studying to complete. Do not sleep like a little baby; you must study
--	--



Screenshot 2



Screenshot 3

The WhatsApp screenshots show that T1 used the WhatsApp group to support learning through communication and guidance. In screenshot 1, T1 encourages learners to revise the work they had learnt in term 1, specifically topics on 2D vectors, Newton's laws, and electrostatics. T1 instructed learners to review their exercise books and previous tests, indicating that WhatsApp is used to guide their study. In screenshot 2, T1 reminds learners to inform their parents about the extra class scheduled for Saturday. This indicates WhatsApp is used to communicate about class arrangements. In the third screenshot, T1 informs learners that an upcoming class will require them to complete their tasks because corrections will be made to those activities.

Within this context, T1 utilised WhatsApp as a medium by foregrounding its affordances for message transmission, with pedagogical use largely confined to sending instructions and announcements rather than facilitating interaction or knowledge construction. These affordances, above all, include enabling communication outside school hours to deliver

instructions and share school-related information, guiding and supporting learning. It was used to communicate guidance on physical science topics, encourage learners to review their schoolwork, remind them about class assessment tasks, and announce class schedules. Communication took place after school hours and is aimed at ensuring that learners remain informed and engaged in the learning process.

Studies confirm that during the pandemic, there was a significant adoption of the WhatsApp platform as a medium (Chirinda et al., 2021; Nkambule, 2023; Nsabayezu et al., 2020). When teachers sought alternative non-contact media to facilitate interaction with learners, WhatsApp became the popular choice. But now, post-COVID, teachers have continued to adapt WhatsApp as a communication medium to share learning-related information. This has included communicating instructions, reminders, class arrangements and guiding schoolwork. The response from T1 indicates a shift in teachers' sense-making, as WhatsApp is no longer perceived as a temporary or emergency solution but as a reliable and beneficial long-term medium for communicating with learners about school- and learning-related issues. Supported in the literature, Chitanana (2024)'s post-COVID study shows that teachers and learners have continued to use WhatsApp for academic communication, learner engagement, and the creation of learning networks. Similarly, a study by Mmakola and Maphalala (2023) confirms that WhatsApp has remained an academic communication channel between teachers and learner's post-pandemic and has been used to support blended learning. This indicates that it is perceived as valuable for educational interaction beyond emergency situations. Even before the pandemic, studies indicated that teachers and learners were embracing WhatsApp for out-of-school teacher-learner interactions to discuss school- and learning-related matters. This has further indicated that interaction outside of school hours has helped in building relationships between teachers and learners, centred around trust, which have a positive outcome for learners in the educational process.

T1's ongoing commitment to using WhatsApp and to continuing to engage learners is linked to her desire for learners to take ownership of the learning process. She mentions

that one of the challenges she faces in teaching in a rural school is low learner agency and autonomy.

T1 The challenge faced at my school is that learners do not want to do anything. Where I stop in class, that is where the learners stop. When they come to school the following day, they will not have attempted to learn beyond what I have taught them the previous day.

I use WhatsApp to send them reminders about their schoolwork and to encourage them to study.

By low learner agency, I mean learner passivity, showing limited initiative and participation in their learning process, and low learner autonomy refers to rural learners' limited ability to self-manage their learning.

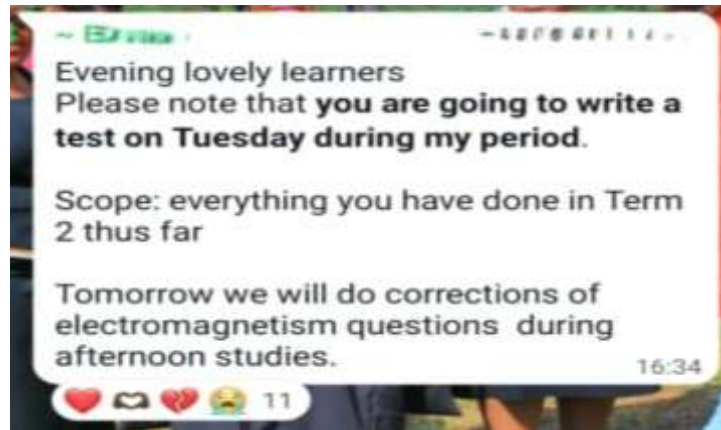
T1 uses WhatsApp to keep learners engaged in learning by communicating with them after school hours about learning-related matters, such as reminding them to review their schoolwork and guiding them on which Physical Sciences content to study. She also uses the platform to encourage learners to take ownership of their studies by maintaining regular communication with them about schoolwork. T1 sends messages of encouragement, reminders about classwork and homework activities and the content learners should focus on. It is a deliberate response to challenges encountered by rural learners concerning low learner agency and autonomy. T1's interview response indicates that her learners are not proactive in their studies and do not attempt to learn beyond what she has taught in the classroom. And so T1 uses the application to connect with learners outside of school, encouraging them to actively participate in the learning process even when they are not in school. Studies have shown that in the rural context, learners have 'bad study habits, low learner agency, and autonomy (Amnesty, 2020; Chowdhury, 2014). They are faced by multiple social and economic factors that prevent them from prioritising schooling and their academic journeys. (Chowdhury, 2014). T1's use of WhatsApp as a medium, highlights how challenges encountered in the rural setting shape its adaptation to support learners' engagement and responsibility. Sending

messages that prompt learners to revisit tasks and learning content extends learning opportunities by sustaining learner attention, keeping learners engaged with learning beyond classroom time. A review of the WhatsApp chat logs revealed that communication often extended late into the night, with the teacher encouraging learners to complete outstanding activities, revise previously taught content, and remain focused on their academic responsibilities.

This practice can enable continuity of learning outside the formal school day. This is significant, particularly in the rural context, where learners may have low learning prospects and support (Amnesty, 2020; Chowdhury, 2014).

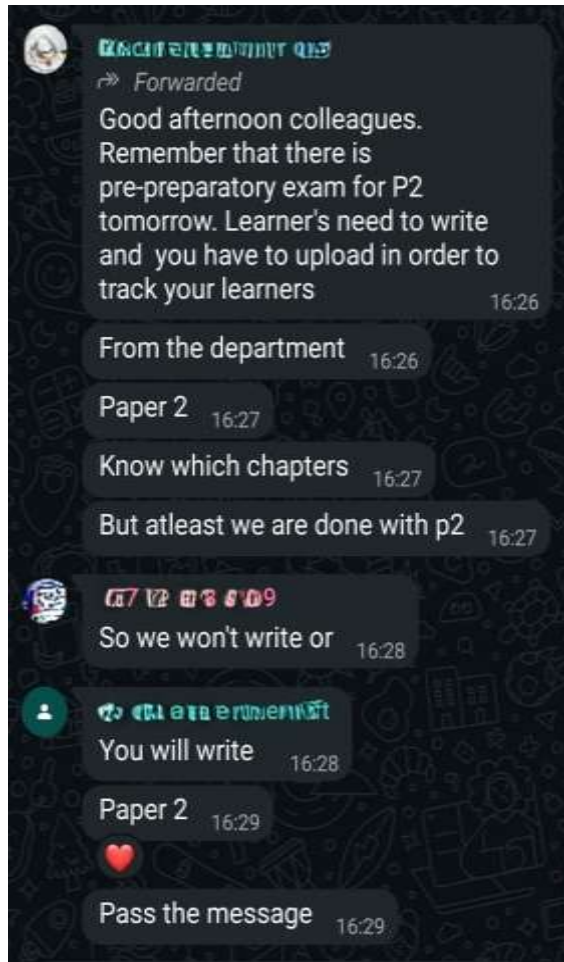
From a connectivist perspective, these interactions illustrate how WhatsApp was used to maintain ongoing connections between the teacher and learners beyond the classroom's physical and temporal boundaries. Grounded in the Connect-ivity framework, WhatsApp supports learning by enabling teachers and learners to create and maintain connections outside school premises and during non-school hours (Siemens, 2004). However, the nature of these exchanges suggests that the platform was primarily used as a channel for reminders and reinforcement, rather than as a space for learner-initiated interaction, collaborative knowledge construction, or networked learning, key principles of connectivist pedagogy T2, who co-teaches with Teacher in School A and is in the WhatsApp group, has also mentioned she uses the group to communicate with learners. Her response suggests that WhatsApp is used to share important information. In this way, these Rural teachers use WhatsApp to support and enhance communication beyond school hours. Below is an excerpt from T 2 to explain that WhatsApp enables her to send timely messages to learners.

T2 I do not need to wait for them to come to school. When I have something important to tell them, I simply send a WhatsApp message to the group.



Screenshot 4

The screenshot shows that T2 also uses the platform to communicate with learners about school- and learning-related matters. She sends learners a reminder that they will be taking a test on Tuesday and that it will cover the content they have covered in term 2. She also adds that during the studies section, they will be doing corrections. This indicates that T2 understand WhatsApp in its primary function. In the same way, T3 and T4' s WhatsApp group chat logs show WhatsApp is used by teachers for communication with learners about school related matters.



Screenshot 5



Screenshot 6

In screenshot 5, T3 shares a message that he has received from the department about a preparation to be written the next day. It prompts learners to seek clarity on the matter, and the T3 learner engages in a conversation about it. In screenshot 6, T4 welcomes learners to grade 12 and sends them an annual teaching plan (ATP) outlining the content they will be studying on the 11th of January, on Saturday. This indicates that rural teachers use WhatsApp to interact with learners remotely, outside school hours, to send messages that enable learners to participate in and own the learning process. These messages inform learners about what to expect in their learning, including updates on

upcoming classes, lessons, tests, and examinations. These messages aim to encourage learners to stay focused and engaged in learning.

Establishing WhatsApp as an educational medium enables rural teachers to increase interaction with learners, opening the door to ELO beyond the classroom. By using WhatsApp, rural teachers can communicate with learners at any time of day and from anywhere. This is significant because communication is a fundamental aspect of any education system (Segal & Biton, 2024), and teaching and learning are impossible without it. Being able to communicate with learners after school about schoolwork is significant in rural contexts because learners may lack parental involvement and other forms of academic support outside school hours, which can lead to lower academic success. (Amnesty, 2020; Chowdhury, 2014).

These findings are supported by various studies that confirm that teachers' primary pedagogical use of WhatsApp is as a communication channel to increase teacher-learner interactions outside school hours (Adams, 2019; Bouhnik & Deshen, 2014; Nuray ZAN, 2019). They indicate that teachers are harnessing WhatsApp's communication capabilities to create learning opportunities that would not be possible otherwise (Adams, 2019; Bouhnik & Deshen, 2014; Nuray ZAN, 2019). This is even true for schools in low socio-economic contexts, such as rural schools, which are known to be on the negative side of the digital divide and have limited access to meaningful ICTs (Adams, 2019; Jere et al., 2019; Nsabayezu et al., 2020). Using WhatsApp to facilitate, support, and enhance communication between teachers and learners is understandable because, by design, WhatsApp is essentially a communication application and should be treated accordingly.

Studies further indicate that WhatsApp promotes positive communication, which extends beyond the mere transfer of content knowledge and information (Phan, 2025). Bouhnik & Deshen (2014) found that teachers often create WhatsApp groups with a single objective; however, as they continued using the application, they found it helpful for a variety of educational purposes. WhatsApp can be beneficial for other aspects, such as promoting learning and creating a conducive learning environment (Adams, 2019; Bouhnik & Deshen, 2014; Nuray ZAN, 2019; Abualrob & Nazzal, 2019). These can also include

collaboration and reinforcement of classroom relationships, information sharing, encouragement and motivation, promote student autonomy, and share academic resources (Adams, 2019; Bouhnik & Deshen, 2014; Nuray ZAN, 2019; Jere et al., 2019; Rambe et al., 2020).

WhatsApp as a medium for proxy virtual social presence

The analysis of the interview data and WhatsApp chat logs indicated that Teachers 3 and 4 conceptualised WhatsApp as a medium that enabled them to maintain a virtual social presence, thereby remaining visible and accessible through their online presence to learners outside formal school contexts. By virtual social presence, I mean that the teacher is within reach, so that learners can connect with them outside normal school time. Below are excerpts from T3 and T4 explaining the intention of using the platform to extend their presence.

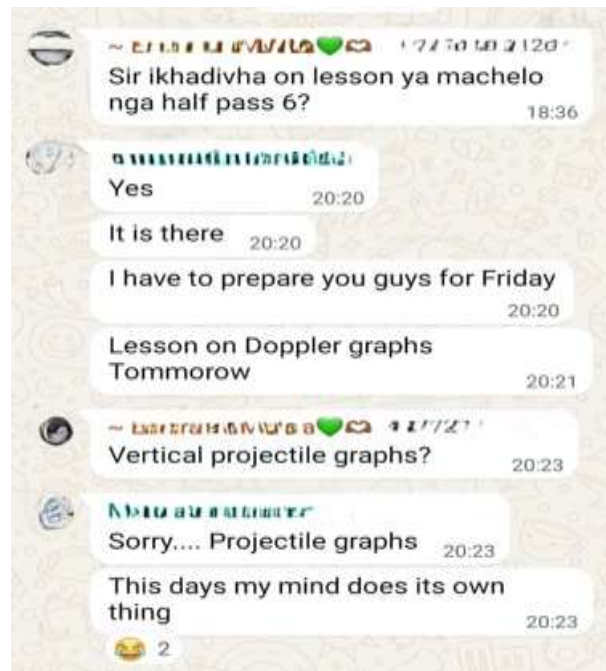
T3 I want learners to be able to reach out to me so I can help them when and if they need assistance with their schoolwork.

T4 I created the WhatsApp group because I realised that I have only two hours of teaching time a week, and there is a lot of work to do.

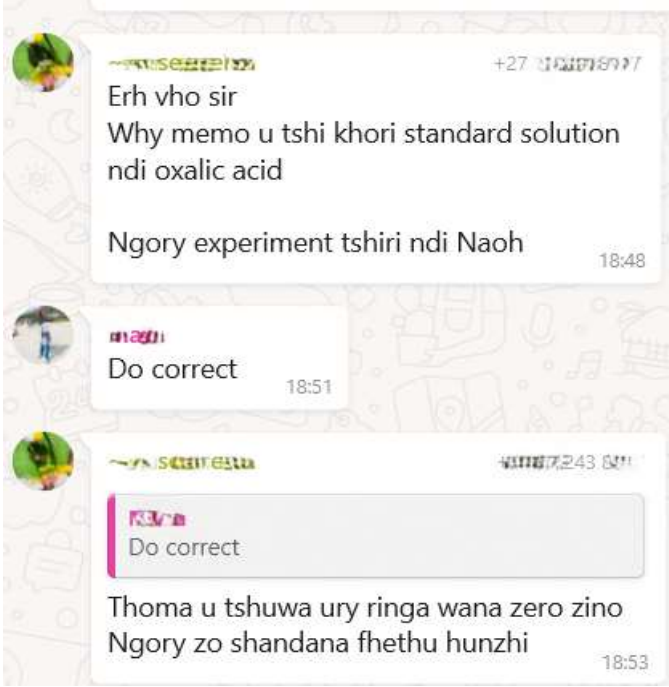
I want to be available to my learners when they need my help.

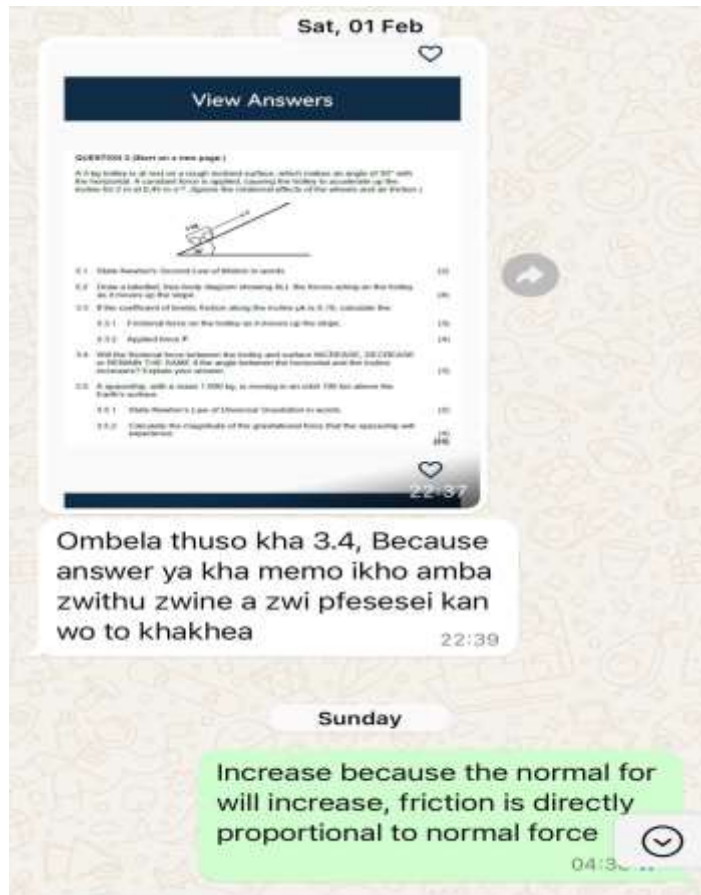
Virtual presence is the teacher's ability to extend their presence even when they are not physically present in that space. T 3's response shows that he wants learners to have access to him so he can provide academic support when learners need it, regardless of time or place. He wants to be able to assist learners with questions or study needs.

Similarly, T 4 has shared that he wants to be available when learners need his help. This intention has been reflected in how both T3 and T4 use WhatsApp. Below are the WhatsApp chat logs showing how T3 and T4 use the platform to be reachable to learners.



Screenshot 7

 Screenshot 8	Sir Why is the memo saying that the standard solution is oxalic acid? Because the experiment said it is NaOH I was becoming worried that I would score zero. Because it affects a lot of steps in the problem solution
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Please help me with 3.4. I do not understand the answer on the memo, is it an error?

Screenshot 9

Screenshot 7 shows a learner asking a question at 18:36 in the WhatsApp group about an upcoming lesson. At 20:20, the teacher responds, confirming that the lesson would still take place at 06:30 the following day. He further gives additional information about the content that will be covered. This interaction takes place in the evening, well after the school day has ended. It illustrates that T3 is accessible after school hours to address learners' school-related concerns.

In screenshot 8, a learner asks a question after noticing an error on the memorandum while reviewing his work. He posts a message to the group about his concern. The teacher promptly responded, confirming that it was an error and should be corrected. The learner's response shows that he was worried because this error affected several aspects of problem-solving. This ensured that the learner did not sit with uncertainty and

frustration as the teacher provided clarification as soon as the issue is raised. Through this action, the teacher uses WhatsApp to present himself as readily available to offer timely academic support outside of school hours.

Similarly, T2 uses the WhatsApp platform to remain accessible and available to learners beyond the classroom. In screenshot 9, a learner asks T2 for help at 22:39 with a Physical Sciences problem they do not understand. T2 responds the following Sunday morning around 4:30. She tells the learner that the quantity increases because friction is directly proportional to the normal force. It shows that WhatsApp is used for teachers to be available when learners are struggling with problem-solving, regardless of the time or day of the week.

The three WhatsApp screenshots provide evidence of how teachers established a virtual presence and remained accessible to learners outside normal school hours. Together, these interactions demonstrate how WhatsApp enabled learners to initiate contact and receive immediate academic support and school-related information at any time, from anywhere. This practice demonstrates that WhatsApp can be used for reinforcing teachers' visibility and accessibility outside formal school contexts. It captures the teachers' responsiveness to learners. This is significant for rural learners because literature indicates that they have limited opportunities for individualised consultation to seek academic help, due to two factors, such as overcrowding and teachers having a heavy workload (Amnesty, 2020; Chowdhury, 2014). WhatsApp enables learners to contact teachers directly and to form part of their learning network (Siemens, 2004). WhatsApp serves as a medium that reduces the gap between school and home, facilitating ELO.

Further, findings from studies on interactions between teachers and learners on WhatsApp show that the platform helps teachers become more accessible and available to learners, anywhere and at any time (Cetinkaya, 2017; Durgungoz & Durgungoz, 2022). This means that learners can reach out to teachers after school hours when needed, and teachers can respond timeously. Factors that enable learners to contact teachers outside school hours include WhatsApp's ease of use and the fact that both teachers and learners

already use it in their daily lives (Bouhnik & Deshen, 2014; Durgungoz & Durgungoz, 2022). Furthermore, it is the method preferred by learners nowadays for everyday interaction (Alabdulkareem, 2015)

Research also shows that WhatsApp enables quick responses through both synchronous and asynchronous communication (Alabdulkareem, 2015). This is beneficial in rural contexts, where connectivity is limited (Nkanyani et al., 2024). Using WhatsApp as a medium helps learners feel that the teacher is within reach, even when the teacher is not physically present in school (Adams, 2019). This increases the likelihood that learners will use the platform to seek assistance from their teachers. Although WhatsApp is widely used and available even in low socio-economic communities, not all rural learners have access to it (Bouhnik & Deshen, 2014; Jere et al., 2019; Rambe et al., 2020).

However, these screenshots demonstrate that WhatsApp permits teachers to sustain a virtual presence to provide timely academic support and school information outside school hours. It is important to consider that such accessibility may increase teachers' workloads for those already contending with heavy workloads in their rural contexts. Furthermore, it may reinforce inequalities among rural learners because not all learners have access to the benefits (Rambe, Chipunza and Ng'ambi, 2020).

WhatsApp as a pedagogical tool

The analysis of interview data and WhatsApp chat logs revealed that T1 and T2 have conceptualised WhatsApp as a pedagogical tool. In this sense, a tool is understood as any object used to accomplish a task or achieve a desired outcome. While WhatsApp and its features are not originally designed for educational purposes, they can be pedagogically repurposed when users identify and exploit their affordances to support teaching and learning. Thus, a tool is not inherently apparent in an object; rather, it emerges through users' sense-making processes, as they recognise, interpret, and exploit affordances to accomplish desired outcomes. It is influenced by how a person thinks and, in turn shapes their behaviour (Engeström & Sannino, 2021; Roth & Lee, 2007). The tool is studied within the context of that person (Engeström & Sannino, 2021).

Rural teachers use WhatsApp to help them fulfil instructional objectives and overcome challenges related to teaching and learning resources, insufficient time for teaching and dealing with a content-dense subject. In this way, WhatsApp is used for more than just communication, but also to support curriculum activities and extend instructional support.

Three aspects of WhatsApp as a tool emerged from data collection, namely (i) Access to resources, (ii) Supporting curriculum coverage, and (iii) Providing instructional support beyond the classroom.

WhatsApp for providing access to digital resources.

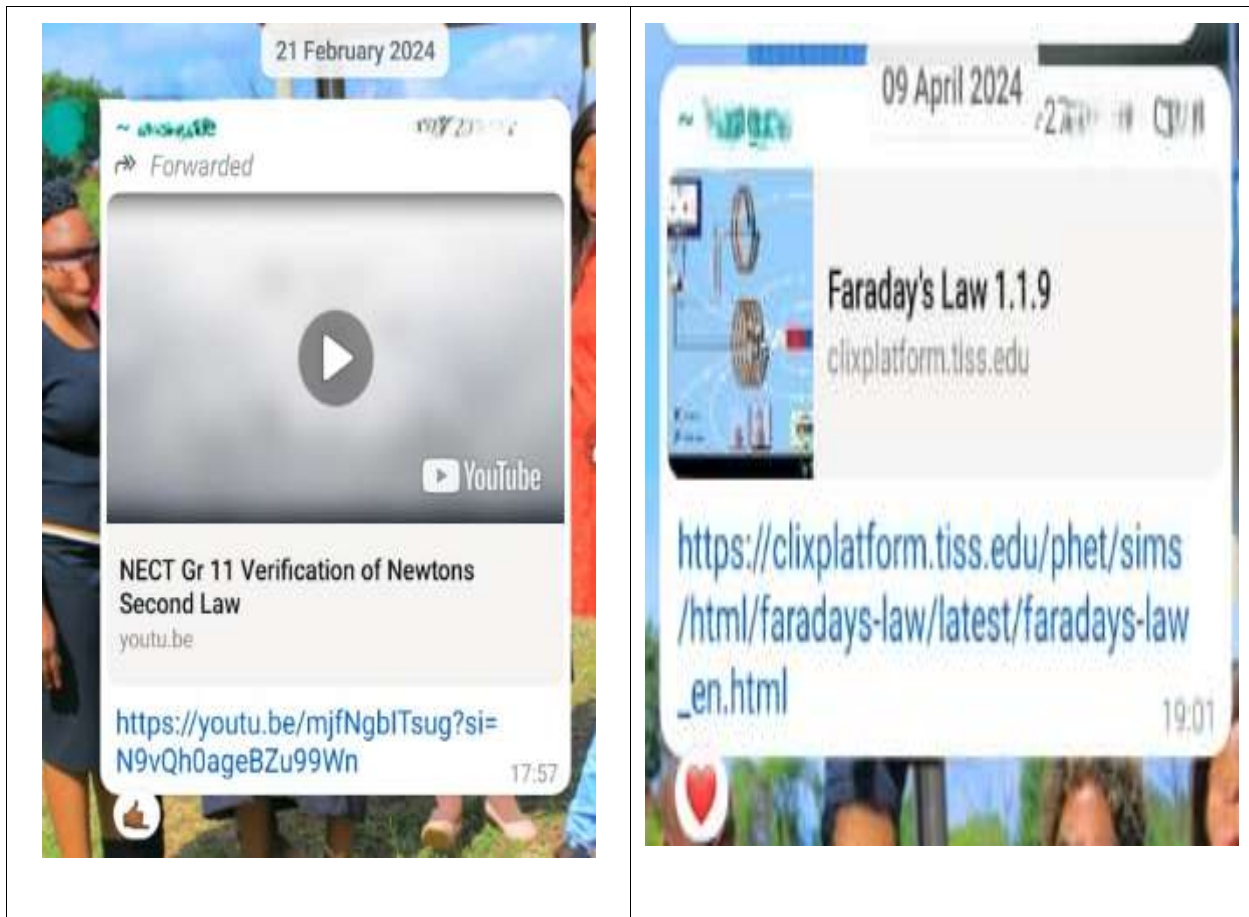
In response to resource constraints at school A, T1 and T2 conceptualised WhatsApp as a platform for distributing learning, revision, and virtual laboratory resources, such as study guides, past question papers, and links to videos and simulations of experiments. It allows learners to access them beyond the classroom. These resource constraints were particularly evident in relation to conducting science experiments. Although T1 and T2 reported having access to a science laboratory, they noted it was poorly equipped and lacked the requisite resources, limiting opportunities for practical work. Due to overcrowding in their school, it is not possible for all their learners to participate in experiments. Below are excerpts from T1 and T2 explaining the challenges they face when conducting science experiments.

T 1 Our school has a lab, but the apparatus is not enough to go around. I can show my learners videos of experiments so that they can see how it's done. When I arrived in class, they had already watched the experiment on the video and were familiar with what was happening.

T 2 I want learners to be able to manipulate apparatus. I want them to arrive at their own findings. This is

important because it helps them develop sound knowledge on a concept, but unfortunately, we do not have enough equipment. So, I use the platform to send them videos or simulations of experiments. I want them to see how it is done.

The interview responses from T1 and T2 indicate that they faced challenges when completing the practical component of teaching and learning in Physical Sciences. Even though T1 and T2 have access to a science laboratory at their school, they do not have enough resources, such as apparatus and equipment, to conduct experiments. WhatsApp is used to allow learners access to virtual experiments through videos and simulations. Using WhatsApp in this way helps teachers execute the practical aspect of learning Physical Sciences. This is reflected in T1 and T2's chat logs as shown below.



Screenshot 11	Screenshot 12
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In screenshot 11, T1 sends a link to a video on verifying Newton's laws, and in screenshot 12, T2 sends a link to a simulation of Faraday's law.

Teachers 1 and 2 use WhatsApp to provide a substitute for laboratory experiences in contexts where apparatus and equipment are absent or limited. T1 sent learners videos of experiments so they could see the procedural steps for conducting the experiments to verify Newton's second law (see screenshot 11), enabling learners to visualise experimental processes that could not be physically enacted. Similarly, T1 and T2 believe it is an advantage because learners will have a visual experience of the experiment and become aware of its aim and outcomes. Kettle (2020) confirms that videos are being used to replace experiments, especially when resources are limited. Using videos in physical science instruction has been shown to be beneficial because it caters for diverse learning preferences and learners, and through watching demonstrations, they are more likely to conceptualise concepts and retain content (Kettle, 2020; Pratama & Kartikawati, 2017). Simulations are interactive tools that provide virtual experiments and have been found to be effective in helping learners complete practical investigations and activities (Ouahi et al., 2022). In this way, teachers can provide learners with practical learning opportunities and overcome barriers posed by insufficient laboratory resources.

Moreover, the study found that T2, T3, and T4 use the platform to share learning and revision resources with learners. These can include study guides, previous question papers, and notes. T2 says that using previous question papers is beneficial for learners to practice and prepare for examinations. However, T2 notes that it is not feasible to make multiple copies sufficient to accommodate all the learners, given the school's stationery costs. Below is an excerpt from T2 explaining how she distributes previous question papers.

T2 *Learners need to practice as much as possible; to do so, we use previous question papers. But printing hard copies for learners is not possible because of the stationery. The school can't afford to print all these papers for every learner. WhatsApp provides me with an easy way to give my learners question papers*

T2's interview response shows that previous exam papers are a learning and exam-preparation strategy; however, it is not possible to continuously make copies for her class because of the stationery costs the school would incur. The WhatsApp chat logs confirm that T2 uses the platform for sharing previous question papers. Below are screenshots showing T2 sharing question papers as attachments and as links.



Screenshot 13



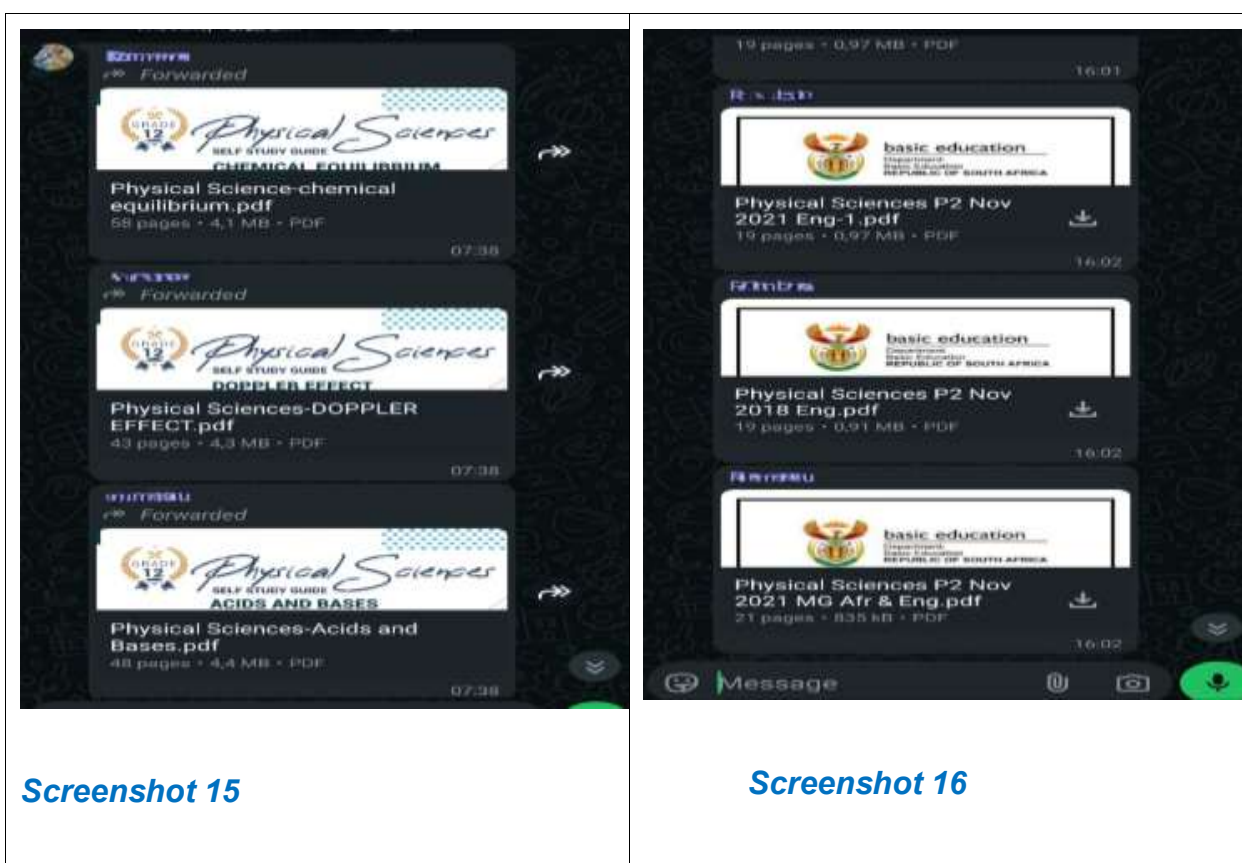
Screenshot 14

Screenshot 13 shows T2 sending question papers, and in screenshot 14, T2 sends links for learners to access question papers.

Similarly, Teacher T3's resource-related concerns centred on the limited teaching and learning materials. Although he acknowledged the availability of textbooks, he noted that they did not always provide clear or accessible explanations for learners. Consequently, T3 uses WhatsApp to enable learners to access supplementary learning materials, including study guides and multiple question papers, to support understanding and revision. Below is an excerpt from T3 explaining how he uses WhatsApp to send learners resources.

T3 *'Sometimes our textbooks do not fully explain a particular concept, and you find it much clearer in another textbook. WhatsApp helps me to send materials to my learners that explain topics well.'*

T3's use of WhatsApp to provide supplementary learning materials is reflected in the WhatsApp chat log. Below is an example of learning resources posted by T3



Screenshot 15 shows T3 sending study guides with numerous pages, and in screenshot 16, he sends multiple previous question papers to the group.

Teacher T4's responses and chat logs also indicate that he uses the platform to send learning and examination preparation materials to learners. He mentions that at his

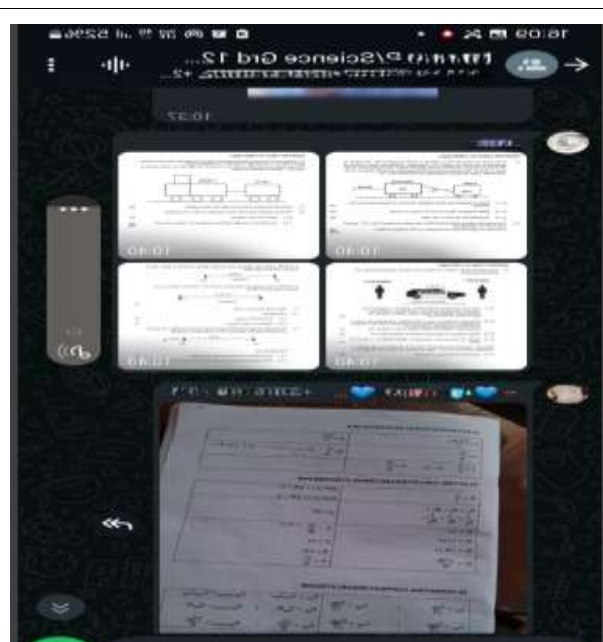
school, they are running short of resources and that WhatsApp is used to address this shortage. The following excerpt from T4 explains how he uses WhatsApp to provide resources.

T4 I use WhatsApp to send learners previous question papers, study guides, exam guidelines, and resources to help them study and prepare for exams.

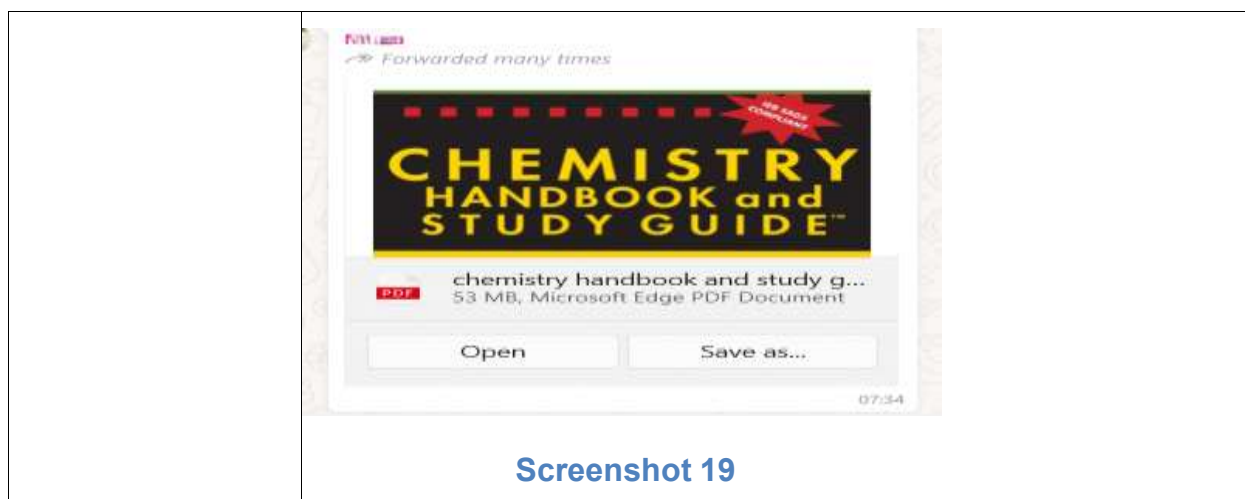
T4 response indicates that learning materials such as study guides, question papers, and exam guidelines are important for learners in their studies and exam preparation. T4's intention is reflected in how he uses WhatsApp to distribute learning materials to his learners.



Screenshot 17



Screenshot 18



Screenshot 17 shows several question papers sent to the group. In screenshot 18, T3 sends a picture of the physical science formula sheet and questions, and in screenshot 19, T4 sends a chemistry study guide. These WhatsApp screenshots demonstrate that distributing electronic resources is a significant activity in the WhatsApp group. Teachers can distribute various study guides and make learning materials available to learners who might not otherwise have access. This is particularly significant for rural schools, which often struggle with limited resources for teaching and learning (Baloyi et al., 2023), which is directly linked to low learner performance (TIMSS, 2023). WhatsApp even allows teachers to send documents with large numbers of pages effortlessly. It is used to share rich, diverse resources that supplement existing learning materials. They can send materials targeted to help learners conceptualise hard-to-understand topics, such as study guides.

Further, the study found that learners find accessing learning materials via WhatsApp beneficial because teachers share a variety of resources that learners can download for learning and study. Below are excerpts from learners discussing how accessing resources through WhatsApp helps them.

- L1A I can download question papers and or documents that the teacher sends to the group. I use the question papers to practice.*
- L2A The teachers send us learning materials and videos that I can watch and study from, i do this while i am at home.*
- L1B I like that I can get the question paper and study guides on my phone.*
- L2B I get previous question papers that help when I am studying science.*
- L1C It's helpful because I download study materials, question papers and memorandums anytime.*
- L2C The teacher sends us a lot of question papers and memorandums so that we can treat as many questions as possible and prepare for exams.*

The learner responses indicate that WhatsApp affords a simple way to access learning materials. It is used to share question papers, study guides, memorandums, and instructional videos. Learners have emphasised the ability to download and store materials on their mobile phones, which allows them to interact with academic content at times that suit them.

A key insight from the learners' focus group responses is that learning is extended at any time and from anywhere. Learners mentioned using the materials at home and revisiting them repeatedly, suggesting that WhatsApp supports learner autonomy and agency. This shows a shift from teacher-led learning and reflects the Connectivism proposed by

Siemens (2024), a learning model in which learning results from learners making connections among themselves, learning materials, and WhatsApp (technology).

Overall, both Teachers' and learners' responses indicate that this sharing and access to resources are appreciated and beneficial. Teachers find this particularly useful because it allows them to curate learning materials specifically designed to help learners and connect them to resources that may be out of their reach. These findings suggest that WhatsApp is utilised to provide learners with various access to a variety of electronic resources for learning Physical Sciences. Because WhatsApp content can be saved on mobile devices, learners can access, save and revisit these resources at any time.

Learning resources are fundamental to any education system because they facilitate, support, and enhance curriculum delivery (Rajan et al., 2008). A growing body of literature confirms that pedagogical adaptations of WhatsApp are highly effective for disseminating learning resources (Abualrob & Nazzal, 2019; Adams, 2019; Awal & Imam, 2023; Bouhnik & Deshen, 2014; Rambe et al., 2020). For the rural Physical Sciences classroom, this is a significant aspect of extending learning opportunities. As resources play a crucial role in teaching and learning Physical Sciences (Baloyi et al., 2023; Muremela et al., 2023), A lack of them has been directly proportional to low learner achievements (Nemadziva et al., 2023; TIMSS, 2023). Furthermore, teaching and learning in the Physical Sciences rely on experiments to develop scientific content knowledge. Physical Sciences require specific equipment and materials to fulfil the objective of 'doing science' as underscored in the South African curriculum (CAPS. All participants in the study reported facing resource-related challenges in their schools that impede effective teaching and learning of Physical Sciences. A lack of experiment-related resources disadvantages learners, as they cannot conduct experiments without the necessary equipment. The teachers' use of WhatsApp for experiments shows innovation, as they use WhatsApp to provide resources easily. In this way, rural teachers utilise the platform to address the resource challenges that they face in their classrooms.

WhatsApp as an instructional tool

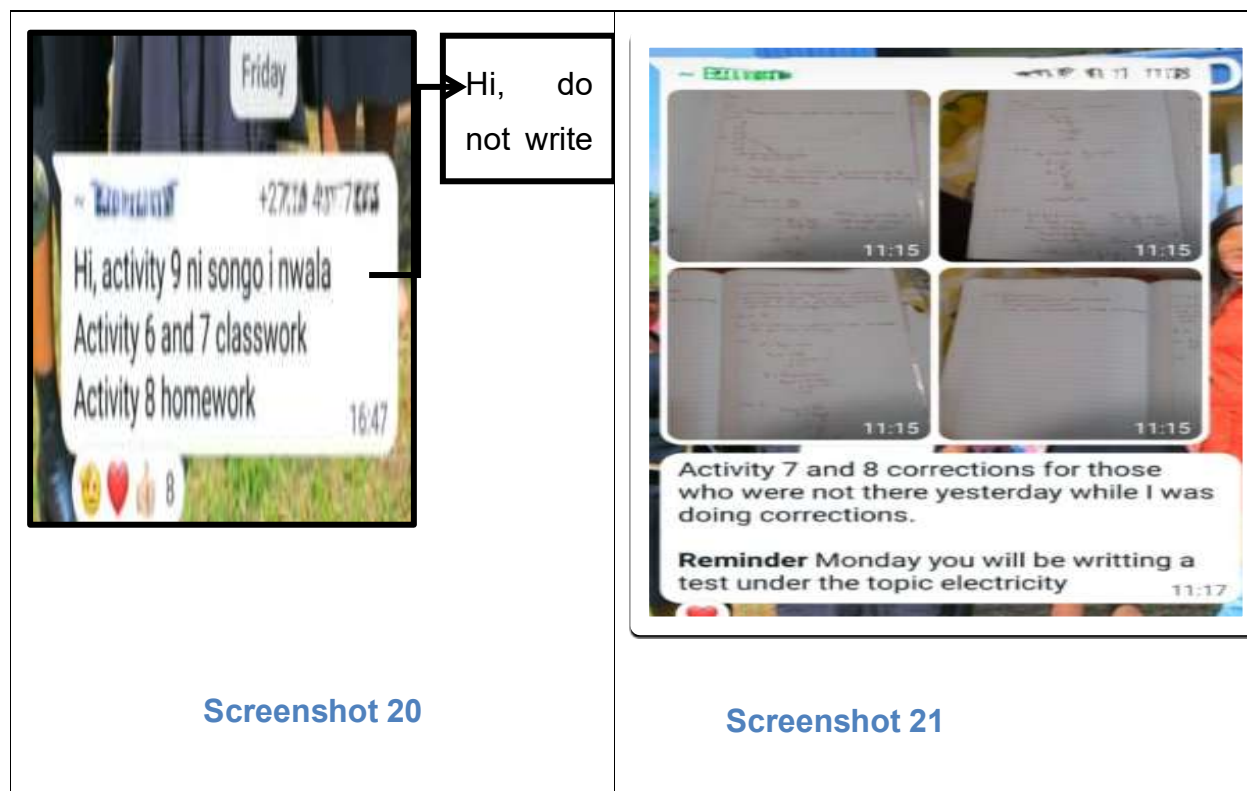
The study found that T1, T2, T3 and T4 understand WhatsApp as an instructional tool. As an instructional tool. It is used for direct teaching and learning activities, such as assigning classwork, homework, and assignments, and providing academic support. Below are excerpts from teachers discussing how they use WhatsApp to deliver instructional activities.

- T 1 Sometimes I can send the class activities and corrections to the group.... I also give them practice questions for them to learn while at home*
- T 2 And sometimes, when I see that they are struggling with a question in class, I use WhatsApp to give clarity*
- T 3 Physical Sciences are not like other subjects; they need a lot of time for teaching. The time allocated for teaching the subject is not enough... so I can use WhatsApp to send some of the work to learners*
- T 4 I use WhatsApp to send questions and activities we couldn't do in class...*

The interview responses indicate that teachers use WhatsApp as an instructional tool to extend learning beyond classroom time. All four teachers describe using WhatsApp to share and deliver learning activities directly related to subject content, showing that teaching continues outside formal school hours.

T 1 uses WhatsApp to send class activities, corrections, and practice questions. This indicates that WhatsApp is used to reinforce learning and support practice at home. By providing corrections, the teacher helps learners to identify and correct misunderstandings, which supports independent learning. This is reflected in how T1

uses the platform in the WhatsApp chat log of her group. Below is a screenshot showing T1 uses WhatsApp to extend classroom activities.



In screenshot 20, T1 assigns learners their class activities. T1 shares on the platform that activities 6 and 7 are classwork, and activity 8 is homework. In screenshot 21, she shares a picture of a handwritten correction for learners who were not in class while corrections were being made. This implies that WhatsApp is used to provide instructions even when learners cannot be in class.

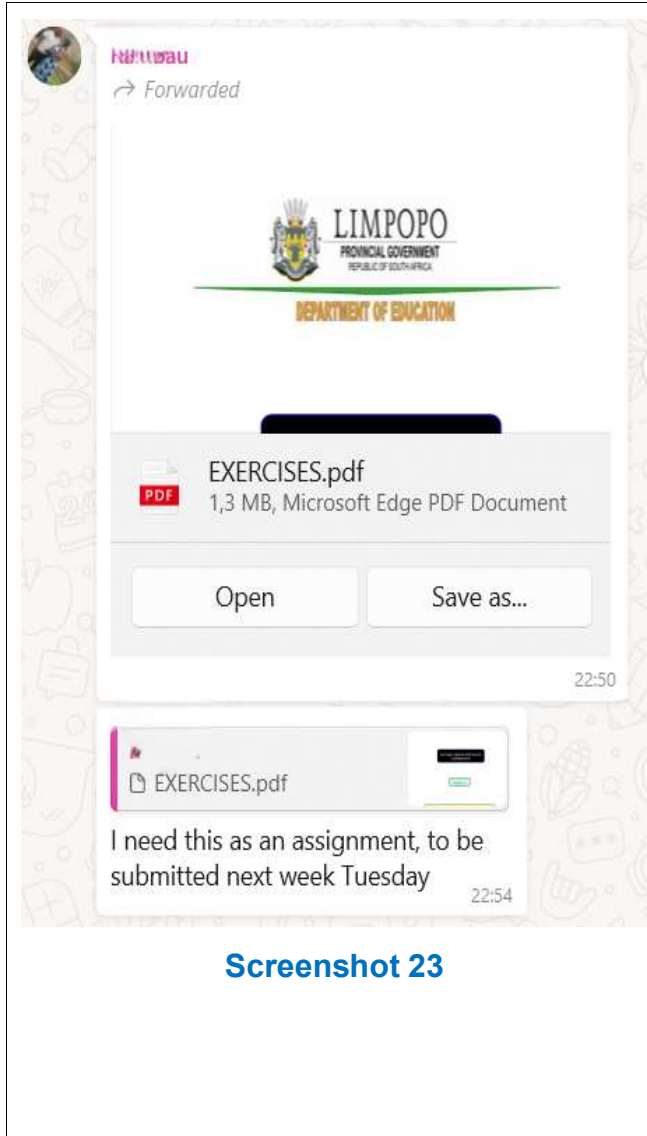
T2 uses WhatsApp to provide clarity when learners struggle with questions. This suggests that WhatsApp functions as a support tool for explaining difficult concepts and addressing learning challenges as they arise. The focus here is on immediate clarification rather than planning or organisation. Below is an example of how T2 use the platform to extend instruction.



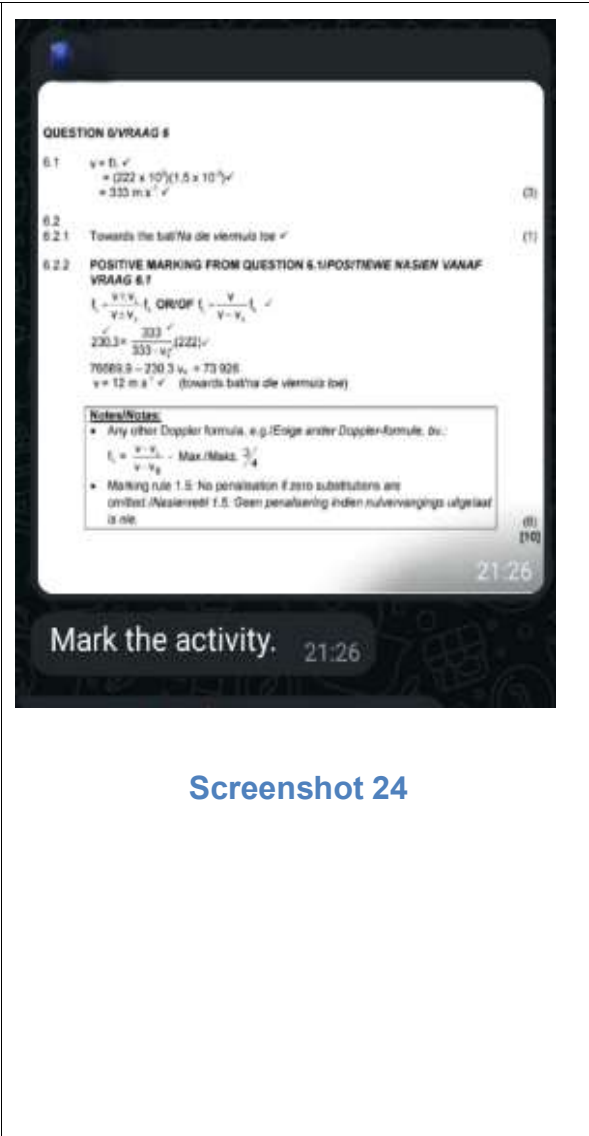
Screenshot 22

In screenshot 22, T2 share the sine rule with learners. This mathematical rule was fundamental to learners' understanding of how to solve a particular problem in the Physical Sciences. The teacher then used WhatsApp to send a picture of this rule. This action represents direct teaching, as the teacher explicitly links a Mathematical concept to its application in a Physical Sciences context. This is significant, particularly because teaching and learning time are already limited; the teacher may not have time to explain a mathematical concept in a physical science classroom, but using WhatsApp, T2 provides supplementary instruction that supports learners' development of scientific concepts.

T3 highlights time constraints in the Physical Sciences classroom and uses WhatsApp to make up for limited classroom time. T3's response shows that WhatsApp is used to extend instructional time, to support content coverage beyond the classroom. Below are screenshots from T3's WhatsApp group. Similarly, T4 uses WhatsApp to send questions and activities that could not be completed in class. This shows that WhatsApp is used to bridge time-related gaps, ensuring learners still engage with the required content. Below are screenshots from T3 and T4's chat logs



Screenshot 23



Screenshot 24

In screenshot 23, T3 sends learners and the assignment, and in screenshot 24, T4 sends learners corrections and tells them to mark the activity.

Overall, the responses and screenshots indicate that WhatsApp is used as an instructional tool to support content delivery and provide academic support. This can be practice, clarification, and continuity of learning. The platform enables teachers to manage curriculum demands and learner needs, by extending teaching and learning beyond the physical classroom.

In this way, rural teachers utilise WhatsApp to extend the school day by allocating additional instructional time to complete syllabus-compliant content. WhatsApp can serve as a learning environment where teachers can continue their classroom instruction. Studies by Adams, 2019, Jere et al., 2019; and Nyamupangedengu et al., 2023 have indicated that WhatsApp can be used to house and support instructional activities. These studies underscore WhatsApp's potential to complement classroom-based instruction, showing that it can be used for curriculum delivery. Jere et al. (2019) demonstrated that WhatsApp can assist teachers in covering classroom activities, particularly when they face time constraints. WhatsApp is valuable for prolonging teaching time allowing learners additional time to engage with content knowledge. It is worth noting that many studies have been conducted in higher education institutions, particularly universities, with a limited number focusing on the basic education sector, specifically primary and secondary schools (Ibrahim* et al., 2018; Mabaso et al., 2023; Rambe et al., 2020). And the few studies that have examined secondary schools, particularly those in rural areas, also confirm this finding; however, limited research exists concerning Physical Sciences (Jere et al., 2019; Nduduzo et al., 2023; Nkanyani et al., 2024)

Studies caution that WhatsApp is not an officially recognised learning platform and has not been designed to meet academic standards (Romero-Saritama et al., 2025; Segal & Biton, 2024b). Therefore, instructional activities conducted through the platform cannot be officially recognised or recorded. Although it has proven beneficial for complementing classroom-based instruction, it falls short in accountability and monitoring, as classroom activities such as homework and classwork are not effectively managed and lack institutional oversight (Romero-Saritama et al., 2025).

Not only do teachers use the platform to support content delivery, but they also use the WhatsApp platform to coach and support learners with their schoolwork and studies after school hours. The study found that T2 and T4 conceptualise WhatsApp groups as a learning platform where learners can ask questions directly related to learning science, such as problem-solving. Learners can ask for help when they struggle with classroom activities or have difficulty understanding certain topics in the Physical Sciences. These

activities go beyond the standard classroom instruction, allowing teachers to expand their teaching, offer additional help and provide individualised support. Teachers or other learners can provide explanations or resources to address the requests of those learners who are struggling. Below are excerpts from teachers explaining how they use WhatsApp to provide academic support to learners. This finding is important because it indicates that rural teachers are actively extending learning opportunities in the context where the classroom alone is inadequate. In the rural Physical Sciences classroom, factors such as limited teaching time, overcrowded classes, and inadequate resources can limit teachers' ability to address learners' needs, especially during lessons (Amnesty, 2020; Baloyi et al., 2023). By using WhatsApp to provide additional support and counteract these challenges. Supported by the Connect-ivity framework, connections among teachers, knowledge, and WhatsApp create learning opportunities. Using WhatsApp to provide academic support after school enables learning across a network comprising the teacher, the learner, and shared resources (Siemens, 2004). Learning is strengthened through interaction and shared problem-solving and is not limited to an individual (Siemens, 2004). In this way, WhatsApp functions as a networked space that supports continuous, ELO.

The interview responses indicate that T1, T2 and T4 use WhatsApp to address individual learning concerns, particularly when learners are at home. Below are the excerpts from the teachers talking about how they use WhatsApp to assist learners.

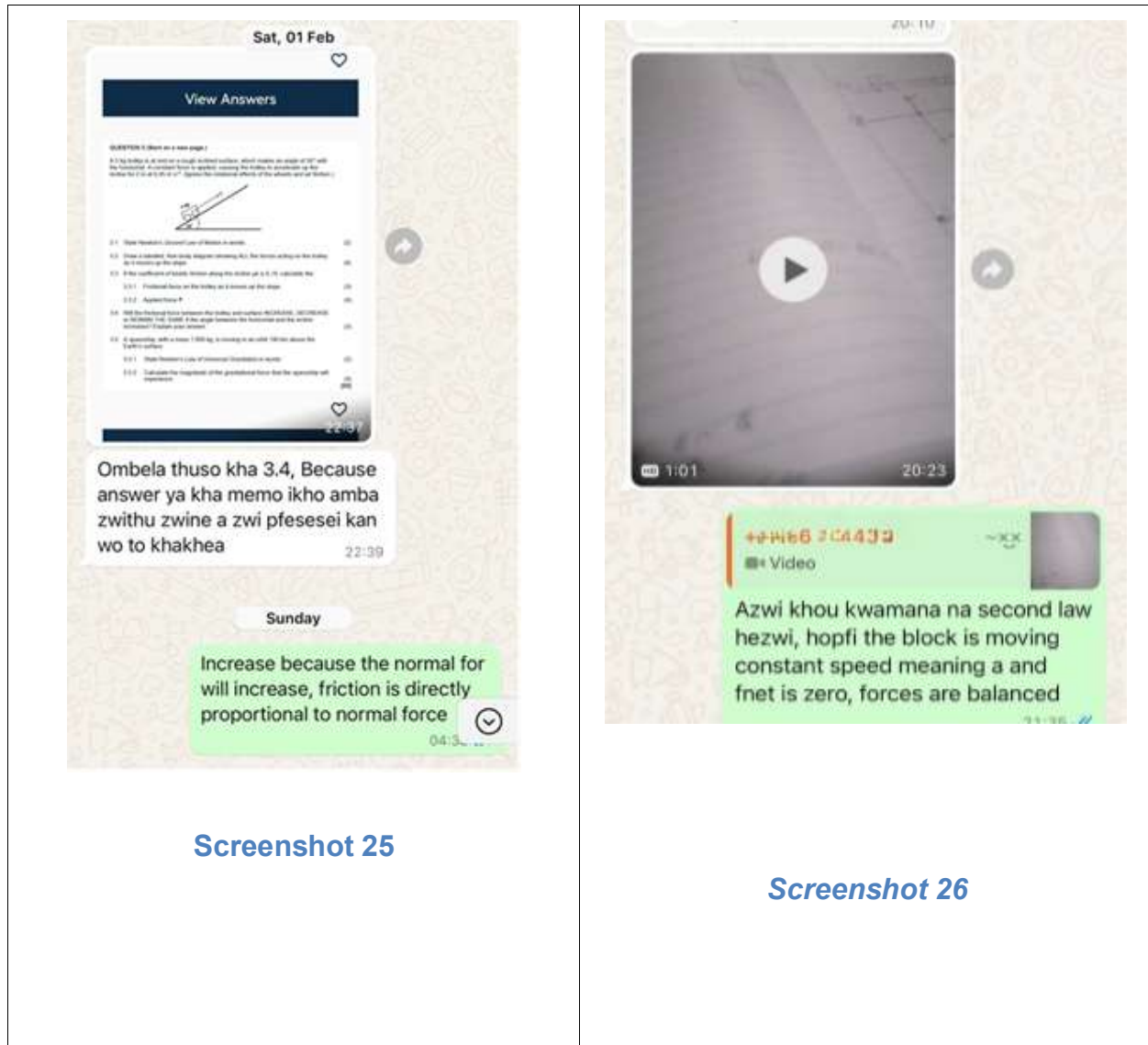
T 1 Learners can get stuck when studying or doing an activity at home. With WhatsApp, learners do not have to wait to get a solution. They do not have to remain stuck because they can send a picture of their problem, and I can help them understand.

T2 Some learners are shy and do not ask questions in class, even when they struggle to understand specific topics. However, you can find those learners later; inbox me via WhatsApp, asking for help

T4 When learners are struggling with a question, they can send it to the group, and we can discuss it and help them with problem-solving solving.

T1 mentions that learners who get stuck while studying at home can send a picture of their problem, allowing the teacher to provide explanations and clarifications. This shows that WhatsApp enables timely, personalised support, preventing learners from remaining stuck and ensuring learning continues outside formal class time.

T2 mentions that some learners are shy and do not ask questions in class. WhatsApp allows these learners to seek help privately by sending messages to the teacher, creating a safe space for questions and personalised guidance. This demonstrates that the platform can support learner participation and engagement for those who might otherwise remain silent. Below are screenshots showing T2 answering learners' problem-solving queries.



In the screenshot, a learner sends a picture with a physical science problem that they are struggling with, and in screenshot 26, a learner sends a video about what they are struggling with. In both screenshots, T2 gives clarification and assists learners in answering the question.

T4 describes using WhatsApp to facilitate problem-solving discussions within the group when learners struggle with questions. While this occurs in a group setting, the teacher can still provide targeted explanations to individual learners during the discussion,

extending support beyond what is possible in limited classroom time. Below is an example showing a learner asking for help from T3 on problem-solving.

The screenshot shows a WhatsApp chat interface. At the top, there is a header with a group name and a status bar. The main content of the chat is a physics problem involving a 20 kg block on an inclined plane. The problem is divided into several parts, including stating the principle of conservation of mechanical energy, calculating kinetic frictional force, and calculating the speed of the block at the bottom of the ramp. Below the problem, there are three messages from a learner asking for help with parts 5.2 and 5.3. The messages are in Zulu and English. The first message is: "Who sir , cou humbela u thusiwa nga 5.3". The second message is: "5.2.2 and 5.3". The third message is: "Anyone to assist, am not home yet". A black arrow points from the first message to a text box that says "Sir please help me with 5.3".

5.1 State the principle of conservation of mechanical energy in words.

5.2 The kinetic frictional force between the 20 kg block and the surface of the ramp is 20 N.

Use energy principles to calculate the:

5.2.1 Work done by the kinetic frictional force on the block.

5.2.2 Speed of the block at point B at the bottom of the ramp.

5.3 A 100 kg object is pulled up the SAME RAMP at a constant speed of 2 m/s² by a small motor. The kinetic frictional force between the 100 kg object and the surface of the ramp is 20 N.

Calculate the average power delivered by the small motor in the pulling of the object up the incline.

Who sir , cou humbela u thusiwa nga 5.3

5.2.2 and 5.3

Anyone to assist, am not home yet

Sir please help me with 5.3

Screenshot 27

Screenshot 27 shows a learner asking for assistance with problem-solving. T4 responds by prompting other learners to help. This demonstrates that WhatsApp is used to attend to individual queries. It also shows that other nodes, except the teacher, can assist each other, and that it is not only the teacher's role but also every member of the group.

Overall, the findings suggest that WhatsApp enables teachers to provide individualised instructional support outside formal school hours. In this way, teachers can expand their reach and offer academic support. They help learners with their schoolwork, problem-solving, concept clarification, and additional learning materials. Learners use WhatsApp to communicate their challenges and concerns to teachers, allowing teachers to offer individualised support. In addition, the role of the teacher(s) shifts from a rural, traditional, classroom-bound teacher to an online, readily available tutor.

Using WhatsApp in this way is appreciated by the learners in the group. The learner's responses indicate that they find it beneficial to receive academic assistance when they encounter challenges understanding concepts or solving Physical Sciences problems. Below are excerpts from the learners explaining how teachers use WhatsApp to help them.

*L1A I prefer physically interacting with the teacher in class,
because in a group I cannot ask questions to the group.*

*L2A I can send my questions to the teacher, and she can help
me*

*L1B I like that my teacher can help me when I don't
understand something*

*L2B I like using the WhatsApp group because I can talk to the
teacher and even send a picture of what I do not
understand*

*L1C I can send a picture with some problem that I don't
understand, and the teachers helps me*

L2C If I am at home and there is something that I don't understand, I send the question to the group, and the teacher or my classmates help me

Apart from Learner 1A, the learners' responses indicate that teachers are both accessible and available to provide academic assistance when needed. In school A, the group is closed, and only the teachers can post; however, they can send the questions directly to the teachers' WhatsApp numbers. One limitation of using WhatsApp in this way is that if a learner has a concern and sends it privately to the teacher, other learners cannot see the question or benefit from the discussion. Rambe et al. (2020) indicate that learners on the WhatsApp platform learn from others' questions and discussions.

Moreover, studies have shown that WhatsApp can be used by teachers to remotely assist learners during study time or address concerns related to their studies. (Chitanana, 2024; Durgungoz & Durgungoz, 2022; Ujakpa et al., 2018). This is particularly useful in rural contexts where learners may not have access to study support elsewhere (Adams, 2019; Chowdhury, 2014). Overall, the findings from these studies suggest that WhatsApp is advantageous for teachers who want to extend their reach and provide ELO through instructional support outside formal school hours. (Adams, 2019; Chitanana, 2024; Durgungoz & Durgungoz, 2022; Ujakpa et al., 2018). However, the use of WhatsApp for extending classroom instruction, supporting content delivery and providing individualised help is not accessible to all rural learners as some may not have the devices that support the WhatsApp application, which then reinforces inequalities amongst learners (Rambe et al, 2020)

Overall, the study found that the rural teachers' sense-making of WhatsApp is an outcome that emerges at the intersection of (i) The rural teacher's agency, (ii) Rural working and learning conditions, and (iii) The adaptation of WhatsApp as both a medium and a tool. The findings demonstrate that the platform is primarily used for communication between teachers and learners and as a medium for extending teachers' reach. It is also conceptualised as a tool for extending the classroom by providing teaching and learning

resources, supporting curriculum delivery, and providing academic support to learners beyond the classroom.

4.3 RESEARCH QUESTION 2

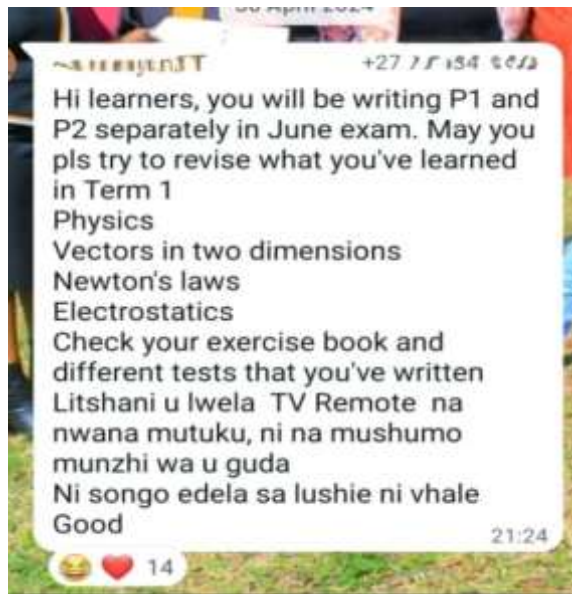
What affordances does WhatsApp provide for ELO for learners in rural schools?

In this section, the affordances of extending learning opportunities through the WhatsApp platform are discussed, with a particular focus on how it enables digital inclusion for rural teachers and learners. By affordances, I mean the potential actions and opportunities that WhatsApp makes available to teachers and learners, enabling them to participate in pedagogical interactions despite the challenges of the rural setting. This discussion captures not only how WhatsApp is used by rural teachers, but rather, how its features actively enable participation in an electronic and mobile learning environment. Specifically, WhatsApp allows the formation of (i) A networked community of learning, provides (ii) Accessibility beyond classroom walls, offers (iii) A low-cost and widely available technology, and supports (iv) Resource sharing and supplementary support. Together, these aspects create practical opportunities for learners and teachers to engage in learning that might otherwise be limited by digital exclusion. Digital inclusion, in this context, refers to individuals' ability to access, participate in, and benefit from digital technologies, facilitated by the actionable opportunities offered by WhatsApp.

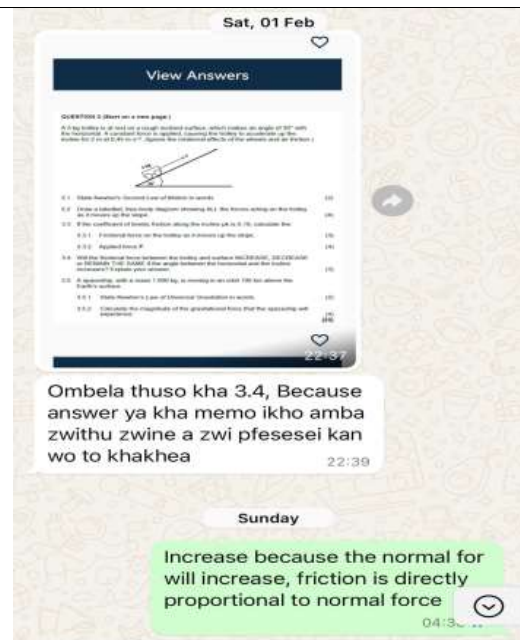
Networked Community of Learning

The study revealed that WhatsApp helped create a learning community in which teachers and learners connected outside school hours for learning. WhatsApp affordances provide effective education by leveraging its built-in features through immediacy, multimedia sharing, group dynamics, and accessibility that can help to facilitate flexible, engaging, and low-cost learning.

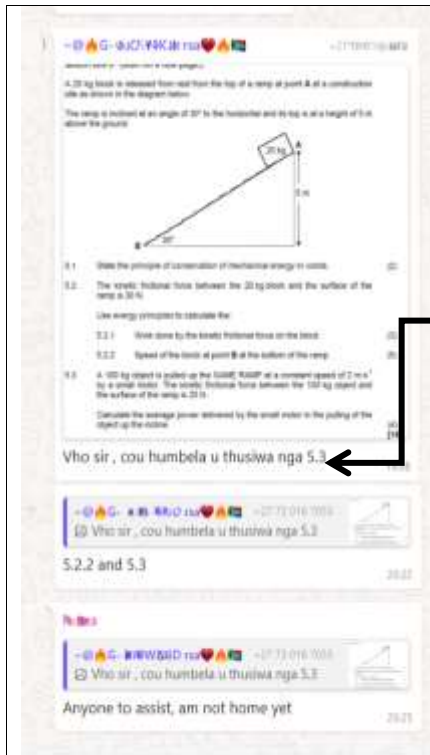
A networked community of learning refers to a learning environment where teachers, learners, and information are connected through a medium that allows for continuous interaction, collaboration, and the sharing of knowledge (Siemens, 2004). This theme highlights both the academic and social aspects associated with a learning network. The study in RQ1 has demonstrated that T1, T2, T3 and T4 have used the WhatsApp groups to communicate with learners about school and learning-related matters. They also used the group to answer questions, share learning resources, offer encouragement for learning, and engage in social conversations. Below are screenshots showing the academic aspect of the learning network.



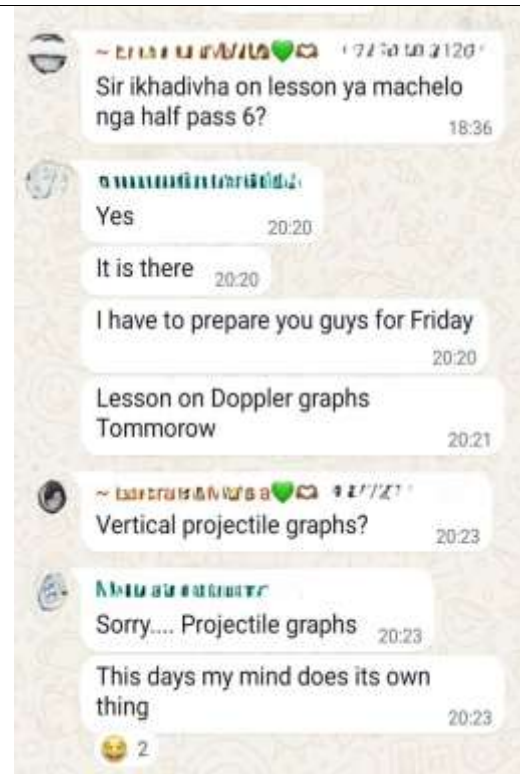
Screenshot 29



Screenshot 30



Screenshot 31



Screenshot 32

In screenshot 29, T1 shares examination information, revision guidance, and key content areas that learners must focus on for the upcoming exam. Learners responded using emojis of acknowledgement and appreciation. In a digital learning network centred on WhatsApp, emojis serve as a form of communication. They allow learners the opportunity to participate with minimal effort compared to writing out a text (message (Nyakana & Smith, 2023). More importantly, in a closed WhatsApp group like those of T1 and T2, where the teachers are the only ones who have the right to post messages, it becomes the way learners can provide feedback and confirm that the message has been seen. Emojis are a form of non-verbal communication that supports efficient communication in academic WhatsApp groups (Firdiani & Kahar, 2022). However, these studies also caution that people have different interpretations of what each emojis mean, which may cause confusion about what the sender is saying (saying (Firdiani & Kahar, 2022; Nyakana & Smith, 2023). In this interaction, a learning network is evident, showing

multiple ways of communication, even if the learners are using emojis instead of words, because it is an acceptable form of interaction

In screenshot 30, a learner asked a question based on Physical Sciences content. The learner sends a picture to T2 showing a trolley moving up an incline and states that they do not understand how the answer to question 3.4 was derived, as shown in a memorandum. T2 responded with a clear explanation and texted back to the learner that the quantity would increase because friction is proportional to the normal force. This interaction demonstrates that WhatsApp is used as a space for academic support, thus a learning network, allowing a two-way communication where learners can ask questions and receive clarification outside the classroom. Evident in this screenshot, this interaction occurs on the weekend, which is significant in rural contexts because the learner may not have academic opportunities outside school hours. Studies confirm that academic WhatsApp groups allow learners to receive academic assistance and support at anytime from anywhere. Framed by the Connect-ivity framework, the learner accessed learning when they connected to T2 and information which was in their learning network (Siemens, 2004)

Similarly, in screenshot 31, a learner asked a content-based question; however, the teacher replied that he was not home and unable to help at that moment, and he then prompted another group member to help. This indicates distributed learning as the teacher is not the sole source of knowledge (Siemens, 2004).

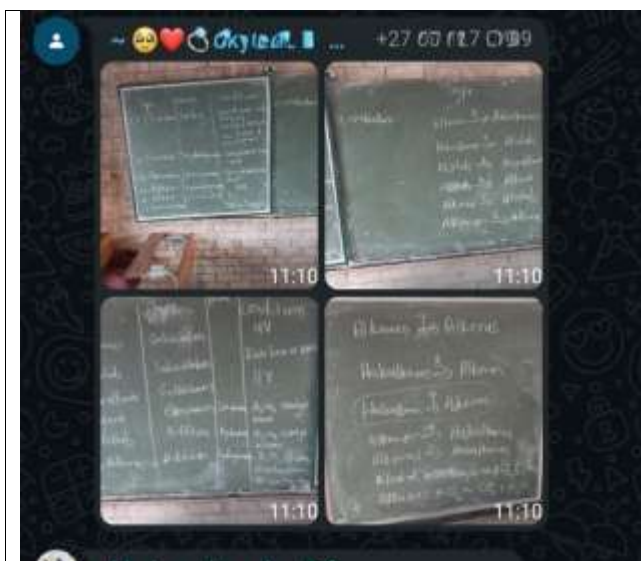
In screenshot 32, a conversation took place between a teacher and a learner when the learner asked a question about an upcoming class. This indicates a learning network, as learners can connect and access up-to-date, relevant information (Siemens, 2004).

Overall, these message transactions demonstrate that WhatsApp serves as a link between nodes in a community of learning rather than merely a communication tool. On the platform, learning is shared and distributed among group members. In this learning network, learners can ask questions, receive information and academic assistance and access learning resources. It enables learners to access current, relevant knowledge and

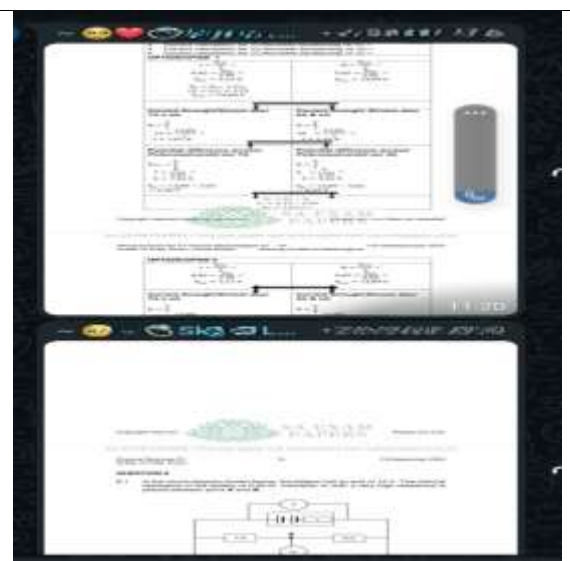
information through the network. Members of the learning community share the same objectives and are thus collectively engaged in the learning activity (Engeström & Sannino, 2021) . In this learning network, teachers and learners are connected by a common goal, which revolves around supporting the learning of Physical Sciences, and that shapes the interactions on the platform (Siemens, 2004). All these findings are reflective of the Connectivity framework (Siemens, 2004).

The findings above demonstrate that WhatsApp functions as a link node in this network, connecting teachers and learners in a shared virtual learning space after school hours. It serves as a central node because it is the main point through which teachers and learners connect with each other, share information and access to learning resources, these screenshots illustrate the affordance of a networked community of learning, where the platform enables teachers and learners to stay connected, collaborate, and co-construct knowledge as part of a socially supported learning environment.

Not only does the platform connect teachers and learners, but it also links learners with their peers. The study found that in T3 and T4's WhatsApp groups, learners assist one another with their schoolwork and learning-related queries. Below are screenshots that show learners helping each other in the group.

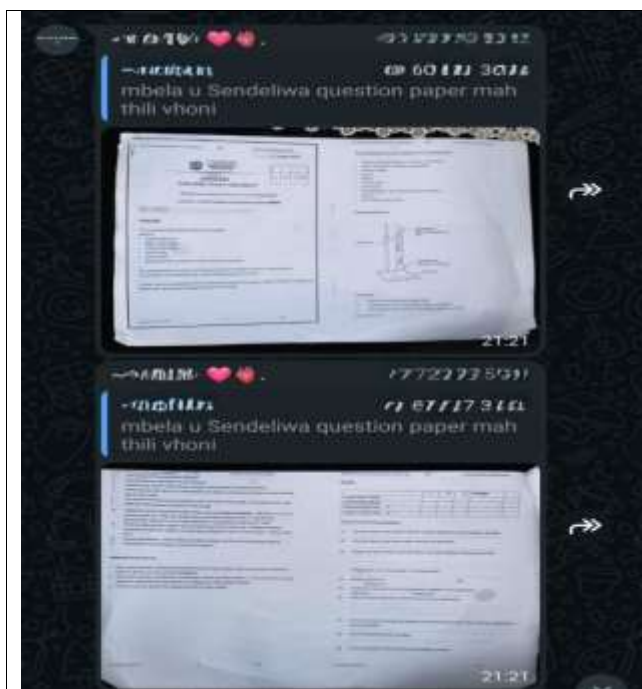


Screenshot 33

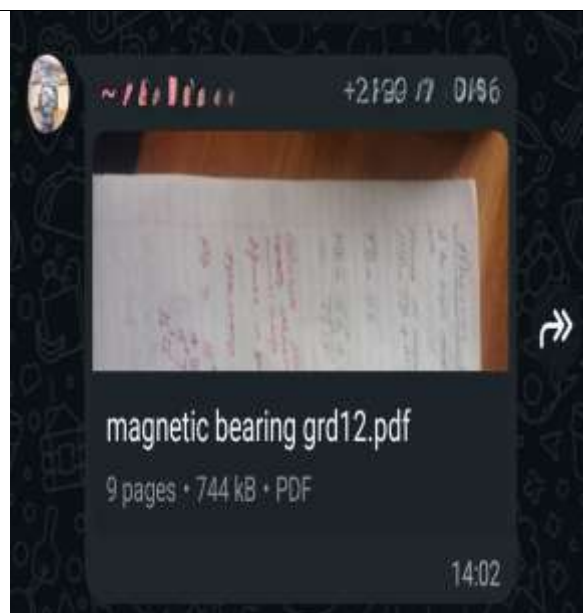


Screenshot 34

In screenshots 33 and 34, learners from T3's group shared resources with the rest of the group. In screenshot 33, a learner shared notes from the chalkboard and in Screenshot 34, the learner shared a memorandum for an assessment.



Screenshot 35



Screenshot 36

Similarly, in screenshots 35 and 36, learners from T4's group also shared resources. In screenshot 35, a learner sent a picture of a question paper after another learner had requested it. In screenshot 36, a learner shared handwritten notes on magnetic bearing.

Screenshots 33, 34, 35, and 36 demonstrated that learning rests on the diversity of opinions (Siemens, 2004); it is not only the teacher who is responsible for learning, because learning is a shared responsibility. In this way, WhatsApp, as a community of learning, affords learners opportunities for peer collaboration beyond the classroom. This is important because it shows that the pedagogical use of WhatsApp extends learning opportunities beyond the teacher and strengthens the network. Learners do not have to rely solely on teachers for assistance; they can connect with their peers to get the help they need. Learning opportunities are not restricted to the teacher's intentions and use of WhatsApp; they are distributed across the network. This is significant in rural settings

because learners have limited academic support at home. In the group, learners who have questions or challenges post their concerns on the group platform, and their peers respond with answers or solutions (Durgungoz & Durgungoz, 2022).

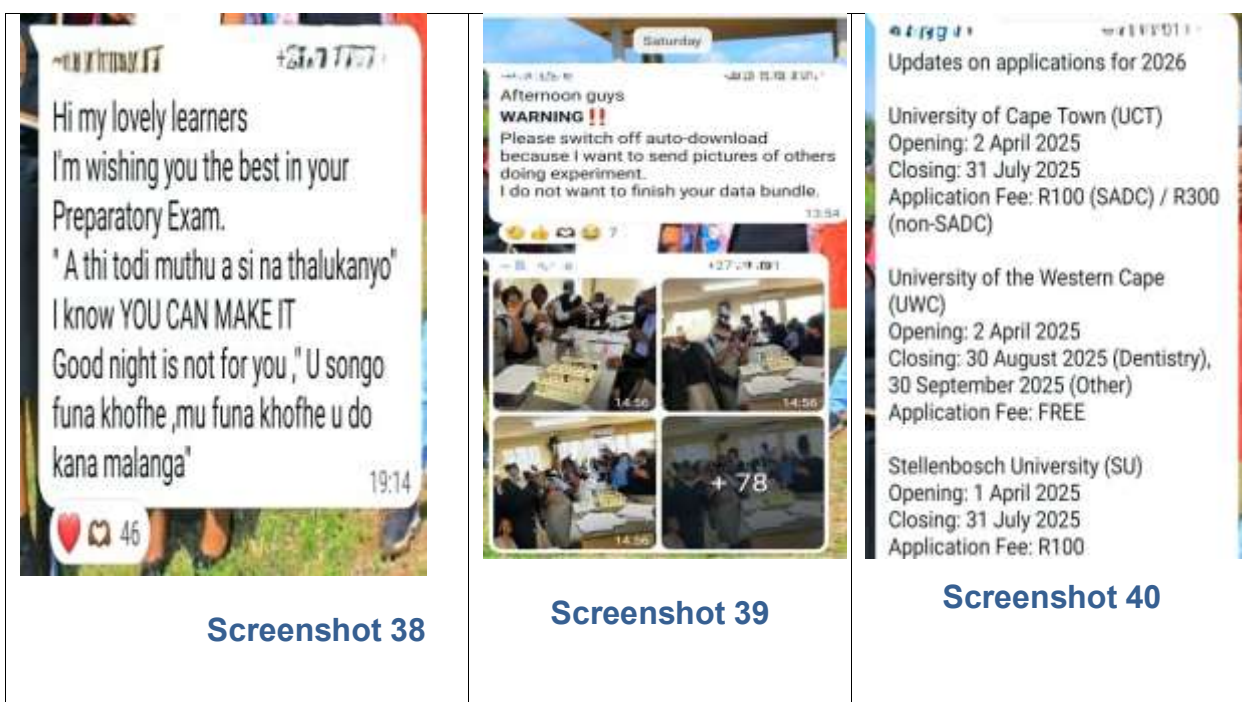
Framed by the connect-ivity theory, this confirms that learning opportunities are distributed in a network. However, the study also found that although some events warranted peer collaboration, learners did not fully exploit this aspect within their respective WhatsApp groups. In screenshot 31, the teacher asks members of the group to help solve a problem-solving question sent to the group; in this case, none of the other members (learners) attempted to solve the problem. This shows a missed opportunity for peer collaboration.

Moreover, in T1 and T2's WhatsApp groups, learners were restricted from posting and could only react with emojis; learning opportunities through peer collaboration and support were limited. This reduces learners' ability to benefit from each other's questions and explanations, positioning the teacher as the sole source of information and academic input. This contradicts how a learning network functions, as it does not decentralise authority from the teacher. As a result, such a learning network reduces its effectiveness for providing ELO through collaborative learning. Although T3 and T4's WhatsApp allowed all members of the group to participate, the study found that peer collaboration was minimal and that discussions can start off academic but deviate from this as the interaction continues, leaving learners off topic.

Studies examining WhatsApp as an academic tool have confirmed that WhatsApp groups promote peer collaborative learning (Abualrob & Nazzal, 2019; Bouhnik & Deshen, 2014; Jere et al., 2019). Jere et al. (2019) describe WhatsApp groups as productive, promoting collaboration among learners on their studies outside of school hours. WhatsApp is advantageous because learners can access it from anywhere, communicate easily with each other, and even exchange resources. Abualrob and Nazzal (2019) highlight that WhatsApp fosters collaborative learning in a time-saving environment because learners can do so from the convenience of their own homes. However, they note that a large portion of messages on the app were social rather than learning oriented. Nevertheless,

the portion of academic discussions exchanged between learners was relevant to the curriculum and contributed to learning (Abualrob & Nazzal, 2019).

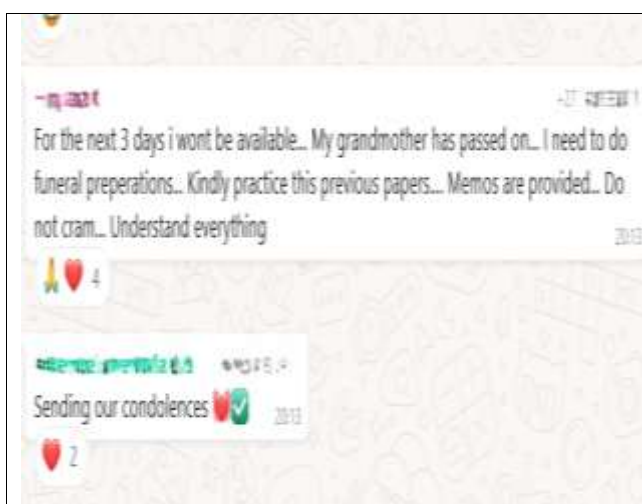
Given that WhatsApp is a social and instant messaging tool, the study found that this rural network has a significant social aspect. In T3 and T4's WhatsApp groups, members engaged not only in teaching and learning activities but also in social conversations relevant to their context. Below are screenshots showing the social aspect of a learning network:



Screenshot 38 shows T1 sending a message of encouragement to learners in their studies. She used terms of endearment, saying, 'Hi, my lovely learners. She then wished the learners the best for their preparatory exams, saying she knows they can make it. She further uses Tshivenda, a vernacular language, to say that those who enjoy sleeping will reap the benefits of sleeping. In this screenshot, T1 portrays care and support for the learners, which, according to, helps build trust in a learning network.

In Screenshot 39, T2 shared pictures of the learners from school A doing their physical sciences experiments during school hours. Because learners can download and store these pictures, they serve as reminders of shared moments among network members.

However, this does not help learners with their practical work in physical sciences but shows the social aspect of the WhatsApp group. In screenshot 40, T2 sent learners information about the different universities' application dates and associated fees. This screenshot also demonstrates care; T2 goes beyond the current curriculum content to offer learners information about their future pathways. Screenshots 38, 39, and 40 demonstrate that learning is relational, because in this learning network, it is more than just sharing and engaging in learning activities; it also involves cultivating a supportive environment that considers the context of group members. By using vernacular language (screenshot 38), T1 sends a personalised message of encouragement that can be understood by her Venda-speaking. It shows the personalised aspect of a learning network.



Screenshot 41



Screenshot 42

In screenshot 37, T3 shared information about his grandmother's passing, and a learner responded with their condolences, while other learners responded with heart emojis. In screenshot 38, T3 shares in on a joke with learners, the learner makes references to the T4 teaching Alkanes and Alkanes, to which T4 responds with laughter emojis and says, 'you guys are crazy', he further says to the learner that he will chase them around the

school. Other learners joined in on the joke by using laughter emojis. The teacher humanises themselves, making themselves more approachable, building a learning community that is centred around trust(Adams, 2019; Durgungoz & Durgungoz, 2022).



Screenshot 43



Screenshot 44

Screencaps 39 and 40 show the social aspects of teacher T4's group. In screenshot 39, T4 shared photos of his graduation with learners, and in screenshot 40, the group members discuss an upcoming lunar eclipse. T4's actions confirm that the screenshots show activities that are not related to learning, but support maintaining beyond just engaging in content-based discussions. It shows that T4 builds relationships through the social aspect of his actions.

Teachers and learners, in this respect, have maintained WhatsApp's primary objective: socialising. Teachers and learners greet each other, exchange well wishes, indulge in humour, and teachers sometimes share small personal experiences. In T1 and T2's

WhatsApp group, minimal social conversation occurred, and the few interactions that could be considered social were directly linked to the learners' academic benefit. Particularly, T1 and T2 used friendly language and terms of endearment when addressing learners, communicated in their vernacular, and used the platform to send learners' information regarding admissions to higher institutions and career paths, or photos of learners doing experiments at the school. Teachers also send encouragement and motivation to learners to study hard. Evident from how T1, T2, T3, and T4 make sense of the pedagogical use of WhatsApp, their intention was to use the application for academic communication, as a proxy of virtual presence, as a resource and instructional tool and not for social communication. However, because of the application's primary design for social interaction, social communication becomes unavoidable. WhatsApp

Although these social interactions are not directly linked to learning, they play a role in how the group functions. The social aspect is how T1, T2, T3 and T4 build relationships with their learners and thus maintain the learning network (Siemens, 2004). It shows learning as a relational process. The findings suggest that social messages within the group promote a positive rapport among its members. This is supported in the literature, that social communication facilitates relationship building, fostering a comfortable and inclusive learning environment (Adams, 2019; Chitanana, 2024; Durgungoz & Durgungoz, 2022). As a result, the WhatsApp group becomes a supportive learning network that indirectly supports ELO. Numerous studies support these findings, noting that academic WhatsApp groups are beneficial for educational and social activities and foster positive teacher-learner relationships (Durgungoz & Durgungoz, 2022). WhatsApp, at its core, is a social networking application, and even when it is repurposed for learning, people still see it as a social tool, which explains the social messages (Abualrob & Nazzal, 2019). However, this does not negate the academic potential and benefits of a school-based approach. Sharing social content fosters a learning atmosphere that makes learners feel comfortable and creates a positive working environment (Chitanana, 2024).

The study also found that the presence of a social aspect in a learning network entail having to contend with messages that are completely irrelevant and unrelated to learning

and do not serve the group's functioning. These messages are off-topic and do not provide any support for ELO. They do not align with the group's objective and expectations. They are often unappreciated by other group members, particularly teachers and learners who are focused on the academic aspect of the group. In this way, social messages become constraints on the learning network. Below are excerpts from the teachers talking about irrelevant messages in the group.

- Teacher 1* *Sometimes these learners can say anything if you let them, which is why we have decided not to let them talk in the group.*
- You can find that they send messages, and it's a night, when you are trying to sleep...*
- Teacher 3* *What I don't like is that sometimes learners will just speak, and what they are speaking about is not school-related... it's also a waste of other learners' data and time when they access the group only to find out that what is being said is not beneficial.*
- Teacher 4* *I don't like it when learners discuss things that are not relevant to the group.*

The teacher's responses express annoyance when messages are not linked to the objectives or functioning of the WhatsApp group. These findings suggest that learners can deviate from the overall group object, disrupting the flow of meaningful interactions and thereby reducing the opportunities available to the group for learning. Within the Conecti-vity framing, learning networks have rules and exceptions of how group members should act. The chat logs do not explicitly state rules for how the WhatsApp group should operate, but the intentions and objectives of using the group for school- and learning-related matters indicate that members are expected to act in ways that support the group's function. Further, in T1 and T2's WhatsApp group, rules have been enforced via group settings, allowing only T1 and T2 to post messages. Moreover, irrelevant messages have

been cited by T1 and T2 in their interview responses as one reason learners are excluded from actively participating in the group. They have opted for a closed group, where only the teachers are allowed to share and post content on the platform. Learners can only react using emojis. In T3 and T4, irrelevant messages are unwanted, as learners often complain that they are wasteful of their connectivity data, are time-consuming and unnecessary. This aspect is evident in the rules and expectations that come with the learning network, even if they are not explicitly stated. Members of the group have a shared expectation that the group is for supporting learning and interaction, which does not align with what is frowned upon. In the T1 and T2 groups, the group settings have been used to enforce rules and keep the groups aligned with their primary objectives. The presence of unwanted messages suggests that some members of the group do not know how to draw the distinction between WhatsApp as an educational application and WhatsApp as a social interaction tool, and it creates tension within the group. To avoid such pitfalls, Durgungoz and Durgungoz (2022) suggest that group members receive training focused on effective communication and the etiquette of using WhatsApp as a learning platform.

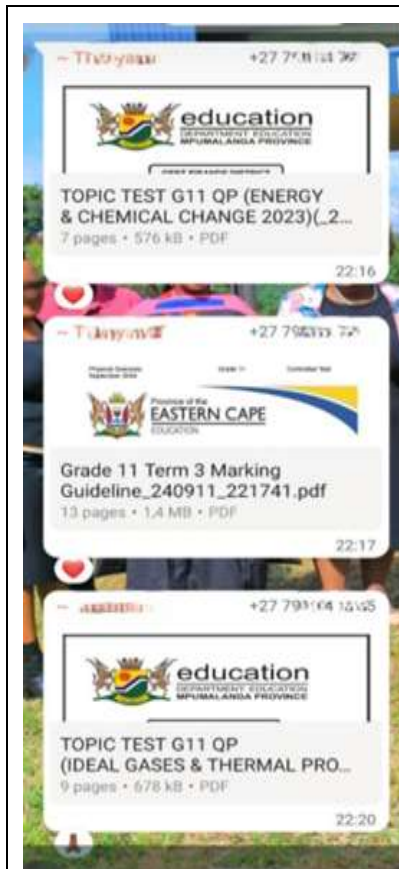
Studies have cautioned that irrelevant messages have been the pitfall of academic WhatsApp groups (Nduduzo et al., 2023; Nyamupangedengu et al., 2023). Learners tend to misuse the school-based WhatsApp group (Nduduzo et al., 2023). They post irrelevant messages, particularly when foul language and misbehaviour by learners are involved, which may make teachers feel uncomfortable and burdensome (Bouhnik & Deshen, 2014). Mabaso et al. (2023) have indicated that irrelevant messages can distract learners and threaten learning opportunities.

Resource sharing and Supplementary support

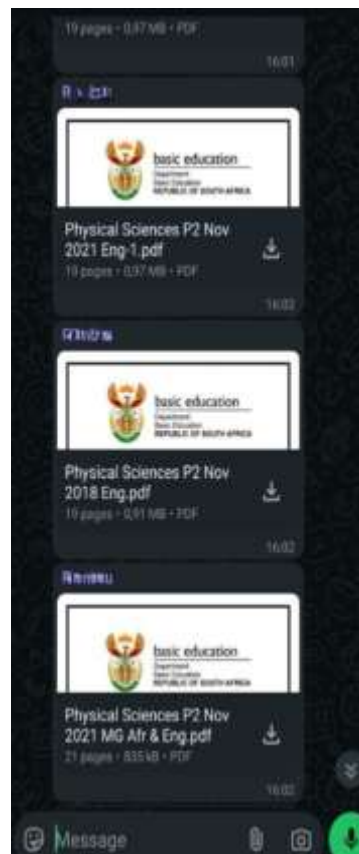
The findings revealed that WhatsApp affords T1, T2, T3 and T4 WhatsApp groups and learners' access to diverse electronic teaching and learning resources, as well as supporting learning beyond the classroom. These include study guides, notes, question papers, and simulation links, images, videos, and link formats. This is important because it underscores that learning opportunities are extended through the platform's built-in features. It further indicates a shift from the 'rural school resource-challenged' narrative

to a focus on capability, examining how rural schoolteachers and learners use a readily available tool to create ELO by accessing diverse resources. In theme 1, the use of WhatsApp for distributing study guides, question papers, notes and other learning materials reflected the teachers' sense-making and pedagogical intention. Under this subtheme, the study aims to demonstrate the affordances of WhatsApp's properties, which facilitate ELO and make teaching and learning resources more readily accessible. In rural schools where teaching and learning resources such as textbooks, laboratory apparatus, and rich learning materials are often limited, WhatsApp enables access to digital resources that would otherwise be unattainable. This finding is consistent with the connectivity framework, which holds that learning can be mediated through digital technologies like social media applications.

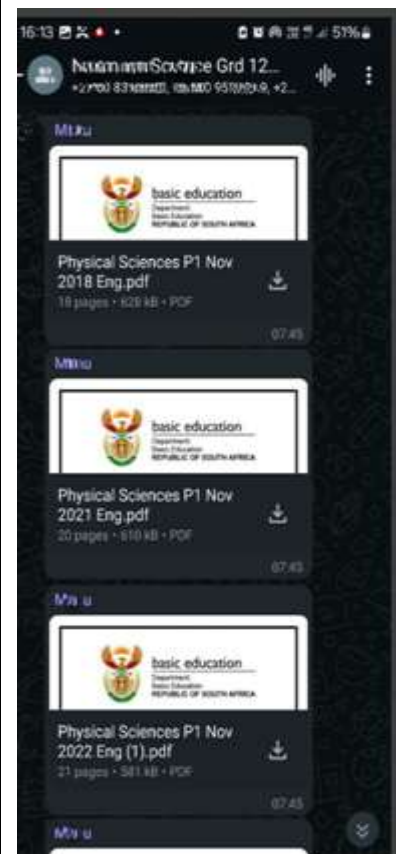
Through the applications, learners have access to examination revision materials, particularly past exam papers for practice. Below are screenshots showing the distribution of exam papers.



Screenshot 45



Screenshot 46



Screenshot 47

Screenshots 45, 46, and 47 show T1, T3, and T4, respectively, sharing multiple question papers in the WhatsApp group. In screenshot 45, T1 shares question papers from the Eastern Cape, which is another province.

The use of question papers for examination revision shared via WhatsApp is beneficial, particularly for high-stakes exams. It provides ELO by enabling learners to engage in assessment-focused learning beyond formal schooling. In the rural classroom, teaching time is already constrained, leaving even less time for learners to revise and prepare for their examinations. Learners can access and use past question papers as a study and preparation strategy. Which can boost their confidence and make them feel more comfortable during their exams. The familiarity they gain from using past papers to study helps them identify patterns and familiar concepts, understand challenging ones, and therefore reduce exam-related pressure (Ontong & Bruwer, 2020). Studies show that

learners regard reviewing and practising question papers as influencing their performance in high-stakes exams (Ontong & Bruwer, 2020). On WhatsApp, learners can access multiple, diverse question papers for exam preparation; however, teachers cannot monitor whether learners are using the question papers they post.

Even though the primary objective of rural teachers was simplistic, in that they wanted to communicate with their learners after school about their studies, findings indicate that it extended beyond this to forge a functional learning platform. However, the teachers' interview responses show that WhatsApp was used haphazardly and lacked a clear structure with no prior planning of teaching and learning activities. Below are excerpts from the teachers detailing their teaching and learning preparation and process via WhatsApp.

Teacher 1 We don't plan...No, if I find something and I think it will help my learners, then I will send it to them

Teacher 2 I cannot say that there is a planning process, I just send whatever that I came across ...

Teacher 3 When I am sitting at home and happen to come across and maybe I am surfing the internet and I come across material that will help my learners, I just send it to them... I can't say that there is a planning process.

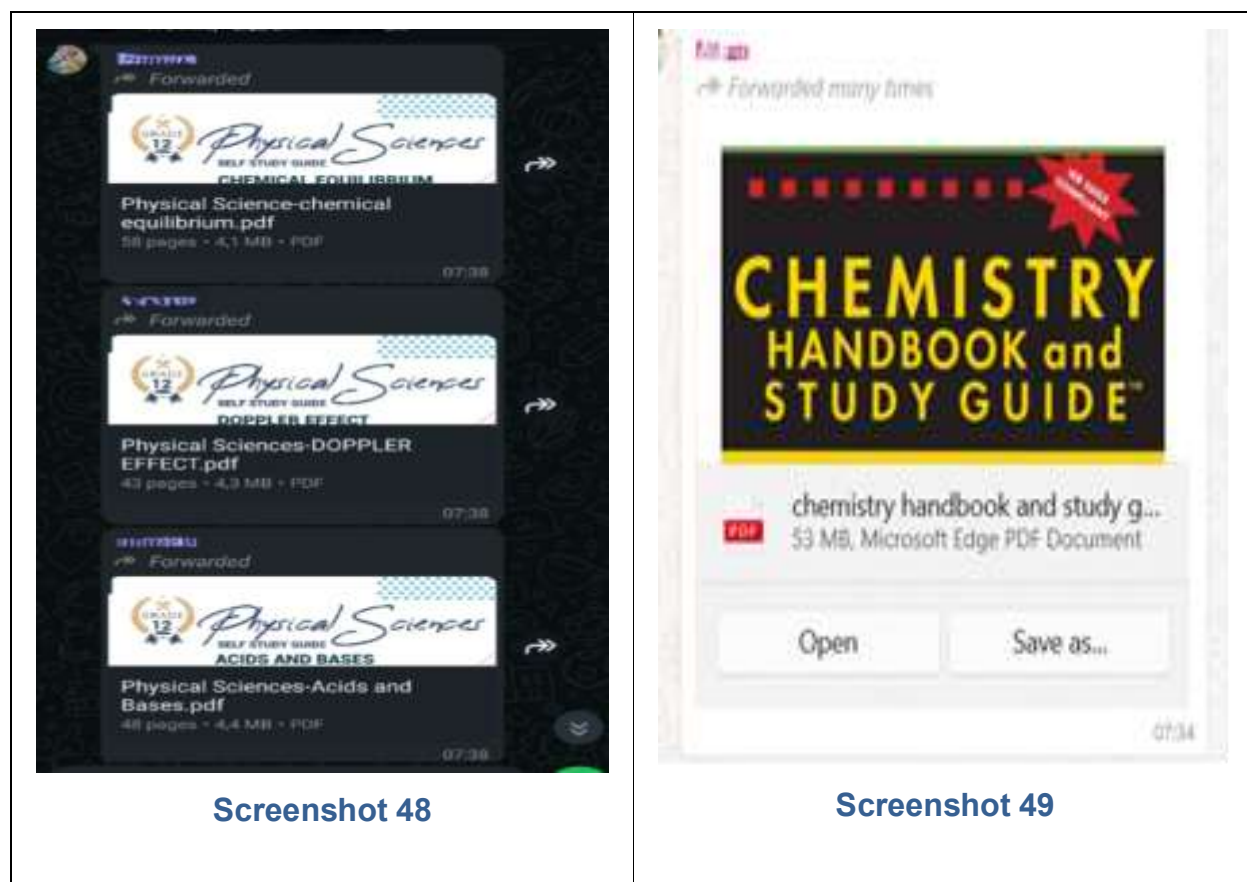
Teacher 4 No, I do plan for it, I send whatever is relevant at the time

The intention, as stated in RQ1 by T1, T2, T3, and T4, was to engage learners in activities that supported learning in the Physical Sciences. But the interview responses show that it was often initiated spontaneously without clearly defined instructional goals and planned pedagogical strategies. The finding suggests that WhatsApp is used for resource sharing and providing supplementary support through blended learning. Blended learning is a

pedagogical approach that integrates face-to-face and online learning through an ICT medium (Lalima & Lata Dangwal, 2017). T1, T2, T3, and T4 are using WhatsApp as an extension of the traditional classroom in which resource sharing and supplementary support go beyond classroom hours. This is significant, particularly in a rural context, because it underscores rural teachers' agency. Showing initiative and innovation in response to challenges that they face while teaching in the rural setting. The study frames this as 'spontaneous blended learning', because teaching and learning activities on the WhatsApp group are both informal and unplanned. According to Lalima and Lata Dangwal (2017), setting up and practising blended learning is rigorous, requiring fundamental preparations across all aspects of the teaching and learning process. Moreover, all the teachers in the study have confirmed that they have not received any formal training in teaching and learning with digital tools and applications. But they have felt comfortable enough with WhatsApp to repurpose it as a pedagogical tool, as they already use it regularly to communicate with family and friends. However, familiarity with the application does not translate to technological and pedagogical proficiency. Lalima and Lata Dangwal (2017) indicate that teacher training is a prerequisite for the successful implementation of blended learning. Teachers should be trained to develop and structure content for digital platforms and to efficiently utilise them for teaching and learning. Further, Rambe et al. (2020) caution that teachers need to plan learning activities to maximise WhatsApp's pedagogical potential.

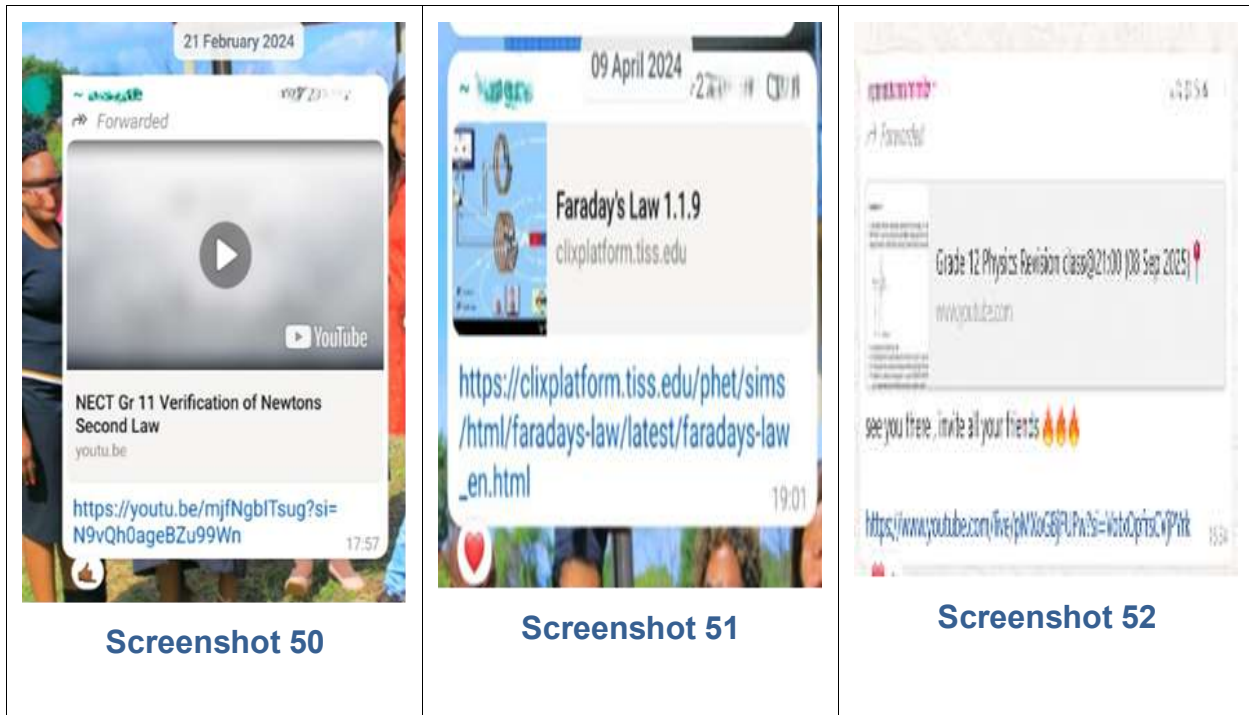
Although pedagogical activities were not planned, this does not negate the ELO offered to rural learners. Its pedagogical use plays a significant supportive role in teaching and learning (Nyamupangedengu et al., 2023), particularly in the rural setting that sits on the negative end of the rural divide (Amnesty, 2020). In the Grade 12 subject analysis report, the DBE states that ICTs should be used to enhance and support the teaching and learning of Physical Sciences, as they improve learners' understanding of scientific concepts and enhance learner performance (Department of Basic Education, 2024). However, the literature has recognised that rural settings lack digital learning opportunities, rendering the DBE's suggestion unattainable for rural teachers and learners (Amnesty, 2020; Baloyi et al., 2023).

Through the application, learners have access to updated study guides, notes, textbooks and other learning materials.



Screenshots 48 and 49 show T3 sharing various study guides in the WhatsApp group, indicating that WhatsApp is used to distribute and access learning materials that would otherwise be cost- and logistics-prohibitive.

The sharing of study guides, updated textbooks, and notes affords rural learners ELO by enabling them to access comprehensive, structured learning materials beyond the limited textbooks available in classrooms. By offering multiple and extensive learning materials, learners have access to curriculum-aligned and relevant learning materials.



Screenshot T1 shares a link to a YouTube video for verification of Newton's law. Screenshot 51 shows T2 sharing a link to a simulation on Faraday's law, and screenshot 52 shows T4 sharing a link to an online class on grade 12 revision.

The above screenshots 50, 51, and 52 demonstrate that WhatsApp provides simple, immediate access to diverse educational resources, which is important in a rural setting. The resources shared through the platform are available after school hours and on weekends, and learners can revisit them at their convenience.

Within the Connec-tivity framework, the finding that WhatsApp affords rural teachers and learners' access to diverse teaching and learning resources underscores the platform's role. It is both a mediating tool within the rural activity system (Engeström & Sannino, 2021) and is also understood to be enabling learning through networks (Siemens, 2004).

As a mediating tool, WhatsApp mediates the relationship between rural teachers and learners (subject), how they pursue understanding physical science concepts (object), and the ELO (outcomes) (Engeström & Sannino, 2021). The affordance lies in

recognising how WhatsApp reconfigures teaching and learning activities in the rural context, characterised by resource limitations. WhatsApp becomes a tool through which teachers reorganise and implement instructional practices to support curriculum aims and learners' understanding of physical science concepts. (Engeström & Sannino, 2021; Grimalt-Álvaro & Ametller, 2021)

In enabling a network, learning opportunities occur when individuals are able to access, navigate and make connections across distributed sources of knowledge (Siemens, 2004) The pedagogical use of WhatsApp allows learners to connect to a network of digital resources, such as notes, study guides, videos, simulations, and past question papers, which function as nodes within a learning network. The platform enables learners to engage with content knowledge outside of school hours. Supporting learning opportunities that are continuous, flexible and responsive to learners' needs. It allows learners to access multiple learning materials in a paperless, economical, and logistically less demanding way.

Again, literature across various contexts shows the important affordances of WhatsApp for distributing and accessing ample learning resources (Abualrob & Nazzal, 2019; Adams, 2019; Bouhnik & Deshen, 2014), more especially in resource-challenged environments (Jere et al., 2019; Rambe et al., 2020). WhatsApp's design as an instant messaging application has multimodal capabilities that make it effective for distributing diverse teaching and learning resources. Abualrob and Nazzal (2019) demonstrate that delivering content knowledge in visual formats, such as pictures and videos, is beneficial for learning science because they can convey information that cannot be conveyed otherwise. Such content often prompts learners to ask questions, leading to content-based discussion amongst group members. This indicates that varied formats are likely to encourage learners to engage in learning outside the classroom. In particular, this is useful in a rural setting, where the primary methods of teaching are lectures and note-taking. In the Physical Sciences, such methods have been shown to be less effective in achieving learning outcomes and high learner performance.

Despite these ELO, access to learning materials on the platform depends on learners having a mobile phone and data. Again, Rambe et al. (2020) have cautioned that although WhatsApp is widely used and available, even in rural settings, not all learners will have access to it.

The finding that WhatsApp is used by rural teachers for blended learning is significant because it underscores rural teachers' agency. Showing initiative and innovation in response to challenges that they face while teaching in the rural setting. The study frames this as 'spontaneous blended learning', because teaching and learning activities on the WhatsApp group are both informal and unplanned. According to Lalima and Lata Dangwal (2017), setting up and practising blended learning is rigorous, requiring fundamental preparations across all aspects of the teaching and learning process. Moreover, all the teachers in the study have confirmed that they have not received any formal training in teaching and learning with digital tools and applications. But they have felt comfortable enough with WhatsApp to repurpose it as a pedagogical tool, as they already use it regularly to communicate with family and friends. However, familiarity with the application does not translate to technological and pedagogical proficiency. Lalima and Lata Dangwal (2017) indicate that teacher training is a prerequisite for the successful implementation of blended learning. Teachers should be trained to develop and structure content for digital platforms and to efficiently utilise them for teaching and learning. Further, Rambe et al. (2020) caution that teachers need to plan learning activities to maximise WhatsApp's pedagogical potential.

Although pedagogical activities were not planned, this does not negate the ELO offered to rural learners. Its pedagogical use plays a significant supportive role in teaching and learning (Nyamupangedengu et al., 2023), particularly in the rural setting that sits on the negative end of the rural divide (Amnesty, 2020). In the Grade 12 subject analysis report, the DBE states that ICTs should be used to enhance and support the teaching and learning of Physical Sciences, as they improve learners' understanding of scientific concepts and enhance learner performance (Department of Basic Education, 2024). However, the literature has recognised that rural settings lack digital learning

opportunities, rendering the DBE's suggestion unattainable for rural teachers and learners (Amnesty, 2020; Baloyi et al., 2023).

Using WhatsApp for blended learning benefits both learners and the school. It has a transformative potential, offering rural teachers and learners the opportunity to embrace technology for education and strengthen networked learning (Department of Education, 2004; Poon, 2013).

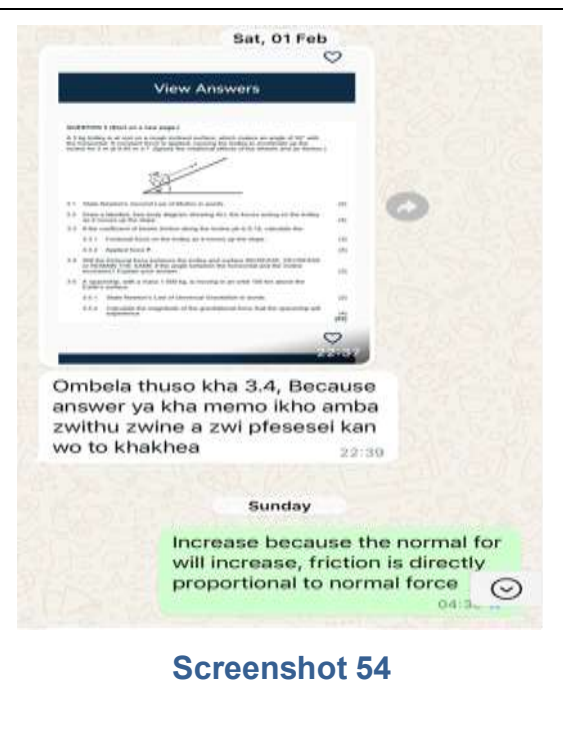
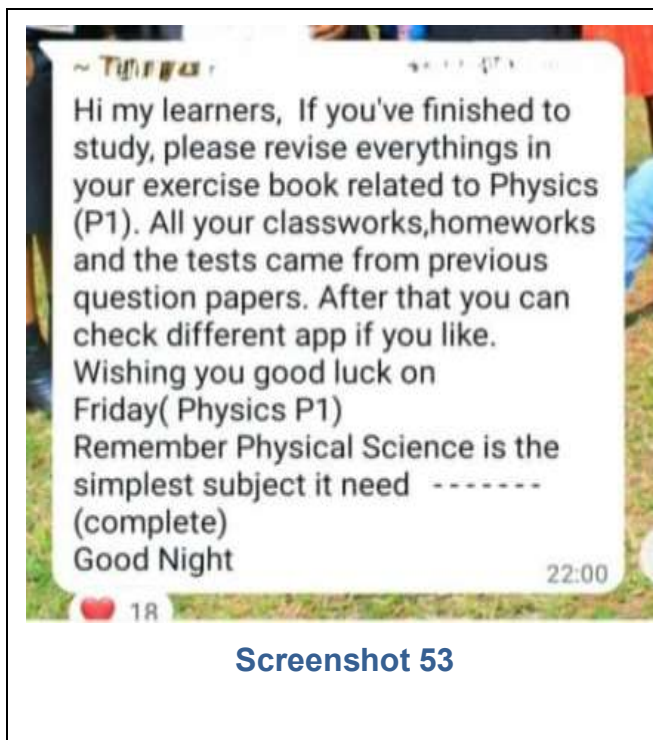
Accessibility beyond classroom walls

The study found that WhatsApp enables T1, T2, T3, and T4 learners to communicate and share information and learning materials even after school hours and from any location. This means that teachers and learners can connect and continue interactions after the school day ends while in the convenience of their own homes. For example, teachers can send reminders, notes, explanations and various learning materials at any time of day. In the same way, learners can also ask questions or share resources and information regardless of the time of day, or day of the week.

This finding suggests that WhatsApp's adaptation as an educational platform makes learning possible and accessible through teacher-learner interactions after school hours and not limited to a classroom. It indicates that learning opportunities are extending beyond the classroom, as teachers and learners can interact at any time and from anywhere. The literature describes WhatsApp as a ubiquitous learning application that enables teaching and learning that transcends temporal and spatial boundaries. Jahnke says that, in the digital age, teaching and learning are no longer restricted to a physical classroom; learning occurs through building learning networks that support learning in virtual space. Further, studies show that WhatsApp supports both synchronous and asynchronous communication, which is particularly significant in areas with low or unreliable network coverage, such as rural settings. However, WhatsApp is not a zero-rated application, meaning users still incur data costs to access the platform. Moreover, WhatsApp is available only on smart devices, meaning that learners who can afford data and/or have access to WhatsApp-enabled devices will not be able to use the application.

This means that not all learners in rural schools will be able to gain access, reinforcing inequalities.

However, repurposing WhatsApp for learning opportunities has resulted in T1, T2, T3 and T4 working beyond their professional hours. Having a boundless, virtual community of learning has created the expectation that teachers are available to help at any time, on any day of the week. WhatsApp chat logs show teachers and learners interacting throughout the day, on weekends, and even on school holidays. Below are screenshots showing interaction at various times of the day.



Screenshot 53 show T1 sending a revision guidance and well wishes for an upcoming exam at 22:00. In screenshot 54, a learner asks a content-based question on solving a physical science problem on Saturday at 22:29 and the teacher responds to the question on Sunday at 04:30. Both these screenshots demonstrate accessibility beyond classroom walls as T1 and T2 can interact with learners during non-school hours.



Screenshot 55



Screenshot 56

Screenshots 55 shows T3 sharing pictures with questions and answers sometime past 22:00, and screenshot 56, T4 shares a summary on Doppler's effect and grade 12 question paper at 01:07. Both screenshots 55 and 56 demonstrate accessibility beyond the classroom walls as teachers can share learning material during after-school hours, which can be very late at night or very early in the morning.

In response to the learning network interacting at any time, teachers' responses indicate that it interferes with their personal time. The following excerpts from the teachers explain how it interferes with their personal time.

Teacher 1

Leaners don't want to study on their own, sometimes they send your questions that they have not even attempted to solve and that time you are at home

- Teacher 2 What I dislike about using WhatsApp with my learners is that they can contact me at any time. They can send messages around 12 pm, and at that time, I am sleeping. Sometimes they even call and keep quiet*
- Teacher 3 Particularly around exam time, and when learners are studying, the WhatsApp group gets busy. Since learners can reach me on WhatsApp, the downside is that it often consumes my personal and family time.*
- Teacher 4 Learners always think you are available, and sometimes you are busy with your own things, and they expect you to help them*

The teacher's response highlights a key constraint of accessibility beyond classroom walls namely interrupting personal time and boundaries. While WhatsApp can support continuous access to academic communication, learning resources and support, this also creates unfair expectation of unlimited teacher availability.

T1's comment suggest that learners may became too reliant on teachers, contacting teacher without first attempting to solve a problem themselves. T2, T3 and T4 's interview response show that communication can become intrusive particularly when it's done late hours. However, the screenshots 53,55 and 56 show that the teachers themselves send message after school hours.

Ironically, the teachers' responses indicate that the teachers may be annoyed that learners have unlimited access to them when they have stated in RQ1 that their intention for the WhatsApp groups was to make themselves accessible and available to learners. It shows they underestimated the effort required to extend learning opportunities via WhatsApp, which provides learners with unlimited access.

The findings indicate that the pedagogical use of WhatsApp to extend learning opportunities increases rural teachers' workloads and working hours, as a trade-off for expanding their reach. This has been discussed as a negative outcome of using WhatsApp to support learning. (Durgungoz & Durgungoz, 2022; Segal & Biton, 2024). This aspect can be attributed to the nature of the WhatsApp application, which is essentially a social tool where people can socialise at any hour of the day.

Low-Cost and Widely Available Technology

The study found that T1, T2, T3, and T4 have repurposed WhatsApp into an educational platform because they have technical affordances that make them a viable option for extending learning beyond the classroom. Below are excerpts from teachers explaining why they chose WhatsApp as a communication medium with learners.

- T1* I chose to communicate with my learners because I use WhatsApp and they use WhatsApp too; it makes it easy to communicate with them because it's an application that both my learners and I are already using.
- T 2* Everybody uses WhatsApp nowadays. I am using WhatsApp, and my learners are also using WhatsApp. Those who do not have their own phones use their guardians' WhatsApp to access the group. Other application charges a lot of data for access, but with WhatsApp, you don't need a lot of data. However, I do know that not all my learner has access to WhatsApp
- T 3* At my school, all the teachers have WhatsApp groups with their learners. It's how we communicate nowadays. My learners use WhatsApp and I use WhatsApp; it makes it easy and practical.

T 4 My learners and I use WhatsApp, and its cheap because they can buy a WhatsApp ticket for about R30, and they can access WhatsApp the whole month.

The teacher's responses indicate that WhatsApp is widely used, even in their context. All the teachers state that it is an application that both the learners and they have been using. This indicates that WhatsApp use is prevalent, particularly for social communication. T2 and T4 also highlight the application's affordability in terms of data usage. T2 mentions that WhatsApp has lower data consumption than other available applications, and T4 mentions that learners can use a WhatsApp data ticket, which costs around R30.00 for a month's access.

The teacher's responses indicate that WhatsApp is both affordable and widely used, even for rural communities. Their familiarity with the application has made WhatsApp a viable option for educational purposes. Studies confirm that WhatsApp is a low-cost app widely used by individuals for personal communication. Because of these affordances, it has even been used by individuals of low socioeconomic status in rural schools. Because WhatsApp is readily available, as teachers and learners already use it in their personal lives, it presents fewer implementation and adaptation challenges (Ujakpa et al., 2018). And particularly because WhatsApp is low-cost and easy to use, studies have highlighted that it is suitable for use as a learning network even in rural settings (Adams, 2019; Bouhnik & Deshen, 2014; Rambe et al., 2020)

Overall, the study found that WhatsApp provides both pedagogical affordances. The pedagogical affordances lie in how the application enables teaching and learning actions possible beyond the classroom. This includes enabling a community of learning, resource sharing and providing supplementary learning support. Whereas the technical affordances refer to making certain actions possible, such as low cost, accessibility, and simple operation.

4.4 CHAPTER SUMMARY

In this chapter, the researcher presented and interpreted the findings from qualitative data collected through teacher interviews, learner focus group discussions, and WhatsApp chat logs. The analysis identified key themes that addressed the research question, highlighting how rural teachers make sense of WhatsApp for ELO beyond the classroom and its affordances and constraints. Guided by Connect-ivity, the chapter examined teachers' perceptions and use of creating WhatsApp groups, as well as the pedagogical activities that occurred within these groups. The study also examined the affordances of WhatsApp for ELO as a rural learning network and their implications. The next chapter summarises the main findings and concludes the study.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter, the researcher summarises the key findings drawn from Chapter 4. These findings also serve as the basis for the recommendations provided later in the chapter. The purpose of the study was to investigate how teachers used WhatsApp to extend learning opportunities in Physical Sciences to mitigate the challenges rural schools face. This case study focused on rural secondary school teachers in the Vhembe District. The theoretical framing of this study was provided by the conflation of Connectivism and Cultural-historical activity theory to form the portmanteau Connect-ivity. Interviews with teachers and learners, and WhatsApp chat logs, were used as data sources. Overall, the findings show a simplistic sense-making of WhatsApp that was grounded in its potential affordances.

By reflecting on the broader implications of the pedagogical use of WhatsApp for rural education, the study concludes by suggesting practical recommendations including making WhatsApp more profitable as an educational tool for education stakeholders. These educational stakeholders include the educational department, schools, teachers, parents, and learners, for future research. In concluding this chapter, the researcher also discusses the study's limitations.

5.2 SUMMARY OF THE STUDY'S KEY FINDINGS

Research question 1: How do rural teachers understand the use of WhatsApp to provide ELO?

In relation to research question 1, the study investigated teachers' sense-making of WhatsApp for ELO in Physical Sciences and found that rural teachers demonstrated a relatively simple, unsophisticated pattern of use. The teacher's construction of WhatsApp was through a tool-to-medium lens, using the application for communication and as a pedagogical resource. The key findings from research question 1 are summarised below under the themes as documented in chapter 4.

5.2.1 WhatsApp as a communication medium

The study found that rural teachers primarily perceived WhatsApp as a communication medium for interacting with learners. It served as a link to convey messages from teachers, materials, equipment, or activities to create conditions for learners to successfully complete the learning process (Lubis et al., 2023). Teachers used the medium as a link to interact with learners, sharing school and learning-related information. In this way, teachers have primarily seen WhatsApp as a communication tool rather than a learning platform. This view limited their effective use of WhatsApp's affordances. The Connect-ivity framework presented several opportunities for using WhatsApp. For example, the teachers had opportunities to create activities that promoted division of labour, so that all learners could be connected/linked and actively engaged. Because teachers focused mainly on communication, the potential to optimise WhatsApp for ELO was not fully realised. This reflects current teacher practices and exposes a lack of knowledge about using digital tools for learning, which may change with exposure to training and professional development.

The findings indicated that, initially, the WhatsApp platform was adopted by teachers and learners as a communication medium due to the COVID-19 pandemic. During this period, face-to-face instruction and schooling were suspended. Teachers used the WhatsApp group to connect with learners virtually to discuss schoolwork and class schedules and to provide academic guidance. Because teachers and learners were already familiar with WhatsApp, using it personally for social communication, adopting WhatsApp for teacher-learner interactions was easier, posing minimal challenges for implementation. Learners

who did not own smartphones were linked via their parents' devices, making WhatsApp a practical and accessible solution in rural contexts.

Further, the study revealed that even post-COVID era, when schooling had resumed, teachers continued to use WhatsApp as a link to communicate with learners after school hours. Teachers used the platform to send reminders about test dates, clarify instructions, and share school- and learning-related information, including Department of Education communications and documents. The continuous interaction enabled learners to receive timely, up-to-date information, helping them remain engaged and supported in the learning process outside of school hours.

Teacher-learner communication, particularly outside of school hours, is significant in the rural context because learners may lack parental involvement and limited academic support, leading to lower academic success (Chowdhury, 2014; Amnesty, 2020). Communication, as highlighted by Segal and Biton (2024), is foundational to effective teaching and learning, as learning is impossible without it. In this way, WhatsApp extended learning primarily through communication, where teachers shared school and learning-related information with learners, keeping learners engaged in the learning process. However, some learners are excluded from participation because of unequal access to technology (Rambe, Chipunza & Ng'ambi, 2020)

This finding has been supported in the literature, with studies confirming that teachers have employed WhatsApp in the educational setting for facilitating communication and increasing interaction outside of school hours (Adams, 2019; Bouhnik & Deshen, 2014; Nuray ZAN, 2019). Even in low socio-economic and digitally constrained rural settings, WhatsApp has proven to be a practical tool for facilitating communication. Using WhatsApp to facilitate teacher-learner communication helps learners access updated and relevant information, reducing uncertainty and learner disengagement (Nuray ZAN, 2019).

Although rural teachers primarily used WhatsApp for communication, studies suggest that the application's role often expands to supporting pedagogical activities, cultivating a learning environment and promoting social cohesion (Bouhnik & Deshen, 2014).

5.2.2 WhatsApp as a medium for proxy virtual social presence

The study revealed that teachers conceptualised WhatsApp as a medium for maintaining a virtual social presence. Teachers are available through the WhatsApp platform, which is through digital means as opposed to physically being present. Teachers deliberately used WhatsApp to enable learners to access academic support at any time and from any location. This meant that teachers remained visible and within reach, enabling learners to have access to teachers beyond formal school hours. Learners asked questions, and teachers responded either immediately or within a short time. During these out—of—school interactions, teachers confirmed information about class schedules, clarified misconceptions and errors in memorandums, and explained physical science concepts. It also reduces anxiety for learners who may be shy to ask question in the classroom. In this way, the WhatsApp platform enabled teachers to extend their presence by interacting with learners in a virtual space from at time and from any location, allowing continuous academic engagement and support after school hours.

Importantly, virtual accessibility was seen as a significant factor in extending learning opportunities, as studies indicate that rural learners often face limited opportunities for individualised academic consultation due to overcrowded classrooms and heavy teacher workloads (Amnesty, 2020; Baloyi *et al.*, 2023). By extending their presence, teachers were available to assist learners timeously when needed, reducing the gap between home and school.

The findings are consistent with existing literature, which indicates that WhatsApp promotes teacher accessibility through synchronous and asynchronous communication (Alabdulkareem, 2015; Cetinkaya, 2017; Durgungoz & Durgungoz, 2022). Particularly in

rural contexts with limited network connectivity, WhatsApp's low data requirements make it a practical option for sustaining academic interaction. The WhatsApp platform allows teachers to be available to learners for consultation on school and learning-related matters.

WhatsApp as a pedagogical tool

The study found that teachers conceptualised WhatsApp as a pedagogical tool used to provide the following: (i) Access to learning resources and (ii) Instructional support beyond the classroom.

5.2.3 WhatsApp for providing access to learning resources.

The findings showed that teachers perceived WhatsApp as a platform for distributing teaching and learning resources-digital learning tools. Because of the resource constraints that rural teachers faced, such as insufficient teaching and learning resources, they used the WhatsApp platform to enable learners to access revision and experiential resources.

Rural teachers reported having inadequate laboratory resources which are required for successful physicals sciences experiments. This limits learners' potential to acquire content knowledge through practical activities. In response to this, teachers sent links or videos and simulations that allowed learners to experience experiential moments by watching the videos or engaging in virtual simulations. This is commendable. However, there was no formal activity to engage learners in using the tools, which limited the potential of WhatsApp to extend learning opportunities beyond the classrooms. Further, the ad hoc use of WhatsApp, limited rules, the lack of the object of the activity, and the outcomes of the activity all contributed to the unsophisticated use of WhatsApp as an instruction tool.

Another important resource challenge was the limited availability of learning and revision materials. Teachers believed that using previous question papers is advantageous for

revision and exam preparation, including past papers, question papers, study guides, and links to videos and simulations of experiments. The teachers' use of WhatsApp for distributing learning materials via WhatsApp groups enabled them to have access to them after school hours, and it also enabled the teachers to counteract resource challenges that were experienced in the school. Due to limited opportunities for conducting experiments that are because of inadequate laboratory resources, the rural teachers used the platform to enable learners to simulate these experiences through videos or virtual simulations. Teachers sent video and simulation links for learners to visit while at home.

Another important resource challenge stemmed from the limited availability of learning and revision resources. Although these teachers reported having textbooks at their disposal, they were found to be inadequate for explaining some concepts. Not all textbooks explained concepts the same, and some textbooks have had to understand definitions. Having ample learning materials allows teachers the opportunity to curate and present learners ways to better understand concepts. The other issues arose from the inability to make sufficient copies of previous question papers for learners' revision and exam preparation. The study found that WhatsApp enabled teachers to effortlessly distribute question papers, study guides and notes beyond the classroom. In this way, WhatsApp provide ELO through the provision of learning resources outside the rural classroom.

These findings are consistent with broader literature highlighting WhatsApp's effectiveness in disseminating learning materials, particularly in low-resource contexts (Abualrob & Nazzal, 2019; Adams, 2019; Rambe et al., 2020). Given that rural schools often struggle with limited teaching and learning resources, an issue linked to low academic performance (Baloyi et al., 2023; TIMSS, 2023), WhatsApp serves as a practical tool for bridging resource gaps. Physical Sciences education relies heavily on experimental engagement as emphasised in CAPS; thus, the use of virtual experiments represents a meaningful pedagogical adaptation in constrained contexts.

5.2.4 WhatsApp as an instructional tool

The study revealed that rural teachers have understood WhatsApp as an instructional tool. It was used for direct teaching and learning activities, such as assigning classwork, homework, and other assignments, and for corrections and concept clarification. Teachers used the application to extend teaching and learning beyond the classroom. This meant that teachers used WhatsApp to extend the school day by allocating additional instructional time to complete curriculum-compliant content.

The study also found that teachers go beyond classroom-based instructions to offer learners individualised learning support. Learners can ask clarity-seeking or problem-solving questions at home about content they do not understand and receive assistance from the teacher or other learners in the group. In this way, teachers extend learning support beyond the classroom.

Using WhatsApp as an instructional platform meant that teachers could counteract the time constraints they faced in the rural classroom, as there was not enough time to thoroughly cover concepts. Studies confirm that WhatsApp functions as a learning environment, housing classroom-based instruction activities which enable learning to go beyond normal school hours (Cetinkaya, 2017; Jere, Jona and Lukose, 2019; Durgungoz and Durgungoz, 2022). In this way, WhatsApp can help extend the time spent on teaching and learning. However, studies have been concentrated in higher institutions of learning, with limited studies focusing on its pedagogical use in basic education (Ibrahim*, Hafiz and Musa, 2018; Awal and Imam, 2023). Studies also caution that WhatsApp is not recognised as an official learning platform and is not designed to meet academic needs. And so, learning activities through the platform cannot be recorded (Romero-Saritama, Espinosa-Tapia and Palacios-Rodríguez, 2025).

Research question 2: What affordances does WhatsApp provide for ELO for learners in rural schools?

In relation to research question 2, the study investigated the affordances of WhatsApp for ELO. The findings demonstrated that the application's use extended beyond mere

utilisation by teachers, showing how its features actively enabled participation in mobile/online learning. The study found that WhatsApp afforded the following: (i) a Networked community of learning, (ii) Accessibility beyond classroom walls, (iii) Low-cost and widely available technology, and (iv) Resource sharing and supplementary support.

5.2.5 Networked Community of Learning

The study found that WhatsApp created a learning community in which teachers and learners connected outside school hours. The learning network is multifaceted, with both academic and social aspects that work together to strengthen it. In this learning network, communication is bidirectional, as both teachers and learners act as nodes, sources of knowledge, reflecting the connectivity framework (Siemens, 2004). Even in closed groups where only teachers can post, learners use emojis to communicate. Emojis are an acceptable form of communication, allowing users to respond quickly instead of writing out words.

Considering the learning aspect of the learning network, the study found that WhatsApp functions as a central node, connecting teachers, learners, information, and resources beyond the classroom. Furthermore, knowledge is distributed among its members; the responsibility for providing resources or knowledge content is distributed throughout the network, with both teachers and learners serving as knowledge contributors (Siemens, 2004). This was evident when learners also shared resources such as notes, question papers, and memorandums with the group.

Furthermore, having learners as knowledge sources created conditions for peer collaboration and learning. However, the study found that learners did not optimise opportunities for peer collaboration, even when prompted by the teacher, contrasting with studies that confirm that WhatsApp promotes peer collaborative learning.

The learning network had a considerable social aspect, from greetings and the use of terms of endearment, to sharing personal events and information. Although these activities are not directly linked to learning, they support group functioning by sustaining

connections between members (Adams, 2019; Chirinda, Ndlovu and Spangenberg, 2021; Durgungoz & Durgungoz, 2022).

However, due to the social aspect of the learning network, off-topic and unwanted social discourse that neither supports learning nor group functioning was experienced. Studies caution that irrelevant messages pose a drawback in academic WhatsApp groups, which can be attributed to learners perceiving WhatsApp as a social communication tool (Romero-Saritama, Espinosa-Tapia & Palacios-Rodríguez, 2025).

Resource sharing and Supplementary support

The study found that WhatsApp affords rural teachers and learners some access to diverse digital teaching and learning resources and provides supplementary support beyond the classroom. These teaching and learning resources include study guides, previous question papers, notes, videos, and simulations. These are shared in various formats, including images, PDFs, simulations, and video links. This is significant as it demonstrates a shift from a resource-challenged classroom to focusing on capability. WhatsApp enables teachers and learners to share a variety of learning resources.

Providing resources enabled teachers to offer additional learning outside the classroom. Learners were able to access materials that supported exam preparation and revision, including past examination papers. It also helps learners build content knowledge in Physical Sciences through videos and simulations.

The study also found that how teachers use the platform to share learning resources and provide supplementary support randomly, in an ad hoc manner, as teachers do not plan these ELO. Caution that a lack of structure in digital education reduces its effectiveness (Lalima & Lata Dangwal, 2017).

Within the Connect-vity framework, WhatsApp is both a mediating tool within the rural activity system (Engeström and Sannino, 2021) and understood to be enabling learning through networks (Siemens, 2004). As a tool, it mediates the relationship between teachers and learners (subject), the pursuit of understanding physical science concepts

(object) and ELO (outcomes) (Engeström and Sannino, 2021). In its role of enabling learning through networks, WhatsApp becomes central in connecting teachers, learners, information and learning resources across a network (Siemens, 2004).

The literature confirms that WhatsApp affords teachers and learners access to diverse teaching and learning materials (Adams, 2019; Rambe, Chipunza and Ng'ambi, 2020). This is significant considering the resource challenges faced by rural schools. Due to its multimodal design, WhatsApp makes it effective for distributing diverse teaching and learning resources. However, the ability to access these resources and provide supplementary support depends on learners having access to mobile devices and data connectivity. Not all learners have access to smartphones or data, which further widens inequalities, as not all will be able to access resources (Rambe, Chipunza and Ng'ambi, 2020).

Accessibility beyond classroom walls

The findings revealed that WhatsApp enabled accessibility beyond classroom walls, as teachers and learners could connect and interact outside school hours. During these interactions, teachers and learners engaged in teaching and learning activities such as sharing learning-related information, providing explanations, clarifying physical science concepts, and sharing learning resources, regardless of the day of the week or time of day.

This finding suggests that pedagogical adaptation of WhatsApp extends learning opportunities beyond the classroom, as teachers and learners can interact at any time and from anywhere. This finding is supported by the fact that learning is not restricted to a physical space, as WhatsApp allows it to transcend temporal and spatial boundaries (Adams, 2019). However, boundless interaction led to increased working hours for teachers, as they assisted learners beyond their professional working hours (Durgungoz and Durgungoz, 2022; Segal and Biton, 2024).

Low-Cost and Widely Available Technology

The study found that teachers have repurposed WhatsApp as an educational platform due to its technical affordances. The platform is low-cost, widely available and low in data consumption. This makes WhatsApp practical, suitable, and readily available for use even in low socio-economic contexts, such as rural settings. Because it is widely available, both teachers and learners are already using it in their personal capacity. This makes adapting WhatsApp for educational use less challenging to implement. However, it is worth noting that not all learners have access to WhatsApp.

Literature concurs with this finding, indicating that teachers and learners are familiar with the application because they have been widely by individuals for communicating with friends and family (Ujakpa et al., 2018). Particularly, this is an application that has been embraced by the youth. Further, the application is affordable and accessible to most teachers and learners, even in the rural context. Furthermore, because WhatsApp supports both synchronous and asynchronous communication, it is able to facilitate accessibility beyond the classroom walls in the rural setting, which often has low or unreliable network coverage. However, WhatsApp is not a zero-rated application, as users still incur data costs, which means that it is not accessible to all users.

5.3 RECOMMENDATIONS

Based on the key findings of this study, several recommendations were developed to improve teachers' use of WhatsApp for ELO, particularly in rural school contexts such as those in the Vhembe district. While acknowledging that WhatsApp is an informal, officially unrecognised platform used for learning, the findings indicate that it can be used to enhance teaching and learning in Physical Sciences. This makes the inclusion of WhatsApp in formal instruction worthwhile. The focus of these recommendations below is on improving how WhatsApp is accessed and adapted to support teaching and learning.

- **The Department should acknowledge grassroots initiatives as part of their plan for e-education.**

The Department of Education (DoE)'s proposal to equip every learner with some form of ICT by 2013 (Department of Education, 2004) has not been realised because of the significant investment required (Department of Basic Education, 2024b; UNESCO, 2023). Because of this, the study recommends that the education department formally acknowledge and support the use of WhatsApp and similar applications as part of the national e-education strategy. Although teachers and learners have independently adopted WhatsApp to enhance educational processes and experiences, it remains largely informal, unregulated and unsupported. By recognising such grassroots innovation and initiatives, the DoE can harness readily available tools to promote access to e-education. Moreover, the Department of Education can also offer official support, which includes leveraging for real-time, low-data communication, hosting virtual classes, offering personalised learner support, and distributing curriculum content directly.

- **Education stakeholders to collaborate to improve access to mobile devices and connectivity.**

Due to the WhatsApp platform's requirement for mobile devices and data connectivity for learners to access the application, the study recommends that key education stakeholders, such as the Department of Education and schools to collaborate with non-governmental organisations, local businesses, and communities, with a focus on improving access. Network providers like Vodacom, MTN, Cell C and Telkom can be engaged to consider either subsidised or zero-rated educational WhatsApp data. Schools could further collaborate with companies or businesses for assistance with providing access to affordable mobile devices to benefit learners who are excluded from participation due to a lack of access.

Furthermore, the Department of Education should support WhatsApp education by integrating it into official digital strategies, such as the Teacher Connect WhatsApp line.

- **Professional teacher training and development in mobile and blended learning.**

The study recommends that structured development programs be designed and implemented to equip teachers to successfully use WhatsApp and similar mobile applications to support learning. The study demonstrated that teachers use WhatsApp independently to support learning; however, this was done spontaneously, which may reduce effectiveness. Through training, the education department can equip teachers with the necessary knowledge and skills to effectively use WhatsApp and similar technologies to support and enhance pedagogical processes. It will also assist teachers in moving beyond perceiving WhatsApp as a communication tool to a potentially interactive learning environment.

- **Teachers should structure their pedagogical use of WhatsApp.**

The study recommends that teachers adopt a structured, planned approach to using WhatsApp for ELO. The findings indicated that teachers in rural schools have successfully initiated learning networks through WhatsApp and have sustained them over a long period. However, these practices largely remain spontaneous, lacking clear direction in how they are intended to support educational aims. Teachers should therefore play a more active role in structuring educational activities to fit into their overall pedagogical approach.

- **Recommendations for schools, parents and learners**

The study recommends that schools, parents, and learners should play a more active role in how they use WhatsApp as a learning platform. Given WhatsApp's potential for pedagogical use in schools, it would be worthwhile for schools to engage parents and learners on how it can be used to support teaching and learning, particularly outside school hours.

Firstly, schools should engage parents and discuss the values of academic WhatsApp groups with them. This will allow parents to understand how best to support and assist learners, whether it's by providing access to the platform, the devices needed, and data for connectivity, or by monitoring to ensure learners take full advantage of the academic WhatsApp group for learning.

Secondly, because the findings showed that learners usually interact socially even in academic WhatsApp groups, this suggests they may not be aware of how a simple mobile application like WhatsApp can be used to enhance and support learning. For such cases, the study also recommends that schools engage learners in meetings to explain to them the value of the pedagogical use of WhatsApp. Learners should also be made aware of the importance of participation in such groups, as well as the appropriate behaviours expected within them.

5.4 RECOMMENDATIONS FOR FUTURE RESEARCH STUDIES

While the study provided insights into how rural teachers use WhatsApp pedagogically to create ELO in Physical Sciences, it had limitations that warrant further investigation. Through qualitative inquiry, the study used in-depth and multiple case studies, primarily focusing on teachers and investigating teachers' sense-making of WhatsApp for ELO and its affordances. The study did not capture the impact of these activities on learning and learner achievements. Given the study's scope, contextual limitations, and issues that emerged from the findings, the study suggests several directions for future research. Further investigations are necessary to deepen understanding of the pedagogical use of WhatsApp and to broaden its applicability and implementation. Below, the following recommendations outline key areas for future researchers.

- **The Impact of the pedagogical use of WhatsApp on learner performance**

Using quantitative or mixed-methods studies, researchers could investigate whether using WhatsApp has a measurable impact on learner performance, particularly in high-stakes examinations such as the grade 12 Physical Sciences.

- **Expanding to other learning areas and grades**

Future research projects could investigate the pedagogical use of WhatsApp in other learning areas and across varying grade levels to determine if similar sense-making patterns and affordances emerge.

- **Policy and regulation of WhatsApp for pedagogical use**

With the increased adaptation of WhatsApp for pedagogical use, future research studies could examine how schools and the education department could develop policies for regulation. With the aim of balancing innovation, teacher and learner protection, as well as accountability when using this application for teaching and learning.

- **Training and professional development of teachers**

Research could investigate how teacher training on digital tools and applications influences the use of WhatsApp as a blended learning model in rural schools.

5.5 LIMITATIONS OF THE STUDY

The study faced several limitations, either due to the selected methodological design or factors encountered during data collection that affected the study's outcome.

- **Methodological constraints**

The study had a qualitative orientation, using multiple case studies that prioritised in-depth understanding over generalisability. This approach provided detailed insight but restricted the extent to which the findings can be applied to larger populations because it is restrictive of the number of cases that can be studied.

- **Sampling limitations**

The study was conducted in a limited number of schools, mostly rural, with only a small group of teachers and learners. While this is allowed for an in-depth investigation into teachers' and learners' experiences, the findings do not reflect all teachers' and learners' experiences across the Vhembe District or rural schools across South Africa.

- **Depending on self-reported data**

Interviews and focus group discussions were used for data-collection in conjunction with WhatsApp chat logs; this meant they were subject to participants' perceptions, memories, and willingness to disclose information. Teachers and learners may have shared socially desirable responses, particularly when discussing how they use WhatsApp for ELO.

- **Ethical clearance delays**

The Department of Education gave permission late in the academic year; at this time, schools were focused on exam preparation and writing. To avoid disrupting both teachers and learners during this period, the study opted for telephonic rather than face-to-face interviews. It also limited the time frame in which the study was conducted. However, because the researcher collected chat logs spanning the existence of each WhatsApp group, the study could examine interactions over a long period, thereby increasing its credibility.

- **Time Limitations**

Considering that not all learners have access to WhatsApp, this means that the study only captured the experiences of the learners who had access to WhatsApp, potentially overlooking the practices and experiences of learners who were excluded.

- **Researcher interpretation.**

As expected in qualitative research design, the interpretation of the data is influenced by the researcher's analytical perspective (Creswell & David Creswell, 2022). To counteract this, efforts were made, such as peer debriefing and participant validation, to reduce risk and ensure trustworthiness.

5.6 CONCLUSIONS

The study set out to investigate rural teachers' use of WhatsApp to create Extended Learning Opportunities in Physical Sciences to mitigate the challenges that rural schools encounter. Using the Connect-ivity framework, the study analysed and presented findings that considered the contextual factors associated with these WhatsApp groups and the implications of digital applications for learning.

Based on the research questions, the study explores rural teachers' sense-making of WhatsApp for ELO and its affordances. The findings indicated that teachers' sense-making is formed at the intersection of (i) The contextual factors such as resource and time constraints experienced in the rural school setting, (ii) Their professional obligations and (iii) Widespread use of WhatsApp. Teachers used WhatsApp simply and uncomplicatedly, viewing it as a medium and a tool. The findings indicated that the application was used for communication, for sharing school and learning-related information. As a proxy of virtual presence, enabling teachers to remain visible and within reach when learners need assistance.

Rural teachers also viewed it as a pedagogical tool for sharing learning resources that addressed the resource challenges rural schools encountered and for providing instruction beyond the classroom. This enabled teachers to extend the rural classroom and support learning outside school hours.

The findings demonstrated that WhatsApp boasts of affordances that make it practical and suitable for rural contexts. The application is low-cost and widely spans a diverse population of rural teachers and learners. The application enables a learning network where teachers and learners engage in pedagogical and social activities that strengthen

the network. However, some social content is unwanted and does not support the group's functioning. The Application provides access beyond classroom walls, as teachers and learners can interact with each other at any time and from anywhere. This was particularly significant for rural learners, as they may have access to academic support elsewhere.

Another important finding was that WhatsApp provides rural teachers and learners with access to diverse teaching and learning resources through its multimedia capabilities.

However, the study has highlighted key challenges in implementing WhatsApp for ELO. Because of a lack of training in digital tools, teachers lack a clear structure for using WhatsApp to support the pedagogical process, possibly reducing its effectiveness. And having a boundless interaction platform has led to increased working hours for rural teachers. Teachers and learners interact at any time of the day, any day of the week, infringing on teachers' personal time.

Ultimately, the study contributes to the broader scope of knowledge concerning WhatsApp and similar technologies in learning. Particularly, mobile learning /blended learning in rural schools. It underscores the importance of grassroots initiatives and innovation in finding alternatives to enhance and support rural education.

Finally, it is hoped that this study will inform the formulation of policies and regulations of informal mobile teaching and learning practices, either through WhatsApp or similar technologies. As a readily available tool, the study hopes that more schools, teachers and learners will harness WhatsApp pedagogically or similar applications to benefit the learners who may not be privy to alternatives.

5.7 CHAPTER SUMMARY

This chapter brought the study to a close by summarising and concluding on the findings presented in the previous chapter. By reflecting on the study's main aim, it highlighted the key findings on how rural teachers used WhatsApp to support and enhance teaching and learning of Physical Sciences in rural schools and outlined the implications. Based on these findings, the researcher made practical recommendations for the DoE, schools,

teachers, parents and learners, to improve future practices. It also suggested areas for future research. This chapter also acknowledged the limitations that were encountered in conducting the study. Lastly, this chapter highlighted the study's contribution to broadening the knowledge of teaching and learning through WhatsApp.

REFERENCES

Abualrob, M. & Nazzal, S., 2020. Using WhatsApp in Teaching Chemistry and Biology to Tenth Graders. *CONTEMPORARY EDUCATIONAL TECHNOLOGY*, 11(1 Retrieved from: DOI: <https://doi.org/10.30935/cet.641772>), pp. 55 -76.

Adams, J. D., 2019. WhatsApp with Science? Emergent CrossActionSpaces for Communication and Collaboration Practices in an Urban Science Classroom. *Emergent Practices and Material Conditions in Learning and Teaching with Technologies*, pp. 107-125.

Alabdulkareem, A. S., 2015. *Exploring the Use and the Impacts of Social Media on Teaching and Learning Science in Saudi*. [Online] Available at: <https://www.sciencedirect.com/science/article/pii/S1877042815030335> [Accessed July 2021].

Amnesty International, 2020. *BROKEN AND UNEQUAL, The state of education in South Africa*, London: Amnesty International Ltd.

Andreotta, M. et al., 2019. Analyzing social media data: A mixed-methods framework combining computational and qualitative text analysis. *Behaviour Research Methods*, Volume 51, p. 1766–1781.

Basic Education, 2011. *Curriculum and Assessment (CAPS): Physical Science 10 -12*, Cape Town: Department of Basic Education.

Basic Education, 2020. *NSC 2020 Diagnostic Report Part 1: Content Subject*, Republic of South Africa: Department of Basic Education.

Batiibwe, M. S. K., 2019. Using Cultural Historical Activity Theory to understand how emerging technologies can mediate teaching and learning in a mathematics classroom: a review of literature. *Research and Practice in Technology Enhanced Learning*, 14(12).

Bouhnik, D. & Deshen, M., 2014. WhatsApp Goes to School: Mobile Instant Messaging between Teachers and Students. *Journal of Information Technology Education: Research*, 13(Retrieved from: <http://www.jite.org/documents/Vol13/JITEv13ResearchP217-231Bouhnik0601.pdf>), pp. 217 -231.

Cetinkaya, L., 2017. International Review of Research in Open and Distributed Learning Process. *International Review of Research in Open and Distributed Learning*, 18(7), pp. 59 - 74.

Cetinkaya, L., 2017. The impact of WhatsApp use on success in Education. *International Review of Research in Open and Distributed Learning*, 18(7), pp. 60-70.

Chirinda, B., Ndlovu, M. & Spangenberg, E., 2021. Teaching Mathematics during the COVID-19 Lockdown in a Context of Historical Disadvantage. *Education Sciences*, 11(177).

Chowdhury, P., 2014. Students' discourse in a science classroom makes better learning: A different approach. *European Journal of Educational Sciences*, 1(2), pp. 334-348.

Cohen, L., Lawrence, M. & Keith, M., 2018. *Research Methods in Education*. 8th ed. London: Routledge.

Creswell, J. W. & Cresswell, J. D., 2018. *Research Design, Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed. London: Sage Publications.

Department of Basic Education, 2017. *Rural Education Policy*, Pretoria: Department of Basic Education.

Durgungoz, A. & Durgungoz, F. C., 2022. "We are much closer here": exploring the use of WhatsApp as a learning environment in a secondary school mathematics class. *Learning Environments Research*, 25(2), pp. 423-444.

Folasayo, A. L. & Olajide, I. . E., 2022. Effects of WhatsApp group learning platform on senior secondary school students' learning outcomes in Science, Technology, and Mathematics (STM) in Ekiti State, Nigeria. *Educational Research and Reviews*, 17(8), pp. 213 -218.

Foot, K., 2014. Cultural-Historical Activity Theory: Exploring a Theory to Inform Practice and Research. *Journal of Human Behaviour in the Social Environment*, 24(3), pp. 329-347.

Goldie, J. G. S., 2016. Connectivism: a knowledge learning theory for the. *Medical Teacher*, 38(10), pp. 1064-1069.

Hassan, M. A., 2021. *Research Population*. [Online] Available at: https://www.academia.edu/5563491/Research_Population [Accessed October 2021].

Hlabane, A. S., 2016. *An Exploration into Learning Difficulties Experienced by Physical Science Learners in South African Schools*. Free State: University Of Free State.

Ibrahim, A. A., 2018. Research Trends on the use of WhatsApp in Education: a content analysis. *The European Proceedings of Social & Behavioural Sciences*, 5(11), pp. 113 -122.

Igira, F. T. & Gregory, J., 2009. Cultural Historical Activity Theory. In: *Handbook of research on contemporary theoretical models in information systems*. s.l.:s.n., pp. 434-454.

Jahnke, I., 2015. *Digital Didactical Designs: Teaching and Learning in CrossActionSpaces*. s.l.:Routledge.

Jere, N. R., Jona, W. & Lukose, J. M., 2019. *Effectiveness of Using WhatsApp for Grade 12 Learners in Teaching Mathematics in South Africa*. South Africa, International Information Management Corporation.

John, M., 2019. Physical Sciences teaching and learning in Eastern Cape rural schools: Reflections of re-service teachers. *South African Journal of Education*, 39(1).

Klieger, A. & Goldsmith, L., 2020. Expanding physics learning beyond the classroom: a case study. *Physics Education*, 55(025004).

Kop, R. & Hill, A., 2008. Connectivism: Learning theory of the future or vestige of the past?. *International Review of Research in Open and Distance Learning*, 9(3).

Lune, H. & Berg , B. L., 2017. *Qualitative Research Methods for the Social Sciences*. 9 ed. London: Pearson.

Mertens, D. M., 2015. *Research and Evaluation in Education and Psychology: integrating diversity with quantitative, qualitative, and mixed methods*. 4th ed. Los Angeles: Sage Publications.

Muremela, G., Kutame, A., Kapueja, I. & Adigun, O. T., 2021. Retaining scarce skills teachers in a South African rural community: an exploration of associated issues. *African Identities*.

Nemadziva, B., Sexton, S. & Cole, C., 2023. Science communication: The link to enable enquiry-based learning in under-resourced schools. *South African Journal of Science*, 119(1/2).

Nkambule, T., 2022. Exploring working conditions in selected rural schools: teachers' experiences. *South African Journal of Education*, 42(1).

Ornstein, A. C. & Hunkins, F. P., 2016. *Curriculum: Foundations, Principles, and Issues*. England: Pearson Education Limited.

Phakeng, M., 2018. *UCT-VC Presentation by Candidate Prof Mamokgethi Phakeng* [Interview] (21 February 2018).

Pratama, H. & Kartikawati, S., 2017. The Effect of WhatsApp Messenger As Mobile Learning Integrated with Group Investigation Method of Learning Achievement. *International Journal of Science and Applied Science: Conference Series*, 2(1), pp. 164 - 173.

Rajan, F. K. M. et al., 2008. *Teaching of Physical Science Theory, Perspectives & Practice*. Mannanam, Kottayam: St. Joseph's Training College.

Roth, W. M. & Yew, J. L., 2007. Vygotsky's neglected legacy: Cultural-historical activity theory. *Review of educational research*, 77(2), pp. 186-232.

Salkind, N. J., 2010. *Encyclopedia of Research Design*. Volume 1 ed. California: Sage Publications.

Siemens, G., 2010. *TEDxNYED - George Siemens*. [Online] Available at: <https://youtu.be/4BH-uLO6ovI> [Accessed 20 06 2023].

Siemens, G., 2014. *Overview of connectivism - Dr George Siemens*. [Online] Available at: <https://youtu.be/yx5VHpaW8sQ> [Accessed 20 06 2023].

Siemens, G., 2017. *A Learning Theory for the Digital Age*. [Online] Available at: <https://pressbooks.pub/lidtfoundations/chapter/connectivism-a-learning-theory-for-the-digital-age/> [Accessed June 2023].

Statista, 2023. *Most used social media platforms in South Africa as of the 3rd quarter of 2022*. [Online] Available at: <https://www.statista.com/statistics/1189958/penetration-rate-of-social-media-in-south-africa/#statisticContainer> [Accessed June 2023].

Suarez-Lantaron, B., Deocano-Ruiz, Y., Garcia-Perales, N. & Castillo-Reche, I. S., 2022. The Educational Use of WhatsApp. *Sustainability*, p. 14.

TIMSS SA Newsletter, 2023. Inequalities in science achievement. *Equitable Education and Economies Research Division Human Sciences Research Council*, 8(2).

Triyanto, 2019. Understanding student participation within group learning. *South African Journal of Education*, 9(2).

Ujakapa, M. M. et al., 2018. *Using WhatsApp to Support Communication in Teaching and Learning*. s.l., IST-Africa.

Utecht, J. & Keller, D., 2019. Becoming Relevant Again: Applying Connectivism Learning Theory to Today's Classrooms. *Critical Questions in Education*, 10(2), pp. 107-119.

WhatsApp, 2023. *WhatsApp*. [Online]
Available at: <http://www.whatsapp.com>
[Accessed April 2023].

Yildirim, H. I. & Sensoy, O., 2016. The Effect of Science Teaching Enriched With Technological Applications on the Science Achievements of 7th Grade Students. *Journal of Education and Training Studies*, 6(9), pp. 53 -68.

LIST OF APPENDICES

Appendix A: University of Venda Ethical Clearance

ETHICS APPROVAL CERTIFICATE		RESEARCH AND INNOVATION OFFICE OF THE DIRECTOR
NAME OF RESEARCHER/INVESTIGATOR: Ms MN Mafadza STUDENT NO: 16000302 PROJECT TITLE: <u>Utilising WhatsApp for Extending Learning Opportunities in Physical Sciences by Rural Secondary School Teachers in the Vhembe District.</u> ETHICAL CLEARANCE NO: FHSSE/25/CSEM/09/1106		
SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS		
NAME	INSTITUTION & DEPARTMENT	ROLE
Dr M Tshepo	UNIVEN, Educational Studies	Supervisor
Ms MN Mafadza	UN-VEN, African Languages	Investigator- Student
type: Master's Research Risk: <i>Minimal risk to humans, animals, or environment (Category 2)</i> Approval Period: June 2025 – June 2026		
The Research Ethics Social Science Committee (RESSC) hereby approves your project as indicated above.		
General Conditions While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following: • The project leader (principal investigator) must report in the prescribed format to the RESC: – Annually (or as otherwise requested) on the progress of the project, and upon completion of the project. – Within 48hrs in case of any adverse event (or any action that interrupts sound ethical principles) during the course of the project. – Annually a member of projects may be randomly selected for an external audit. • The approved applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the RESC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited. • The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the RESC and new approval received before or on the expiry date. • In the interest of ethical responsibility, the RESC retains the right to: – Request access to any information or data at any time during the course or after completion of the project. – To ask further questions, seek additional information; Require further modification or monitor the conduct of your research or: the informed consent process; – Withdraw or postpone approval if: – Any unethical principles or practices of the project are revealed or suspected – It becomes apparent that any relevant information was withheld from the RESC or that information has been false or misrepresented. – The required annual report and reporting of adverse events was not done timely and accurately. – New institutional rules, national legislation or international conventions deem it necessary.		
ISSUED BY: UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE Date Considered: June 2025		
Name of the RESSC Chairperson of the Committee: <u>Prof. M. Mwa'e-Manjoro</u>		
Signature: <u><i>M. Mwa'e-Manjoro</i></u>		
 UNIVERSITY OF VENDA Private Bag X5050 Tlohoengwenou 0550		

Appendix B: Limpopo Department of Education Ethical Clearance



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE PREMIER

Office of the Premier

Research and Development Directorate

Private Bag X9483, Polokwane, 0700, South Africa

Tel: [015] 230 9910, Email: mokobij@premier.limpopo.gov.za

LIMPOPO PROVINCIAL RESEARCH ETHICS COMMITTEE CLEARANCE CERTIFICATE

REVIEW DATE: 17 SEPTEMBER 2025

PROJECT NUMBER: LPREC/219/2025: PG

**SUBJECT: UTILISING WHATSAPP FOR EXTENDING LEARNING OPPORTUNITIES IN
PHYSICAL SCIENCES BY RURAL SECONDARY SCHOOL TEACHERS IN THE
VHEMBE DISTRICT.**

RESEARCHER: MN MAFADZA

Chairperson: Prof I Swarts



Chairperson: Limpopo Provincial Research Ethics Committee

The Limpopo Provincial Research Ethics Committee (LPREC) is registered with National Health Research Council (NHREC) Registration Number REC-111513-038.

Note:

- i. This study is categorized as a Low Risk Level in accordance with risk level descriptors as enshrined in LPREC Standard Operating Procedures (SOPs)
- ii. Should there be any amendment to the approved research proposal; the researcher(s) must re-submit the proposal to the ethics committee for review prior data collection.
- iii. The researcher(s) must provide annual reporting to the committee as well as the relevant department and also provide the department with the final report/thesis.
- iv. The researchers will be required to make presentations of the study findings and recommendations at the Provincial Research Conference/Departmental Research Day.
- v. The ethical clearance certificate is valid for 12 months. Should the need to extend the period for data collection arise then the researcher should renew the certificate through LPREC secretariat. PLEASE QUOTE THE PROJECT NUMBER IN ALL ENQUIRIES

Appendix C: Interview Guide (Teacher)

Interview Guide	
Date	
Start time	End time
Venue	
Teacher	

A. Background Information

1. Can you tell me about your educational background and teaching experience?
2. Which learning areas and grades do you currently teach?
3. How would you describe the physical and educational environment of the school that you currently teach in?
4. Can you talk about your experience of teaching physical science in this school?
5. What are the main challenges you face in teaching Physical Sciences?
6. What resources are available to you for teaching Physical Sciences?
7. Can you talk about the teaching methods and strategies that you use in teaching Physical Sciences?
8. Have you received any training related to using digital tools/applications for teaching and learning?

B. WhatsApp uses in Physical Sciences

1. Can you talk about how your classes' WhatsApp group was established?
2. What has motivated you to start a WhatsApp group with your learners?
3. What has motivated you to continue using the WhatsApp group for teaching and learning?
4. What are you hoping to achieve through the WhatsApp group?
5. Can you tell me how you use the WhatsApp group for teaching and learning Physical Sciences?
6. What are the main activities that you and your learners engage in on the WhatsApp group?

7. Can you describe the planning process around the teaching and learning activities in the WhatsApp group?
8. Can you describe your experience of using WhatsApp for teaching and learning of Physical Sciences?
9. How do your learners respond to using WhatsApp for teaching and learning?
10. Do you have any WhatsApp group rules with your learners
11. If so, please share.

12. Why did you choose WhatsApp amongst other social media platforms?
13. What features of WhatsApp do you mostly use and why?
14. How do your learners access the WhatsApp group?
15. How do you feel about using WhatsApp for teaching and learning Physical Sciences?
16. What do you like most about using WhatsApp for teaching and learning Physical Sciences?
17. What do you like least about using WhatsApp for teaching and learning Physical Sciences?
18. What opportunities do you think you can offer your learners via WhatsApp?
19. Can you tell me how the WhatsApp group has helped you overcome the challenges you encounter in your school with teaching and learning of Physical Sciences?
20. In your experience, what are the advantages of using WhatsApp for teaching and learning Physical Sciences?
21. In your experience, what are the challenges of using WhatsApp for teaching and learning Physical Sciences?
22. Is there anything that you would like to share with me regarding your WhatsApp group?

Appendix D: Interview Guide (learners)

Interview guide (Learner)

Utilising WhatsApp for Extending Learning Opportunities in Physical Sciences by Rural Secondary School Teachers in the Vhembe District	
Date: _____	Time: _____
Grade: _____	

Aim: The purpose of this interview is to gain insight into how rural secondary teachers use WhatsApp to extend learning opportunities in physical science.

1. WhatsApp Accessibility
(a) How do you access the WhatsApp group? (b) How long have you been part of the physical science WhatsApp group in your school? (c) How often do you access the WhatsApp group for physical science activities?
2. Perceptions on WhatsApp use for learning Physical Science
(a) How do you feel about using WhatsApp for learning physical science? (b) What do you know about using WhatsApp for learning? (c) What do you dislike most about using WhatsApp for learning physical science?
3. Experience and usage

- (a) Can you describe how WhatsApp has been used to support your learning in physical science?
- (b) What types of activities or resources do you find most helpful in the WhatsApp group?
- (c) Are there specific features (examples: voice notes, pictures, videos, etc) of WhatsApp that you find useful for learning?
- (d) How does it help you understand concepts in physical science better?
- (e) Do you think using WhatsApp has improved your understanding or performance in physical science? If so, explain how?

4. WhatsApp Interactions

- (a) How do you interact with your teacher in the WhatsApp group?
- (b) How do you interact with fellow classmates in the WhatsApp group?
- (c) How do your classmates contribute to the WhatsApp group?
- (d) Is the participation of your classmates useful in assisting you to understand physical science concepts?
- (e) Do you ask questions or give comments on the WhatsApp group?
- (f) Do you feel supported by your teacher and classmates in the WhatsApp group?
Can you give an example?

5. Conclusion

- (a) Do you have any questions or additional comments about using WhatsApp for learning Physical Science?

Appendix E: Language Editing Certificate



STATS KATT RESEARCH CONSULTANCY

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LANGUAGE EDITOR'S LETTER

20 February 2026

This is to certify that the dissertation titled "*Utilising WhatsApp for Extending*

Learning Opportunities (ELO) in Physical Sciences amongst Rural Secondaries

School Teachers in the Vhembe District" by **Mulalo Nakisani Mafadza** (Student No: **16000302**), has been edited and proofread for grammar, spelling, punctuation, overall style and logical flow. The editing was done with the support of the 'track changes' feature of MS Word.

The language in this dissertation is of an acceptable standard. Alongside this letter, the author has been provided with a draft showing tracked changes and comments where language use recommendations have been made.

If external examiners need further editing, we are willing to receive the edited document, with a charge-free extended service.

Regards,

Mr N. Nghomani

(English Language Editor)



Data analysis for:

- Quantitative data (Descriptive, Correlational, Quasi-experimental/ Causal-Comparative and Experimental studies)
- Qualitative data (Thematic analysis/ Qualitative data coding)

Data management engines: SPSS, Excel, ATLAS.ti and EnVivo

