MAPPING SOUTH AFRICAN TEACHERS' RECOGNITION AND USE OF ICT PEDAGOGICAL AFFORDANCES: A PILOT STUDY OF THE E-WITS MODEL

By

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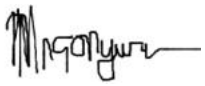
Declaration

I, Ndileka Mnqonywa, declare that this research project titled “Mapping South African Teachers’ Recognition and Use of ICT Pedagogical Affordances: A Pilot Study of the E-Wits Model” is my original work. This study has not been submitted for any other degree or diploma in any university or tertiary institution except as duly declared in the text. To the best of my knowledge and belief, this research project contains no material previously published or written by another person except where due reference is made in the text and the bibliography.

Signed: 

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1. "Make the vision apparent on tablets so that everyone reads it may run. For now, the vision waits for its set time; it hastens to the conclusion and will not lie. If it appears sluggish, wait for it; it will undoubtedly arrive and not be delayed" (Habakkuk 2:2-5). The vision was evident from the start; despite the hurdles of this study, God has been there to guarantee that the vision of finishing this project is realised. My wits faltered a few times, but His amazing faithfulness carried me through.
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Abstract

Among the many challenges facing the effective integration of Information and Communication Technology (ICT) in the classroom, the lack of knowledge on what informs teachers' pedagogical integration into their teaching practice is one of great concern. With the explosion of digital technology, teachers require explicit guidance in familiarising themselves with their ICT pedagogical approach to not compromise teaching and learning. South African ICT education policies and ICT teacher training initiatives have been implemented to ensure sustainable ICT pedagogical integration in the classroom. Nevertheless, these efforts have been proven ineffective, given the reported low uptake and unproductive use of the affordances brought about by digital tools. This study piloted the e-Wits model of the pedagogical affordances of ICTs to analyse 20 South African teachers' recognition and use of ICT pedagogical affordances.

This pilot study reports on how teachers perceive and use digital tools in their pedagogy. The e-Wits model locates teachers' pedagogic practice and guides how teachers can integrate these technological affordances. The study used secondary data from secondary school teachers' interviews collected by three Wits Scholars, Ndlovu (2016), Minty (2020) and Nhlapho (2022), who led research on Gauteng Secondary school teachers using ICT in their pedagogy. Teachers' interviews were used as research instruments. Thematic analysis techniques were employed to re-analyse the data collected by the three scholars. This qualitative study is grounded on a critical realist paradigm. The findings will provide unambiguous guidelines for teachers to make informed pedagogical decisions to facilitate meaningful integration of ICT affordances. Secondly, the study's findings accentuate the need for teachers to encourage an upturn in knowledge construction, active learner participation and collaboration.

Keywords: e-Wits model of pedagogical affordances, ICT pedagogical affordances, explicit guidance, informed pedagogic decisions, ubiquitous, transmissive pedagogies, transformative pedagogies

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List of Abbreviations

CAPS - Curriculum Assessment Policy Statement

CMS - Content Management Systems

DBE - Department of Basic Education

FET - Further Education and Training

GDE - Gauteng Department of Education

HCI - Human-Computer Interaction

HREC- Health Research Ethics Clearance

ICT- Information and Communication Technology

LMS- Learning Management Systems

OECD - Organisation for Economic Co-operation and Development

OER - Open Educational Resources

SAMR - Substitution Augmentation, Modification and Redefinition

SBA - School-Based Assessment

SDLR - Supplementary Digital Learning Resources

STEM - Science, Technology, Engineering, and Mathematics

TPACK - Technological Pedagogical Content Knowledge

UNESCO - United Nations Educational, Scientific and Cultural Organization.

VLE - Virtual Learning Environment

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Chapter 1
Introduction

1.1 Background of the study

There has been a noticeable shift towards incorporating technology into education in recent years. This shift has introduced a wide variety of technological tools, including computers, laptops, interactive whiteboards, tablets, smartboards, projectors, and virtual reality innovations, aimed at meeting the evolving social, economic, psychological, and educational needs of our time (Vandeyar, 2020; Mhlongo et al., 2023). However, despite substantial investments in making these digital tools available in schools, their mere provision has not resulted in a meaningful integration into the teaching and learning processes (Dlamini & Nkambule, 2020; Vandeyar, 2020; Chisango & Marongwe, 2021; La Fleur & Dlamini, 2022).

The effective integration of Information and Communication Technology (ICT) into teaching requires using technology to enhance learner-centred and task-based approaches. This means teachers must adjust their methods by moving away from traditional teacher-centred approaches focused on transmitting knowledge. Even after undergoing ICT training, many teachers still struggle to understand how technology can effectively support teaching and learning. Research has shown that professional development programs often have a one-size-fits-all approach to technology integration without considering individual teachers' differing contexts, subjects, and lesson objectives (Koehler et al., 2013). ICT pedagogic integration is complex and requires consideration of teaching strategies, learning processes, and teachers' content knowledge to make meaningful use of these technologies and their educational benefits (Vandeyar, 2020). Designing ICT training programs that integrate with the actual teaching and learning processes rather than being isolated from them is essential.

As a result, there is a call for more focused and context-specific training programs that are continuous, well-coordinated, and firmly grounded in theory, emphasising the intricate dynamics of teaching and learning (Dlamini & Coleman, 2017; La Fleur, 2022). Additionally, enhanced training programs that effectively integrate technology for teaching and learning are needed (Vandeyar, 2020). While efforts are underway, teachers must invest time in improving their skills and undergoing a shift in beliefs and attitudes for meaningful integration of ICT. This approach would ensure that teachers understand the pedagogical affordances of

technology and how to integrate them into their specific subject areas and classroom contexts (Dlamini, 2022; Mhlongo et al., 2023), creating enriching learning environments in line with the e-Education policy of 2004 and the Department of Basic Education (DBE, 2015).

Furthermore, teachers are encouraged to take a proactive approach to their professional development without solely relying on district or school level ICT training programs. By doing so, teachers are better equipped to align their teaching methods with the individual needs of their learners, allowing for a more tailored approach to integrating ICTs into their lessons. This not only ensures the meaningful and engaging use of technology in the classroom but also fosters learners' critical thinking, problem solving skills and also ensures that learning outcomes are met (Dlamini, 2022).

The concept of affordance, coined by James Gibson in 1977, has been widely used in the medical field. However, its application in education is relatively new. The theory explores the action possibilities between technology and its user (Blewett & Hugo, 2016). For example, a tree offers shelter or shade that a user can perceive based on the weather conditions or the user's needs. The design of the tool or an object determines how the user will utilise it for an intended purpose. In the case of a tree, its affordance is confined to shelter or shade. It can also provide fruits if it is a fruit-bearing tree and can be used to make furniture. Therefore, its use depends on the context and the user's needs.

In addition to Gibson's description of affordances, Norman (1988) postulates that affordances are perceptual. This implies a relationship between how the tool is designed and how the design influences one's use. The user may use the tool for a different purpose based on the user's perception, experience, and beliefs. For instance, traffic lights have three colours that prompt drivers or road users to perform specific actions. A driver who sees a red light must stop. Ember cautions the driver about the imminence of the red light. The green light means that the driver can go. Drivers act based on how they have been trained by the driving school and the universal meaning that society has assigned to these colours.

Norman's (1998) ideology can be extended to understanding how teachers perceive and use ICTs for teaching and learning. This has prompted teachers to create their mental picture of how the technology can be used. A mental representation of ICTs is teachers' internalised knowledge of ICTs. This affects how teachers use ICTs in their classrooms. In using modern technologies like smartboards in the classroom, teachers tend to foreground their training and smartboards' possession of the design and functionalities of a television. They (teachers) then

use these tools to display pictures or PowerPoint presentations and to play videos for learners. This use is limited primarily to their cognitive assumptions. In that case, teachers' mental representation of the tool restricts learners' engagement, active learning, knowledge creation and discussions as the tool is used.

Extending the affordance theory to the pedagogical integration of ICT is necessary. This allows teachers and researchers to understand how technology can be used to ensure successful teaching and learning (Mhlongo et al., 2023). Teachers can then make informed decisions on how they can use ICTs to capitalise on the affordances of technology. This encompasses fostering critical thinking, problem-solving, learner engagement and accommodating different learning styles. When teachers use technology, it leans towards Norman's concept of affordances, which suggests that a tool's design influences its use. ICT training programs focus on teachers' technical competencies, but this emphasis has led to using technology in a teacher-centred pedagogical approach. In this approach, technology is seen as an add-on to the existing approach (Mhlongo et al., 2023), favouring technology manufacturers' sales interests rather than its effective integration for teaching and learning.

Effective ICT integration in the classroom depends on the teacher's ability to recognise and appreciate technologies' endless possibilities. These can be utilised to meet specific lesson objectives (John & Sutherland, 2005). Their study (Mishra & Koehler, 2006) noted that most ICTs used in teaching and learning were not initially intended for such purposes. Thus, teachers must analyse the pedagogical affordances and constraints of ICTs. Given the influx of technological tools in schools, shifting one's focus to the pedagogical affordances of technology would enable teachers and ICT-related teacher-training programs to adopt an analytical approach to integrating the tools at their disposal. This enables teachers to adapt their pedagogic approach to the ever-changing technologies (Mhlongo et al., 2023). The shift from knowing how to use the ICT tool to knowing its pedagogic affordances can promote the selection of ICTs based on explicit identification and systematic reasoning concerning the pedagogic integration of ICT (Moll et al., 2022).

This shift can be achieved when ICT integration programs focus on more than providing teachers with digital competencies. These programs should also equip teachers with the skills to design lessons and create teaching environments that support student learning (Thompson, 2016). Technology should encourage learner participation, critical thinking, and problem-solving (Mhlongo et al., 2023). Thus, teachers can be provided with frameworks guiding them

in designing lessons that support student learning (Thompson, 2016; Dlamini & Coleman, 2017). Such frameworks make the relevant ICT pedagogical affordances explicit and indicate how teachers can capitalise on the applicable ICT affordances and align them with curriculum needs (Dlamini & Coleman, 2017).

Teachers are presented with many technological tools that they usually do not have enough time to learn and use in their practice (Dlamini & Mbatha, 2018). Thus, a theoretical framework could play a significant role in helping teachers use ICTs based on the design of the technology. This should inform their pedagogic approach and ensure meaningful technology integration (Kimmons et al.,2020). The development of ICT frameworks has focused on the capabilities of the tools instead of what they can do to meet the needs of teachers and learners (Reeves & Reeves, 2015, cited in Antonenko et al., 2016). Consequently, no relationship exists between what ICT tools can do and how they can be integrated into teaching and learning. Hence, a framework or model is needed to clarify this.

The e-Wits model, piloted in this study, can be used as an analytical and an ICT integrating guiding tool. The model helps identify the teacher's disposition and provides pathways on how teachers can change their pedagogic practice and beliefs. Through the model, we can locate teachers in interaction levels and hierarchy of affordances. Plotting and mapping teachers in a hierarchy of affordances and levels of interaction provides a detailed analysis of how teachers use technology for teaching and learning. With the help of the e-Wits model, the study suggests ways in which the model can inform teachers on how to change their pedagogic strategies. Lastly, the model suggests how the pedagogic change could impact the teacher's use of ICT in teaching and learning.

1.1.1 Background of the e-Wits Model of Pedagogical Affordances

South African scholars from the Wits School of Education, namely, Moll, Dlamini, Ndlovu, Drennan, Nkambule and Phakathi (2022), have developed a pedagogical affordances framework. This is the outcome of work done over a decade. This involved the conceptualisation of ICT affordances and how they can enhance teaching and learning. The contribution of Drennan and Moll (2018) is based on how the affordances of iPads can be used for educational purposes through the TPACK and SAMR lenses. For these scholars, ICT affordances refer to the extended use of technological capabilities, whereas pedagogical affordances denote how teachers use technological affordances to meet lesson objectives (Moll et al., 2022). As ICT pedagogical affordances are actualised, a tool is deliberately used to

realise its powers (Moll et al., 2022). This justifies the need to know the relationship between technological and pedagogical affordances (Drennan & Moll, 2018).

The Human Communication Interaction Model, elaborated by Desjardins (2005), categorises ICT utilisation into four subdivisions or competencies. Dlamini and Nkambule (2018b) conducted a systematic literature review and mapped ICT pedagogical affordances. They identified four degrees of ICT integration competencies. Desjardin's framework includes informational, epistemological, and social competencies. The fourth is a technical competency that explains how an individual uses ICT tools (Moll et al., 2022).

Ndlovu's contribution to the framework brings in the element of multimedia affordances (Ndlovu, 2015; Ndlovu & Moll, 2016). Multimedia affordances highlight that knowledge can be represented in different media forms. Ndlovu's (2016) investigation developed from Laurillard's (2002) conversational framework. It presents five media forms: narrative, interactive, communicative, adaptive, and productive. Ndlovu (2015, 2016) uses five of Conole and Dyke's (2004) ICT affordances. These are immediacy, diversity, communication and collaboration, multimodality, and non-linearity. She relates these to media forms and what can be considered ICT use with "pedagogical value". The e-Wits framework developed by these scholars has yet to be used to understand how teachers integrate ICT pedagogical affordances.

1.2 Problem statement

The South African Department Basic of Education has significantly invested in providing ICT tools for teaching and learning (Dlamini & Nkambule, 2020). Despite these ICT investments and training programs, teachers use ICTs for knowledge transmission and administrative purposes (Tarling & Ngambi, 2016) instead of as an integral part of teaching and learning. Teachers also do not know how or what ICT tools offer to achieve different learning objectives. When teachers have a limited understanding of what ICT tools offer, the quality of ICT use will be compromised. The existing ICT pedagogical frameworks do not outline how teachers can meaningfully integrate ICTs (Ndlovu, 2016; Dlamini & Mbatha, 2018).

Teachers must have a framework to identify and evaluate ICT pedagogic affordances based on their respective classroom contexts and objectives (Dlamini & Nkambule, 2020). Significant research exists on ICT affordance mapping in fields such as medicine. However, little is known about the ICT affordances that South African teachers use in their pedagogy (Tarling & Ngambi, 2016; Coleman & Dlamini, 2017; Dlamini & Nkambule, 2020).

1.3 Aim of the study

This pilot study explores the recognition and use of ICT pedagogic affordances by South African teachers in their practice. This endeavour foregrounds using the e-Wits model of pedagogic affordances as a diagnostic tool (Moll et al., 2022). The study uses secondary data that constitutes interviews previously conducted by three Wits scholars, namely, Ndlovu (2016), Minty (2020), and Nhlapho (2022). The participants of these case studies were primary and secondary school teachers. These were from suburban and township schools in Gauteng, with access to different ICT tools. The intention is to establish teachers' understanding of ICT affordances and how they are integrated into the classroom. Thematic analysis is used to make sense of the data and document the findings concerning the validity of the e-Wits model (Moll et al., 2022). Based on its findings, this pilot study provides explicit guidance on how teachers can use the e-Wits model for the meaningful integration of ICT affordances into their pedagogic practice.

1.4 Objectives of the study

By using the e-Wits model, this study will:

- Understand teachers' perceptions on how they integrate ICT affordances in their teaching and learning practice.
- Determine the pedagogical value their ICT integration brings to their teaching and learning.
- Map out how the e-Wits model can be used as an analytical tool and inform teachers' pedagogical decisions as they integrate ICTs.

1.5 Main research question and sub-questions

How can the e-Wits model be used as a pedagogical and analytical tool to map out teacher recognition and use of integrating ICTs?

1. What are the teachers' perceptions of the integration of ICT affordances in their teaching and learning?

2. What are the underlying values of ICT affordances that teachers bring to their teaching and learning?
3. How can the e-Wits model be used as an analytical tool and inform teachers' pedagogical decisions for effective ICT pedagogic integration?

1.6 Significance of the study

There is limited empirical research on how teachers use the benefits of ICTs affordances for teaching and learning (Bower & Sturman, 2015; Dlamini & Nkambule, 2020; Dlamini & Ndzinisa, 2020; La Fluer, 2020). This suggests that ICTs are not integrated meaningfully in education (Bower & Sturman, 2015). This warrants the development of a framework that would guide teachers on when and how to use specific ICT tools for meaningful teaching and learning experiences.

The South African education sector has spent money on the provision of ICT infrastructure to schools (Coleman & Dlamini, 2017), and yet teachers are not adequately trained regarding the pedagogical approaches that leverage the use of digital tools (Aktaruzzaman et al., 2011; Voogt et al., 2013; Brown et al., 2020). The South African National Curriculum Policy Statement (CAPS) stipulates that teachers must adapt their practice from teacher-centred to learner-centred approaches. Furthermore, as one of its goals, the policy states that teachers must integrate ICT affordances to promote learner critical thinking and problem-solving (DBE, 2015). However, the policy does not explicitly state how teachers ought to integrate ICT affordances and adapt their pedagogies to learner-centred pedagogies. That contradicts what the policy advocates for.

Teachers are still seen to be using the technology in a teacher-centred approach that foregrounds narrative ways of teaching, even when using ICTs (Tarling & Ngambi, 2016; Mhlongo et al., 2023). Teachers must know that ICTs have extensive benefits that can improve teaching and learning and promote learner-centred approaches. In South Africa, ICT affordances have not been understood (Tarling & Ngambi, 2016; Dlamini & Coleman, 2017). Owing to the lack of a theoretical framework that will help understand how teachers integrate ICT pedagogical affordances and provide systematic guidance on how to integrate ICT pedagogical affordances.

This research seeks a model that outlines systematic and easy-to-follow guidelines on how teachers can integrate ICT affordances into their pedagogy. The research endeavours to address the scarcity of empirical evidence highlighted in the literature. The latter unearths limited evidence of teachers' integration of ICT affordances in teaching and learning across the South African landscape in well-resourced and under-resourced schools. Thus, the study analyses how teachers integrate ICT affordances into their pedagogy. Conducting this study benefits

ICT training programs, trainers, and both pre-service and in-service teachers by supporting the transformation of ICT pedagogical integration.

1.7 Overview of chapters

This research is divided into six chapters as follows:

Chapter 1 is the current chapter. It provides an overview of the research, presenting its context, rationale, and problem. Additionally, it outlines the research aim, objectives, and questions, emphasising the significance of this study and the specific research gap it seeks to address.

Chapter 2 presents a comprehensive review of relevant literature. The literature reviewed covers the concept of ICT affordance theory, the integration of ICT by South African teachers, ICT affordances, and the contextual influences that impact meaningful ICT integration in basic education. This chapter also elucidates the theoretical framework employed in this study and delves into empirical findings from literature pertinent to the study.

Chapter 3 delves deep into research methods and design. It thoroughly explains the rationale for using a qualitative research design for the project and the associated methods. The chapter also highlights the importance of conducting a pilot study and its influence on the main study. It covers data collection procedures, participants, data analysis methods, and ethical considerations.

Chapter 4 presents the findings based on participant responses using qualitative analysis techniques.

In Chapter 5, the study's findings are discussed and compared to previous research similar to this study. This chapter also addresses the research questions concerning the research findings.

Chapter 6 provides a conclusion to the research by providing a summary, outlining the study's limitations, making recommendations, and offering advice for future research.

1.8 Summary of the chapter

This chapter provides an introduction to the study and its contextual background. It outlines the research problem, research questions, and the significance of the study, laying the groundwork for the subsequent chapters. The next chapter will explore existing literature on the research topic, including similar studies and applying relevant theories and frameworks to understand the topic comprehensively.

Chapter 2

Literature Review

2.1 Introduction

The purpose of this chapter is to review the relevant academic literature that provides detailed insight into ICT integration and the benefits of using ICTs in education. Furthermore, the chapter discusses how teachers integrate ICTs into teaching and learning, as well as examine the theoretical debates on affordances. The discussion then expands on the affordance theory by scrutinising how the theory has been applied by well-known international and local (South African) scholars in mapping ICT affordances. This literature review helps identify the gaps regarding how researchers have addressed the question concerning the ICT affordances teachers perceive as applicable and used for teaching and learning. Ultimately, the literature review helps to determine the theoretical frameworks developed upon identifying the ICT affordances teachers use for teaching and learning.

2.2 Affordance Theory

The term affordance was coined by James Gibson (1977), who states that affordances are action possibilities. Affordances are thus endless possible actions that one can take depending on the user's needs. They exist whether perceived or not. McGrenere and Ho (2000) challenge this Gibsonian position. For them, affordances are linked to direct perception, where individuals will perceive the same tool differently based on what informs their perceptions to reach a particular objective. Therefore, how an individual perceives a tool is highly influenced by their culture and experiences, which can limit how they use the affordances. Secondly, Gibson argues that affordances may exist independent of one perceiving them (Gibson, 1977), which does not consider the fact that the user may not perceive them as easy to use (Davis, 2005) as affordances are nested (McGrenere & Ho, 2000). Therefore, the tool's design can be critical in actualising the affordances (Hammond, 2010).

Extending the Affordance Theory to Educational Technology

The concept of affordances, defined by Gibson (1977) as action possibilities, is essential for understanding how teachers and learners interact with technology (Al-Mawaali, 2020). Teachers using technology should promote critical thinking, problem-solving, and participation among learners. Three key aspects are crucial to understanding affordances in this context. Firstly, affordances exist independently of the user's perception of them. Secondly, affordances remain consistent even as users' needs change (Gibson, 1977). Additionally, affordances depend on the action the user wants to take (McGrenere & Ho, 2000). Gibson's arguments acknowledge the influence of ICT tool designers on user actions. However, the teachers design and facilitate learning opportunities using ICT tools as pedagogical devices. Therefore, teachers' perceptions of ICT affordances will shape teaching and learning experiences. This study aims to influence these perceptions by providing guidelines on integrating affordances into teaching practices.

Importance of analysing ICT affordances in education

The previous section highlighted that teachers must utilise evolving digital tools for effective teaching and learning. Mishra and Koehler (2006) point out that many ICT tools were not explicitly designed for educational purposes. Consequently, teachers may not leverage these tools to meet specific objectives and may be swayed by their appearance and general technological capabilities. However, it is essential to note that this does not mean the tools should be overlooked, avoided, or used solely for passive learning. Instead, it is crucial to harness the benefits that ICTs bring to the table for educational purposes. Achieving this goal involves analysing the affordances of ICTs teachers use to enhance their teaching methods. By undertaking this analysis, teachers will be better positioned to select the most suitable ICT tools based on their perceived educational affordances (Bower & Sturman, 2015).

2.3 Mapping ICT Pedagogical Affordances

Since the early 2000s, various researchers have investigated the concept of ICT affordances in the teaching and learning environment. This was in response to the interventions through frameworks coined by Conole and Dyke (2004), Kirschner et al. (2004) as well as Mishra and Koehler (2006). These scholars attempted to close the literature gap by focusing on matters other than integrating ICT affordances for effective teaching and learning. The limited

knowledge of ICT affordances for teaching and learning has led to inconsistencies in integrating ICTs in many classrooms. This indicates that teachers may use ICT affordances based on their perceptions, experience and culture. Thus, to reduce the inconsistencies in integrating ICTs in teaching and learning, ICT affordances must be made explicit to teachers so that they can apply them in their teaching strategies. In doing so, teachers can integrate ICTs into their pedagogy in ways that can provide enhanced learning opportunities (Conole & Dyke, 2004; Yoon et al., 2005). Despite the attempts by Conole & Dyke (2004), Kirschner et al. (2004) and Mishra and Koehler (2008), there has been limited empirical evidence on how teachers integrate ICT affordances in their pedagogies. However, Bower and Sturman (2015) attempted to fill this empirical gap. The two scholars stated that affordances do not influence teaching and learning, but the teachers' perceptions influence how ICT affordances can be utilised.

2.4 Mapping ICT Pedagogical Affordances - South African Case Studies

Research on the affordances of ICT in the setting of South Africa is quite scarce. Resulting in studies that target South African issues while referencing journals from around the world (Dlamini & Coleman, 2017). Two South African scholars, Dlamini and Nkambule (2020), tried to fill the research gap about the lack of frameworks and categorisation of ICT affordances utilised by South African teachers in response to this concern. By carrying out a systematic examination of the literature on the educational affordances of ICT. These researchers categorised ICT affordances into four competencies: technological, informational, epistemological, and social. These competencies may be used to categorise the degree to which teachers incorporate ICT affordances based on their situation.

Empirical evidence

The COVID-19 pandemic sparked a notable increase in empirical research focusing on the affordances of information and communication technology (ICT) in the realm of teaching and learning (Faatar & Norodien-Faatar, 2021; Xue et al., 2023), particularly in response to the shift towards online education. However, most of this research has centred on higher education institutions (Canani & Seymour, 2021), with less attention given to integrating ICT affordances in the basic education sector. Nonetheless, this gap has been addressed by two recent studies. The first empirical study, conducted by Canani and Seymour (2021), delves into the advantages and limitations of implementing LMS as an emergency measure to facilitate Emergency

Remote Learning (ERT) during the pandemic. The study revealed that LMS was pivotal in facilitating widespread teaching and learning, offering flexibility, and enabling effective communication with learners.

The second study by Phakathi and Moll (2022) explored the pedagogical potential of iPads in documenting teaching and learning. This study is especially pertinent to this pilot study of the e-Wits model, as Phakathi and Moll aimed to adapt a model developed by Drennan and Moll to describe learning in the classroom and map teachers' pedagogical approaches when utilising iPads. Drennan and Moll's model forms the foundation of the e-Wits model, which they devised in 2018 to map the pedagogical capabilities of iPads. Notably, both studies were confined to a specific sample population with specific ICT tools and in an affluent area. Neither study encompasses all learners or South African classroom contexts. Given the digital divide in South African schools, as outlined by Van Dijk (2020), which refers to the gap between those who lack physical access to ICT tools and skills and those who possess them, it is crucial to address these disparities through targeted interventions.

2.5 Digital Divide

The digital divide is a long-standing issue that the COVID-19 pandemic has further highlighted. In South Africa, schools in disadvantaged communities often lack essential ICT infrastructure, such as Wi-Fi and adequate bandwidth, which hinders the possibility of widespread teaching and learning. This contrasts schools in urban or affluent areas (Chisango & Marongwe, 2021). Despite the Gauteng Department of Education's 2015 initiative to introduce online teaching and learning through the "paperless classrooms" initiative, as well as providing ICT infrastructure such as smartboards, tablets, and laptops to South African schools, the effectiveness of this initiative has been limited. The research indicates that schools in poorer townships continue to be affected by crime and vandalism, undermining the potential impact of these technological introductions (Chisango & Marongwe, 2021).

Consequently, much of the teaching and learning in South Africa still takes place in traditional classroom settings, relying on technologies such as smartboards, projectors, and whiteboards, which are only in the hands of the teachers (Chisango & Marongwe, 2021). However, teachers' ability to effectively utilise these ICT tools remains a significant challenge. Van Dijk (2008, 2020) has highlighted the lack of ICT skills among teachers. Despite efforts to provide ICT training programs for teachers, Dlamini and Coleman (2017) have reported that these have not yielded the desired outcomes, as teachers often lack the necessary ICT skills to integrate

technology effectively into their teaching practices (Minty, 2019; Chasango & Marongwe, 2021). Simply providing technical skills training is not sufficient. Teachers' ICT training programs must focus on the primary use of technology and on integrating it into specific subject areas while aligning with learning objectives. La Fleur and Dlamini (2022) argue that we must make their ICT pedagogical affordances explicit for meaningful ICT integration.

This is to improve the quality of teaching and learning, irrespective of socio-economic status, increase learner engagement and interest, and provide meaningful learning experiences, which are carefully and well-designed lessons that actively and cognitively engage learners in the learning processes (Nusche & Minea-Pic, 2020). Teachers have access to laptops, computers, and ICT tools which enable them to design lessons with contextually relevant content. Designing and creating content facilitates critical thinking, deeper understanding and meaningful learning. The use of contextually relevant ICT tools such as multimedia promotes inclusivity and provides learners with relatable knowledge. This is particularly important because much of the knowledge available is Western-centric (Nusche & Minea-Pic, 2020).

Thus, in recent South African research, Moll et al. (2022) created a model to make explicit ICT affordances for teachers, which may be utilised to inform meaningful ICT integration. Moll et al. (2022) classified ICT affordances into a hierarchy. This hierarchy contains technical, representational, and pedagogical affordances. The teacher may understand how the affordances emerge and make informed decisions about implementing the ICT affordances. The study proposes that technology provides several affordances that may be exploited to improve teaching and learning opportunities. Moll et al. (2022) presents a systematic approach for teachers to actualise ICT affordances. Given this premise, there is a need for more empirical data demonstrating how teachers' perspectives impact their incorporation of ICT affordances. As a result, this research aims to use the e-Wits model of ICT pedagogical affordances.

2.6 e-Wits model of ICT Pedagogical Affordances

The e-Wits model of ICT pedagogical affordances is an analytical tool that maps teachers' current pedagogies and may offer clear direction to teachers on how to integrate ICT affordances successfully. The e-Wits model is a theoretical framework acknowledging that teaching and learning occur in a social constructivist setting. It distinguishes between ICTs' technological, representational, and pedagogical affordances, allowing for meaningful ICT integration (Moll et al., 2022).

Theoretically, theoretical models must explicitly articulate their pedagogical, epistemological, and ontological assumptions regarding ICT pedagogical integration (Hodgkinson-Williams, 2006). Various theorists have not been able to incorporate these three assumptions into conceptualising their theoretical frameworks. Eliciting a theoretical framework's epistemological, ontological, and pedagogical assumptions helps determine how learning can occur.

Teachers can be horizontally and vertically mapped in two directions on the e-Wits model since it integrates the hierarchy of affordances and the HCHI interaction. Referring to Figure 1, the model can be read horizontally to reveal ICT pedagogical affordances. This pilot study investigates how this model can serve as a methodical framework and analytical assistance for teachers considering incorporating ICT educational affordances. Teachers can also plan and reflect on their ICT use using the e-Wits model as a tool. Ultimately, this will validate the recently created framework because validation is only possible once the model has been published (Kimmons et al., 2020).

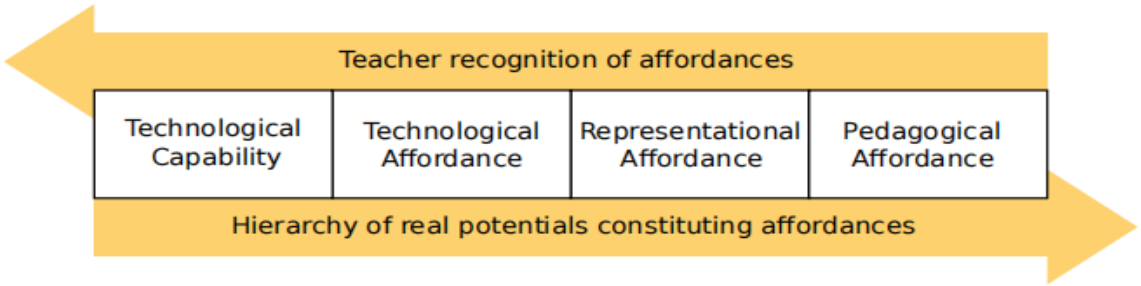


Figure 1: Hierarchy of affordances that teachers can recognise and use. (Moll et al., 2022, p.19)

Technological Capabilities

A framework that can be used to directly analyse the interaction between technology and pedagogy and teachers' usage of iPads has been established by Drennan and Moll (2018). Thanks to this approach, they could think more deeply about ICT affordances. They distinguish between "technological affordances and technological capabilities" in their theoretical framework. A digital tool's hardware and software components are part of its technological capabilities. Regarding built-in design, technologies include size, portability, touch capabilities, battery life, connectivity, browser, and video capturing (Drennan, 2018).

Technological affordances

Under Norman's definition of affordance, technological affordances are the usefulness of the ICT tool determined by its design (Norman, 1988). Technological affordance is the interaction between the user and the technology, according to Gaver (1991). This concept strongly emphasises how easily technology may be used to accomplish a goal, whether for teaching, learning, or communication. According to Kirschner et al. (2004), who cited Norman (1992), people do not accurately perceive the affordances of technology. This is so because opinions are shaped by an individual's interactions with pertinent technology. Because of this, people develop expectations about what the technology should be able to accomplish based on its design. These academics highlight the power of technology by pointing to the physical elements of digital technologies.

Representational affordances

From an engineering standpoint, Gero and Kannengiesser (2012) define representational affordances as still relevant in an educational setting. Representation refers to using various modalities or multimedia, such as sketches, audiovisual content, and gestures. These are several methods of imparting knowledge or communicating with various learning paths (Gero & Kannengiesser, 2012). Representational affordances are how information may be represented in various media formats using multimedia. One of the benefits that ICT offers in the classroom is this.

According to Suthers (2000), a representational tool is an interface that encourages direct manipulation and software-based knowledge production. Word documents and Excel spreadsheets employ basic computer functions. The educational premise is that teachers must use technology to help them spread information, known as a teacher-centred pedagogical approach. According to the epistemological premise, there are several ways to portray information. The teacher must use creativity to communicate the material by implementing multimedia tools (Ndlovu, 2016).

Pedagogical affordances

Pedagogical affordances are the qualities of an ICT tool, according to Kirschner (2002). These features determine how a learning aim may be accomplished in the teaching and learning environment. This definition is comparable to what Drennan and Moll (2018) have said. These researchers believe the technology chosen should encourage student participation, critical thinking, and problem-solving. Pedagogical affordances acknowledge that education takes place inside a social construct. Through group conversations, learners in this environment learn from one another. Additionally, there is an appreciation of the elements of individual learning (Kirschner et al., 2004). Nonetheless, a supportive teaching and learning environment is necessary for gaining an understanding of pedagogical affordances. Teachers must establish a collaborative learning environment that enhances learning.

2.7 Competencies

A comprehensive evaluation of the literature on ICT pedagogical affordances in e-learning was conducted (Dlamini & Nkambule, 2020). A Human-Communication-Human-Interaction Model was used in their research. The concept categorised ICT affordances into levels of competence by taking inspiration from the Normanian approach to ICT affordances. Technological, informational, epistemological, and social levels were among the competencies. By integrating learning concepts, Dlamini and Nkambule (2020) expanded on identifying ICT affordances and demonstrated the interaction between technology and its users. The four competency levels relate to how teachers can use technology to communicate and carry out instructional duties (Desjardins et al., 2001).

Technical competency

Teachers with technical talents are positioned at the technical level of competency on the e-Wits model. They are proficient at using digital tools like computers and smartboards. Teachers at this level create worksheets and mark sheets by typing or using other basic technological functions. Additionally, they possess knowledge of the smartboard's operation. Only the teacher and the material are involved in the interaction. Teachers at this level possess the abilities and understanding necessary to deliver and alter instructional materials (Desjardins et al., 2001).

Information competency

The information interaction level of education uses teacher-centred pedagogies. To help learners remember what they are learning, they use a variety of multimedia and internet searches (Desjardins et al., 2001; PISA, 2022). There will be little to no cognition and engagement among learners when they sort and arrange the content for them to view or copy from the smartboard by sifting through the numerous internet sites. Sometimes, learners must submit a report as proof of their learning.

Epistemological competency

Science, Technology, Engineering, and Mathematics teachers are allocated to this level. These teachers employ software, videos, images, and other unique information and communication technologies as cognitive aids. These ICT resources support the learning process by motivating learners to interact closely with the material or assist learners in creating knowledge (Desjardins et al., 2001). Although cognitive tools do not perform thinking on behalf of learners, they offer techniques and guidance to support the learning process (Korres, 2020). The e-Wits model argues that technology-assisted tools facilitate learners' cognitive growth. Through exercises, learners' capacity for critical thought and problem-solving is promoted. This level of instruction makes more use of technology as there is interaction between the teacher and learners and between learners and the topic. In the epistemological dimension, there is a balance between the learner-centred and teacher-centred approaches.

Social competency

The e-Wits model also acknowledges that instruction occurs in educational social networks using ICT-mediated communication-enhancing technologies (Moll et al., 2022). Emails and social media are examples of ICT-mediated communication. Teachers must know how to safeguard learners and information on social media platforms to use them effectively (Desjardins et al., 2001). Teachers at this level have competencies that "partially overlap with technical ICT skills" (PISA, 2022, p.48). People exchange resources with each other using these and other methods. Consistent with the social constructivist theory (Vygotsky, 1978), the e-Wits model approach emphasises the collaborative nature of teaching and learning. These levels mapped teachers employ transformational pedagogies.

The National Curriculum and Assessment Policy (CAPS) mandates teachers in South Africa to include technology in their lesson plans. Teachers must thus possess the necessary skills to incorporate ICTs in a way that promotes learning opportunities. These are circumstances in which learners use learner-centred educational techniques to acquire, expand, and generate knowledge. However, these regulations do not address how teachers are meant to use technology to support learning experiences, even if they outline the necessary competencies and expectations for teachers and learners. In this sense, the e-Wits model aims to give teachers strategies for integrating ICT affordances to create educational opportunities for learners.

2.8 Summary of the chapter

This literature review provides an explanation of ICT affordances and the development of affordance theory. Applying the affordance lens to assess ICT pedagogical integration is essential. The affordance hypothesis draws attention to the action possibilities that arise when technology involves using it in ways that the teacher is inexperienced with (Gibson, 1977). The idea makes it possible to investigate how teachers identify and incorporate ICT affordances for teaching and learning. Therefore, we use the affordance theory to move the focus from the capabilities of digital tools to how teachers may use the ICT affordances for purposeful teaching and learning. The affordance theory expands our knowledge of the acknowledged and applied ICT pedagogical affordances. We will thus be able to give teachers educational approaches to integrating ICT affordances to support learner active involvement and cognitive growth with the e-Wits model of ICT pedagogical affordances. The e-Wits model is used in this work as a didactic and analytical tool (Moll et al., 2022). It is crucial to assess teachers' technical competency and proficiency in integrating technology to effectively teach their respective subjects and achieve desired learning objectives (Mishra & Koehler, 2006). In the upcoming chapter, of Chapter 3, this study's research design and methodology will be presented.

Chapter 3

Research Design and Methodology

3.1 Introduction

This chapter presents the research design and methods for conducting this qualitative study. The chapter covers the research design, data collection and analysis methods, validity, and the study's limitations. Qualitative research studies the behaviour of humans in their settings. This is achieved by conducting interviews and observations of the participants (Creswell, 2013). For this study, the researcher did not collect qualitative data. This was a secondary analysis of qualitative data from three researchers, namely, Ndlovu (2016), Minty (2020), and Nhlapho (2022). The secondary data analysis of qualitative data is a research strategy that employs previously collected qualitative data. The intention is to investigate new research questions. One significant advantage of using secondary data analysis in a qualitative study is that the researcher can generate new hypotheses and knowledge. Moreover, secondary data analysis eliminates the need to collect data through a time-consuming primary method. Secondary data analysis helps explore less investigated or understated research topics (Heaton, 2004).

The secondary data analysis aligned with the primary data and allowed new research questions to be developed. The three primary researchers employed similar analytical techniques. All three studies investigated ICT integration and conducted face-to-face interviews that formed part of the qualitative data used in this study. Each of the three studies used semi-structured interviews involving open-ended questions to probe teachers' perceptions and use of ICT.

Describe the ICT affordance used by the participants who responded to these questions.

"Which ICTs do you use in your teaching? When and how do you use them?"

"Describe your experience of teaching and learning Mathematics in a paperless classroom".

When the participants described the challenges they encountered when using ICTs, they were also described as using ICT affordances.

The participants responded to these questions to describe the perceived ICT affordances.

"What are your feelings about learning Mathematics in a paperless classroom?"

"What do you think ICT integration into teaching and learning of your subject means?"

To understand the ICT tools that teachers have access to, the participants responded to the question:

"What ICT tool do you have access to, and what ICT tool do you use in your teaching practice?"

3.2 Research Design

Research design refers to the series of steps and processes used to collect and analyse data (Creswell, 2000; Goodwin & Goodwin, 2016). According to Creswell (2000), research design involves a logical progression, starting from formulating a research problem and leading to generating conclusions that are important for how the study is carried out. These processes involve making decisions about how the research should be conducted. The decisions made by the researcher are influenced by the research problem and the researcher's worldview assumptions about the research topic, as well as methods for data collection, analysis, and interpretation (Creswell, 2009). Additionally, the choice of research design depends on the researcher's past experiences, the nature of the research problem, and the intended audience of the study (Creswell, 2009).

This research employed qualitative procedures. It relied on interview texts and followed specific steps in analysing them (Creswell, 2009). The interview texts included open ended data based on the participants' responses to questions related to ICT integration (Strauss & Corbin, 1998; Creswell, 2009).

3.3 Research Philosophy

Research philosophy is the foundation on which the research needs to be conducted. It involves the research's ontology, axiology, and epistemological assumptions (Saunders et al., 2016). The research philosophy shapes the beliefs, reality, and what is to be regarded as knowledge. Saunders et al. (2016) have suggested three research philosophies: interpretivism, positivism, and critical realism. This study adopts the critical realist position. Given that the study maps ICT pedagogical affordances, adopting a critical realist paradigm enables the researcher to

explore how ICT affordances are perceived and used for teaching and learning. Using the critical realist paradigm also provides a report on how and why teachers use ICTs the way they do through empirical evidence.

The interpretive and positivist paradigms would not be suitable for this study. Interpretivism provides meaning or interpretations instead of highlighting the cause of a phenomenon. Positivism foregrounds empirical observations and works on measurable behaviour (Saunders et al., 2016). Therefore, these two paradigms would be unable to assist in identifying the causal factors that shape how teachers perceive and use ICT affordances for teaching and learning.

3.4 Research Approach

The research approach refers to the plans and processes that the research adopts in collecting, analysing, and interpreting data before producing the report (Creswell, 2014). Three possible research approaches exist: abductive, deductive, and inductive. This research adopted a deductive approach. According to Saunders et al. (2016), a deductive approach investigates the changes in the physical environment or observable properties over time. The data were to either agree or refute the theoretical assumption on ICT affordances. The findings helped me understand how teachers use ICTs and provided reasons why they use ICTs the way they do. The findings were used to refine the theoretical assumptions on ICT pedagogical affordances.

3.5 Research Strategies

A research strategy indicates ways of conducting a research study, outlining vital objectives that help to answer the research questions (Saunders et al., 2007). It also identifies the data source and considers time factors, data access, and ethical concerns (Saunders et al., 2007). This qualitative pilot study used textual data from interviews previously conducted by three University of the Witwatersrand scholars. The data were descriptive because they were from interviews.

3.6 Methodological Choice

For Saunders et al. (2016), methodological choice refers to aligning the research goals and considering how the research will be conducted regarding mono, multi, and mixed-method research. This research is mono-method, as it uses qualitative data and employs thematic analysis procedures.

3.7 Sample and Data Collection

The study entailed a secondary data analysis and employed purposive sampling. The data sample for this pilot research was secondary data on 20 teachers from nine Gauteng secondary schools using ICT in their pedagogy. The qualitative dataset had been previously collected by Ndlovu (2016), Minty (2020), and Nhlapo (2022). They utilised a purposive sampling of teachers using ICTs in their pedagogy. However, these scholars explored different ICT integration issues in South African schools. These researchers gathered data, including transcripts and photographs. The data collected provided detailed descriptions of the actions of the observed participants in the classroom. Such a methodology seeks to "accurately describe observed social actions by way of the researcher's understanding and clear description of the context under which the social actions took place" (Ponterotto, 2006, p. 543). These scholars' datasets were used to understand the integration of ICT pedagogic affordances.

The data used for this study was textual data consisting of interview transcripts representing teachers' ICT pedagogical integration. Analysing the meaning of textual data requires different data sources. These may include semi-structured or unstructured interviews, observation notes, images, policy documents, and conversation data. A practical data source must be aligned with the methodology or theoretical framework (Coffey & Atkinson, 1996). There is no single way of analysing qualitative data. However, it is imperative to think about the data and how they fit into the theoretical assumptions made by the research (Freeman, 2017).

Secondary data were used for this study. Johnston (2014), cited by Dale et al. (1988), stresses that secondary data must be evaluated for appropriateness and alignment with the new research question. The following steps must be considered: (a) Purpose, (b) Person collecting data, (c) Date of data collection, (d) Type of data to be collected, and (e) How the data are to be collected. Considering these steps or questions, the primary researchers' data were deemed appropriate to answer the new research question.

3.8 Rationale for the Choice of Data

The semi-structured interviews from the primary researchers contain detailed events and descriptions of the participants' use of ICTs in their classrooms. The interview participants provided a more profound understanding that helped map the ICT affordances they recognised and used in their pedagogies.

Table 1 summarises the data collected by the primary researchers, the methodology used, how the data were collected, and the scholars' respective research focuses.

Table 1: Summarises the data from the three Wits scholars.

Study	**Purpose**	**Sample demographics**	**Year of data collection**	**How was the data collected?**
N.S Ndlovu	"To understand the pedagogical integration of available digital technologies of seven selected township secondary. School teachers that claim their use of ICTs have educational value" (Ndlovu, 2016, p. 38)	Gauteng high schools in Soweto Township 5 teachers with computer laboratory and one with i-box access.	2016	Semi-structured interviews Lesson observations
R. Minty	Investigate the feasibility of paperless teaching methods and understand the perceptions and integration of ICT by Maths teachers.	Gauteng schools (intelligent classrooms) High school Mathematics Teachers N=10.	2020	Semi-structured in-depth face-to-face interviews (interview guide was used). Classroom observations. Focus group discuss
M. Nhlapho	Understand how teachers integrate ICT and what is considered to be of pedagogical value in the classroom.	Gauteng schools in Tshwane District, (Smart classrooms). **Teachers** 1 Primary school teacher 4 High school teachers **Township schools** Ranging from affluent to poor communities	2021	Unstructured interviews, systematic video recording

Selection Criteria

The interviews previously conducted by the three Wits scholars indicated that the participants were aware of the pedagogical affordances of ICTs.

- Where they gained their ICT knowledge
- Their use of ICT tools in their pedagogy

The relevance of these inclusion criteria lies in the ability to extrapolate the affordances that teachers recognise and use in their teaching practices. This is because teachers' integration of ICTs into their pedagogies is influenced by their comprehension of ICT affordances.

3.9 Pilot Study

As secondary or archival material for this pilot research, interview transcripts from the Ndlovu (2016), Minty (2020), and Nhlapho (2022) investigations were consulted. A pilot study establishes the primary research's validity and feasibility. The pilot study's findings determine whether the research instrument should be included or not (Thabane et al., 2010). The tool employed in this study is the e-Wits model. This pilot study would train other researchers and teachers to use the instrument to map ICT pedagogical affordance. Research instruments such as codebooks are never tested and disclosed in research articles. This makes it difficult to replicate the employed practices (Roberts, 2019).

3.10 Data Analysis

According to Neuman (2000), data analysis refers to searching for patterns in the collected data. This study's data was analysed using qualitative analytical methods. During the analysis process, codes were ascribed to the interview data. The codes were applied to a sentence, phrase, or paragraph mentioned by the study participants (Miles & Huberman, 1994).

3.11 Unit of Analysis

The unit of analysis is a variable or entity that the study seeks to analyse to meet the research objectives or reach a conclusion (Sedgwick, 2014). This study's unit of analysis is the teacher’s integration of ICT pedagogical affordances. The pilot study reflected on the ICT affordances teachers perceived and used for teaching and learning.

3.12 Thematic Analysis

Qualitative methods were used to analyse the textual data. Thematic analysis identifies, categorises, and offers an in-depth meaning of data patterns (Clark & Braun, 2013). Thematic analysis involves the use of different techniques in the identification of patterns in qualitative datasets. The thematic analysis offers "theoretical flexibility" (Clark & Braun, 2013, p. 120). It is regarded more as an analytical method than a methodology compared to other qualitative methods. The theoretical flexibility enables researchers to adopt theories from a particular discipline and employ different perspectives to perform thematic analysis. A theoretically grounded thematic analysis helps to generate a meaningful analysis. The textual data were manually analysed through cyclic coding (Saldana, 2009).

Thematic analysis involves recursive processes. The qualitative data collected by Ndlovu (2016), Minty (2020), and Nhlapho (2022) were prepared and organised to facilitate familiarity with the data and to enhance understanding of the participants. The source, location, data collectors, methods of data collection, and the purposes of these investigations were identified and presented in Table 1.

The first cycle of open coding identified and labelled features appropriate for the research question and provided a summary of some of the data. The first step a researcher takes is assigning codes to the entire dataset. This is done by identifying distinct concepts, reflections, and themes (Corbin & Strauss, 1990).

- Since the interviews have been transcribed, the analysis begins by examining the statements in which the interviewees shared their opinions and benefits of technology, using Gibson's definition of affordances. The focus was on the codes regarding the use of ICTs. The goal was to identify common patterns across the interview transcripts and identify any deviations arising from the data. The theoretical framework and research questions guided the thematic analysis. Although the research was primarily deductive, inductive processes were also adopted. Inductive processes were critical in identifying themes that could fit in with the affordance theory but are not in the e-Wits model. Codes were identified from the data and written down for each coding round.
- When the participant speaks about these technological abilities, they are classified as "perceived affordances" / "Recognised affordances".

- Inferences were made regarding words or phrases on affordances when teachers described the objects used for pedagogical purposes and the related constraints. Classify that as “used affordance”.
- The e-Wits affordances model was used as the qualitative codebook, as it has predetermined codes. The pedagogical affordances, representational affordances, and technological affordances constituted the themes.
- The second phase included axial coding (Saldaña, 2009), where the codes identified from the data were collapsed into the e-Wits model themes. The e-Wits model is a codebook with different codes generated by the University of the Witwatersrand scholars. The codes were matched and assessed thoroughly. They were subsequently compared to the e-Wits model. This helped to identify where a code or affordance fits best; if not, a new code would be added to the e-Wits model.
- The e-Wits model was used as a codebook to analyse the interview data. Any codes identified from the data that did not appear in the codebook were included in the e-Wits coding frame/codebook (Creswell, 2009).

3.13 Reliability and Validity

Dale et al. (1988), as cited in Johnston (2014), emphasise that a dataset must be evaluated to ensure it fits perfectly with the research. Since the data were already available, they had to be evaluated for quality and relevance before utilisation. It is necessary to evaluate the code and guarantee the relevance of the dataset. This can be done during the early and late stages of the data analysis (Creswell & Miller, 2000). According to Xiong (2020), cited by Nusche & Minea-Pic (2020), empirical studies have been conducted to examine the integration of teacher ICT pedagogy in the classroom using the Technology, Pedagogy, and Content Knowledge (TPACK) model. However, these studies have reliability and validity flaws. Therefore, this study aims to address and maintain these shortcomings.

Reliability Procedures

In qualitative research, reliability pertains to ensuring the consistency and dependability of the research procedures employed by the researcher, as Gibbs (2007) noted. The researcher followed Gibbs' stance by meticulously reviewing the interview transcripts to conduct thorough

qualitative data analysis. While analysing the transcripts, errors in spelling and grammar were identified, as well as challenges in interpreting the participants' handwriting in Nhlapho's (2022) transcripts. This was due to the participants providing their comments in semi-structured interview responses, making it difficult to read. To mitigate this issue, the researcher carefully read the entire manuscript to identify and address standard terms and expressions that could pose challenges. In contrast, the transcripts of the interviews with Minty (2020) and Ndlovu (2016) were found to be error-free and devoid of such issues.

Validity Procedures

Ensuring validity in research involves confirming the accuracy of the research findings and verifying the accuracy of the researcher's conclusions. In qualitative research, it is essential to validate the findings and establish their accuracy based on the researcher's judgment (Creswell & Miller, 2000). McMillan and Schumacher (2006) describe validity as the agreement between an explanation of a fact and the world's reality.

The researcher employed “member checking” (Creswell, 2009, p. 177) validity procedures to determine the accuracy of the findings. Nokulunga Ndlovu, Rehanna Minty, Mandla Nhlapo, and Ian Moll served as the academic reference group or “member checking”. The primary researchers were essential to the study as they could provide additional information on the respective participants' context, their challenges, and the social context of their studies.

In this research, the accuracy of the themes and the report was evaluated and the researchers were given the chance to offer feedback on the findings (Creswell, 2009). Following the recommendation of (Lincoln and Guba, 1985), a member check-in was conducted to minimise bias in the analysis. The primary researchers and the developer of the e-Wits model were given access to the analysed data. Additionally, data analysis was shared with Rihanna Minty and Nokulunga Ndlovu. Meetings were arranged twice with Ian Moll and Nokulunga Ndlovu to validate the findings. Unfortunately, Mandla Nhlapho could not provide feedback or attend the analysis presentation.

Ian Moll and Nokulunga Ndlovu are among the researchers who developed the e-Wits model. As such, they play a critical part in refining the model, which is a qualitative codebook. Qualitative methods were used to refine the e-Wits model. In this regard, the presence of these

researchers ensured that the e-Wits model's originality was maintained when developing the refined model.

3.14 Consistency

Multiple data sources are imperative to strengthen results (Johnson, 2014). For this study, the three Wits scholars had similar data and concluded that teachers' perceptions and experiences influence how they integrate ICT into their pedagogy. This demonstrates the consistency of the data for the analysis of ICT pedagogical affordances.

3.15 Advantages of Using Secondary Data

For Dale et al. (1988), cited by Johnston (2014), the advantages of secondary data analysis are its cost-effectiveness and user-friendliness. Financial expenditure was not required for data collection because the primary researchers had already collected and stored the data. The secondary analysis also allowed new ideas, frameworks, and theories to be tested (Johnston, 2014).

3.16 Limitations of Using Secondary Data

Limitations are inherent to secondary data analysis. Because of confidentiality considerations, it is impossible to contact the participants from the primary research. The participants' identities are anonymous, based on the ethics and confidentiality principles agreed upon with the primary researchers. This makes it impossible to return to the participants to verify or clarify some of the information collected previously (Johnston, 2014).

The three sets of interview data were not focused on ICT pedagogical affordances. This constituted a challenge for this research because it engendered a misalignment of the research questions. Moreover, the contexts of the original datasets differed from each other. The teachers from the primary data used different ICT tools, and not all the teachers were trained to use ICTs.

Therefore, the secondary researcher had to obtain the original documents concerning the data collection processes and field reports (Dale et al., 1988, cited in Johnston, 2014). Some of the participants' responses from Ndlovu (2016) and Minty (2020) showed a misunderstanding of the questions and ultimately failed to respond to all the questions. Nhlapho's (2022) study used

a questionnaire, making it difficult to gain in-depth knowledge of the participants and understand how teachers use ICT with their learners (Johnston, 2014).

3.17 Ethical Considerations

Research participants, academic integrity, and the study's validity are all protected by a set of consent guidelines or code of conduct known as ethical considerations (Bhandari, 2023). This meant that the researcher had to follow Tripathy's (2013) recommendations about research ethics and the guidelines and norms that applied to using secondary data. The secondary data came from three distinct scholars conducting various ICT integration-related research. The secondary data was obtained from three scholars who conducted research on ICT integration. Their studies were approved by the Human Research Ethics Committee (HREC) of the University of the Witwatersrand and by the Gauteng Department of Education (GDE) for data collection from Gauteng schools. Permission to use this data was obtained from the scholars, and consent forms were distributed to Nokulunga Ndlovu, Rehanna Minty, and Mandla Nhlapho. Additionally, a permission letter is included in the Appendix. The scholars provided their consent for the researcher for re-use and re-analyse.

Access to archived data is governed by the HREC (Non-Medical) Ethical Practice Codes. It was therefore crucial to get consent before using data for study. Regarding access to archival data, this pilot project complies with the University's ethical norms. An ethical waiver for permission was requested and approved by the University of the Witwatersrand ethical Committee in order for the study to move forward. This gave the researcher permission to access the qualitative data that the three previously mentioned scholars had gathered. This is a result of their data being appropriate for the e-Wits framework's pilot program. The study was given permission by the university. Attached in the Appendix is the protocol number and the approval letter.

3.18 Summary of the chapter

This chapter provided a detailed exploration of the ontological and epistemological assumptions used in the study, explaining how these assumptions will affect the research methods. It also thoroughly describes the methods used, including details about the participants and how the primary researchers conducted semi-structured interviews with South African

teachers. Additionally, it discussed the ethical considerations regarding the use of secondary data and acknowledged the limitations of the research.

The next chapter, chapter 4, presents the findings from the interviews. Chapter 4 aims to respond to the first two research questions:

1. What are the teachers' perceptions of the integration of ICT affordances in their teaching and learning?

2. What are the underlying values of ICT affordances that teachers bring to their teaching and learning?

Chapter 4

Findings

4.1 Introduction

The results of a descriptive analysis utilising the e-Wits model are presented in this chapter. Three primary researchers' secondary data sets—from Ndlovu (2016), Minty (2020), and Nhlapho (2022)—were used in this study. Twenty teachers from Gauteng district schools participated in this study. Public and private township schools, including elementary and high, were included in the case studies. The spectrum of teaching expertise among the participants was from novice to experienced. These teachers employed various ICT tools and taught diverse subjects. To ascertain if teachers' views on ICT affordances influence their pedagogical practice, this study set out to map those perspectives. Using the e-Wits paradigm, the research aimed to guide teachers on effectively incorporating ICT affordances into their teaching.

To fulfil the aim of this research study, the following research questions had to be addressed:

1. What are the teachers' perceptions of the integration of ICT affordances in their teaching and learning?
2. What are the underlying values on ICT affordances do teachers bring to their teaching and learning?
3. How can the e-Wits model be used as an analytical tool and inform teachers' pedagogical decisions for effective ICT pedagogic integration?

Teachers can access different ICT tools to facilitate meaningful teaching and learning. Therefore, teachers need to integrate ICT affordances strategically. Hence, it was necessary to understand how teachers integrate ICT affordances into their pedagogy. This helps to create a more learner-centred and learning-centred pedagogy supported by ICT tools (Ertmer & Ottenbreit-Leftwich, 2013).

Analytical Process

The secondary data (interview transcripts) were analysed using a thematic analysis foregrounding deductive reasoning. The e-Wits model was used as the coding frame or analytical tool. When mapping the recognised affordances, the research was guided by the

questions asked by the primary researchers. These questions probed the participants' beliefs, thoughts, awareness, benefits, and attitudes towards ICTs. The participants' responses were mapped as recognised affordances. When the participants responded to questions requiring them to describe how they use ICTs when teaching their learners and those regarding the constraints they encounter when using ICTs, these were considered as used affordances. Some data extracts had grammatical issues, and some participants provided limited responses. This made it difficult to interpret and analyse the collected data. The participants' actual words were used to present the true nature of the original data.

Demographic Description of Participants

The demographic information of the teacher participants in the case studies by Ndlovu, Minty, and Nhlapho is summarised in the table in the appendix. In the study, six participants did not receive any training in ICT integration, while the remaining fourteen had formal training. The sampled teachers represented a variety of disciplines, grades (from primary to high school), and levels of ICT tool access. They varied in teaching experience and ICT proficiency. However, ten participants' ICT usage and teaching experiences were not recorded, and these details were not included in Minty's research study. This study, therefore, classifies the schools into two categories. The first group of five teachers worked in townships with limited resources, while the second group of 15 teachers worked in "Smart Classrooms" with internet access, where the GDE provided tablets for learners to use.

4.2 Mapping Teachers' Recognised ICT Affordances

This section provides data findings and analysis of data to respond to the following research question:

1. What are the teachers' perceptions of the integration of ICT affordances in their teaching and learning?

4.2.1 ICT Affordances for Technical Interaction

Intuitive Interface

Employing the e-Wits model as an analytical tool helps to understand teachers' perceptions of ICT pedagogical affordances. The data revealed that teachers are aware of the affordances

offered at a technical level, both in township and urban areas, irrespective of the available ICT tools. Teachers attribute this to the notion that technology should facilitate teaching and learning and that it does not replace teachers. ICT should be used to supplement classroom activities and traditional teaching methods. One teacher notes:

> *"For me, it is but one of the tools that we can use to assist teaching and learning; it cannot replace a teacher. I understand we have smartboards, etc., but a teacher is indispensable" (Moruti).*

ICTs are said to enhance teachers' pedagogical practices and provide convenience. Whenever teaching and learning occur through technology, teachers believe technology should reflect their usual way of teaching without technology. This is evident from their use of smartboards for the transmission of information. Under the traditional teaching approach, teachers use chalkboards to write notes and hardcopy textbooks. Conversely, on a smartboard and digital textbooks are readily available for teachers to access and display to learners. Their idea of ICT integration is to maintain teacher-centred pedagogical practice, which is challenged by the convenience associated with ICTs. One participant elaborates:

> *"...we often use textbooks from the smartboards and then, when I say, when I am talking about paperless, everything that we do, especially we teach using everything we use technology, like textbooks, we give feedback using the smartboards" (Mr Bonga).*

It is also expected that technology will be accessible for both teachers and learners to use, with limited to no technical difficulties. This means that teachers want to use ICTs based on how they perceive the technology. The design and functionalities of the relevant ICT influence this perception. If an ICT tool has click or swipe capabilities, it is expected to function as such. Teachers highlighted that sometimes smartboards do not respond to touching or swiping – technical interaction – as the smartboard would freeze. Therefore, they resort to their old teaching approach involving chalkboard writing. One participant comments:

> *"...heavy and the other thing which makes it difficult for us, most of the smartboards they just freeze" (Mr Sangu).*

ICT is usually in the hands of the teacher. If learners have access to ICT tools that enable scaffolding, these must allow learners to respond to multiple-choice questions forming part of

formative assessments. Teachers then use learners' responses for scaffolding purposes, as learners would make decisions promoting learner-centredness. Interactive learning is achieved as learners engage with the multiple-choice questions. One teacher shares:

> *"When it comes to true and false questions, yes or no, multiple choice, no, we do, we can do tests" (Ms Gheza).*

Not only should the tool make resources easily accessible, but it must also function as expected. In advanced cases, learners use interactive games. Therefore, any ICT tool with click or touch capabilities must function effectively – the tool must be interactive. One teacher notes:

> *"In teaching maths, can watch videos, use interactive games" (T2).*

The ICT tools must function effectively for classes to be interactive for learners and their teachers. Moreover, teaching and learning resources must be easily accessible on the tablet or the smartboard. One participant shares:

> *"…make use of the smartboard, tablet and a teacher using the laptop in everything like with the test, the quiz, classwork, textbooks and everything, that it should be within the gadgets" (Ms Nkosi).*

When learners can access smartboards and tablets, teachers believe it is easy to write (equations) using smart notes. It is also easy and time-saving to display content on the smartboard. Regarding the specific software used in Maths, Mr Smith noted that by just entering a mathematical equation on the software, one can efficiently and promptly generate graphs for learners to see. In this teacher's own words:

> *"…we have smartboards which enable our maths teachers to make that a little bit easier when they say, for instance, use the smart-note and it, they can use equations, and show the kids better on how it can quickly, take an equation and put it on a graph, you know for an example" (Mr Smith).*

Ubiquitous Teaching and Learning

The introduction of technological tools such as laptops and tablets has made teachers aware that teaching and learning are not constrained to the classroom walls, nor are they bound by time and geographical location. Teaching and learning can take place anytime, offering

potential flexibility. This is particularly true when teachers and learners can access mobile or portable devices. Teaching and learning should continue even at home, where learners can refer to the digital resources installed on their tablets provided by the GDE. T2 and Ms Mashego reiterate this. Technology's flexibility allows teachers and learners to cover concepts that could not be covered during contact time. These two teachers note:

> *"…bring their tablets, mostly give them assignments to do at home on their gadgets" (T2).*

Teachers have administrative duties that, sometimes, cannot be taken to the classroom. For T2, ICT-based teaching and learning is beneficial, irrespective of location. Another teacher concurs:

> *"…meaning that teaching and learning anytime irrespective of how busy you are you are in, or you are out, teaching and learning can take place. It does not need you to be there" (Ms Mashego).*

The digital resources learners can access and use remotely include videos, digital textbooks, and notes about different subjects. Learners can play or access recorded lessons and complete and submit activities online. Mr Sangu and Mlingani shared similar sentiments in that ICT allows learners to do activities without the teacher's physical presence at the location. One teacher emphasises:

> *"I could even teach even if I am not at home or school, sorry. Say I am having a meeting somewhere. Then I put my lesson through the recording, everything, and then they can see me talking to them through the smartboard. Then they do the work, submit it to me, and then I mark it" (Mr. Sangu).*

Social Media

Teaching and learning can happen anywhere and anytime. A classroom can be digital and not confined to a specific physical location. Mr Namane observes that one can use WhatsApp as a virtual classroom. Learners can post videos and other learning materials to watch or access here. Two teachers explain:

"I must go on WhatsApp with the learners, have a clear virtual classroom, and they must have videos that I can say, "Go to your video" (Mr Namane).

"…and bring it that is what I understood about the whole thing" (Mr. Sangu).

Learning Management Systems, Content Management Systems

Learners are encouraged to access OER content from Siyavula and Tendro. These sites are Content Management systems (CMSs) that offer free educational resources in Maths and Science. Learners can access questions and lessons relevant to a particular grade on these sites. These could assist learners in responding to or solving Maths and Science questions at their own pace and time. One teacher comment:

"... Siyavula is not something that is created at the school; it is created outside. Uhm, we encourage our learners to sign up, and the questions are there for them to practice independently" (Ms. Gheza).

"Siyavula, they are linked, the TendoPro and the Siyavula, all of them they are linked. They can access it, the questions they are, it is nice the way it is done, arranged by topic, arranged by grade" (Ms Gheza).

CMSs are ICT tools where learners can only access the content. However, teachers are aware of learning management systems (LMSs) such as Moodle and Google Classroom, which enable interaction between teachers and learners. This fosters ubiquitous and polysynchronous teaching and learning. Two teachers reflect:

"There was another software called Moodle. Yes, there was Moodle software, but we were not adequately trained" (Mr Namane).

"… just trying to make everything electronically and the kids can get all on a tablet, maybe Google Classrooms or whatever the case may be in that form. So, we trying to that" (Mr Smith).

Flipped Classroom

Very few teachers know they can synchronise learners' tablets with teachers' laptops and smartboards. This fosters an effective monitoring of what learners do and share with others. One participant shares:

> *"...they say that on smartboard I can monitor, on smartboard when my learners are writing like that, I can have them all of them connected via email, there is a way it set up ok so that I can click Siyabonga's and see what Siyabonga is writing on his tablet and then when he is done, he can email" (Ms Gheza).*

Material Development

Teachers receive readily made resources such as lesson plans from the GDE and contracted teachers. However, Mr Sangu contended that a knowledgeable teacher cannot use these resources. This is because they need to be adapted to their learners' specific contexts and needs. To achieve this, teachers must have extensive knowledge about their subject. They also need to know how best they can deliver their lessons and be mindful of the resources they need to use. One participant highlights:

> *"But if you know the content and can readjust wherever you want, at least you have something to start on. Unlike you, you have nothing to work on but must go through the lesson plan. Then you re-shuffle whatever; you put in whatever is not there so that the learners could understand better" (Mr. Sangu).*

ICT training programs have taught teachers to record and share their lessons with their learners using smartboards and laptops. Learners can watch the recorded videos on their smartboards or their tablets. Thus, they do not have to rely exclusively on the recorded videos found online and those provided by the GDE through its educational platforms or hubs. Two participants highlight:

> *"I could even teach even if I am not at home, at school. Say, I am having a meeting somewhere, then I put my lesson through the recording, and they can see me talking to them through the smartboard" (Mr. Sangu).*

"You must be able to save your work, you must be able to record, and you must be able to use what is installed with the PS in the smartboard" (Ms Mashego).

The participants emphasised critical themes related to technical interactions with technology, stressing the importance of user-friendly technology (intuitive). Mr Bonga highlighted the significance of technology in providing learners with timely assessment and feedback. Additionally, math teachers accentuated the inherent nature of technology and the efficiency and automation provided by using mathematical software to create graphs and images by entering equations. The second theme focused on technology enabling ubiquitous teaching and learning, rapid resource sharing and communication. Teachers stressed that learning is not confined to the four walls of the classroom and can take place at any time and from any location through e-learning and social media platforms. These platforms can be used for virtual classrooms and communication.

4.3 ICT Affordances for Information Interaction

Multimedia

For the participating teachers, integrating technology does not significantly differ from their traditional teaching methods. It is only there to make things easier and deliver lessons quickly. This is achieved by displaying previously prepared notes on the smartboard. Conversely, teachers would write notes on the chalkboard in the traditional classroom. This is time-consuming. One teacher notes:

"I would say it has not changed that much; it has not changed that much, only that now, as I say, I have my notes prepared so it does not start writing the notes down and all those things, they are there, even the examples they are they and then you go step by step. It is easier and faster, but if you are still going to start writing, it takes some time" (Mr. Sangu).

Teaching is not solely influenced by the teacher's delivery of a lesson. Teaching also depends on multimedia resources such as videos. These illustrations are said to be valuable in teaching. However, as much as videos may constitute teaching resources, learners are expected to complete formal or informal activities and visually display what is expected of them. One participant notes:

"Play videos for learners to show them how to create a crane for their project" (T3).

Learners must write since they are expected to watch with a purpose, such as in Mathematics. Therefore, passively watching a video poses a challenge. One teacher explains:

> *"Like you cannot learn mathematics, like only observing, you need to write it unless they type, but you know sometimes it is cumbersome to type mathematics" (Mr. Dlamini).*

It is believed that using videos helps to address learners' differing learning styles and promote inclusivity. One participant indicates that:

> "*Learners can see and hear lesson (videos) and do some practical" (T5).*

Teachers believe that using multimedia to teach in the classroom does not only require the teacher's voice. Therefore, it is crucial to integrate digital resources such as videos, images, animations, and digital textbooks. These could be downloaded from the Internet or be accessed on the smartboard. These digital resources are said to assist with lesson delivery in the classroom. They constitute a means of providing knowledge in different ways. This is because not all learners in the classroom can capture the concepts taught the same way. One teacher notes:

> *"I can say about the use of technology, and then they watch videos, we can teach, sometimes we can play videos, using the smartboards, and you can upload documents to their phones or tablets" (Mr Bonga).*

Sometimes, the concepts in subjects such as Geography are too abstract. Consequently, learners cannot visualise what the teacher may be referring to, such as when teaching a lesson on volcanoes. By playing a video for learners to watch, the teacher enables them to see what a volcano is instead of relying solely on what the teacher says. One participant illustrates:

> *"Let me give you an example: you are dealing with a volcano; you do not want to risk the safety of the children by making an artificial volcano here that will burn them. It is safer if they watch this thing through this thing" (Moruti).*

In certain instances, digital textbooks are installed on smartboards with the belief that they can only serve to refer learners to specific pages or display them on the smartboard when teaching.

> *"...you know, so I will not go to it unless when they are, I refer to their textbook for the assignment or refer to this page and this, but sometimes just for safety's sake" (Mr. Dlamini).*

Digital textbooks are not only installed on smartboards but also on learners' tablets. These two devices come preloaded with these digital resources for easy access. Both teachers and learners can promptly access their textbooks. This translates the move away from the traditional chalkboard to digital resources. One teacher comments:

> *"Now that the textbooks are in the learners' tablets as well as on the smartboards, we are burying the chalk because we are no longer using any chalk here, we do not have any dusters, we are simply teaching now on the smartboard" (Ms. Sedise).*

Classrooms are filled with diverse learners with different learning skills and academic challenges. Hence, teachers believe that multimedia such as videos, pictures, animations, and PowerPoint presentations would help guide learners more effectively.

> "*Scaffolding, guided instruction through videos, PowerPoint presentation, animation" (T1).*

Even in abstract subjects such as mathematics, learners can watch recorded videos the GDE provides. They can also watch videos downloaded from the Internet that another teacher is explaining or teaching. This exposes learners to a different teaching style. Innovative ways of teaching Physical Science are employed in virtual laboratory. One participant notes:

> "*When teaching using interactive videos and virtual labs" (T5).*

Access To Worldwide Resources

Teachers cannot rely solely on the GDE content on the smartboard and learner tablets. They can also access other resources from the Internet to reinforce what they already have. One teacher acknowledges:

"They installed textbooks, yes, and then on the smartboard. Also, there are textbooks and some websites where you can add more information on a certain subject, like mathematics or any other subject..." (Ms. Puti).

Summary of the findings

The study revealed that many teachers view multimedia integration, also referred to as Open Educational Resources (OERs), into their pedagogy as highly effective and innovative. This includes using tools such as PowerPoint presentations, digital textbooks, videos, and interactive simulations accessed through smartboards or projectors, either through the Internet or shared among colleagues. There is an increased emphasis on customising digital materials to cater to the specific needs of individual learners. In this context, teachers are seen as the primary source of knowledge, responsible for curating, organising, and delivering content to their learners (teacher-centred approach). While there is a consensus that OERs are beneficial for teaching and learning, it is noted that they should be adapted to align with the diverse needs of learners.

4.4 ICT Affordances for Epistemological Interaction

Adaptive media

Teachers who teach science, technology, and maths, which are subjects requiring learners to visualise abstract concepts, such as geography, fall into this adaptive media epistemic category. These teachers believe that ICT can assist learners in conceptualising, visualising, providing knowledge relations, and generating new knowledge. Teachers also think that they can expose learners to concepts that are unfamiliar or difficult to visualise. Therefore, teachers rely on various multimedia to demonstrate and explain certain aspects. This gives learners a sense of what is taught. One participant comments:

"*...you are dealing with things which in real life are dangerous…let me give you an example: you are dealing with a volcano, and you do not want to risk the safety of the children by making an artificial volcano here that will burn them. It is safer if they watch this thing through this thing" (Moruti).*

Sometimes, these videos are used to emphasise concepts. Ms Puti, a Maths teacher, and T1, a Geography teacher, believe that using videos can assist in emphasising concepts. Moreover, they believe it can help learners understand what is taught in their subjects. Two teachers note:

"…integrate technology where you want to emphasise some of the, maybe the concepts or things that they do not understand in mathematics" (Ms. Puti).

"Improves learner concentration, captures learners' attention" (T1.)

Most schools are constrained by the lack of equipment or science laboratory where learners can do experiments in Physical Sciences. Despite these constraints, teachers are expected to conduct these experiments with learners. Mshini believes that using simulations and illustrations is beneficial in demonstrating experiments. This helps to mitigate the situation and enhance learners' understanding.

"It is probably trying to do maybe things that would not be able to, like if you want to show illustrations. That will probably be yah, there can be simulations that you can maybe adapt" (Mshini).

"Or if there is an experiment, just when you are demonstrating a simple experiment. Sometimes there are flow diagrams" (Mshini).

In mathematics, teachers can draw graphs and shapes using GeoGebra software. This helps to show the relationship between equations and geometric shapes skillfully. One participant reflects:

"…deeper because the content, you know, mostly it was the icons, you see if you want to draw a graph, you want to plot a graph, maybe you want to insert a shape, you know the angles and stuff, you know geometry and mostly it was on plotting graphs and on the formulas as well…" (Mr. Dlamini).

Learners can access videos, textbooks, and question papers on their tablets. These are regarded as additional resources that can assist learners in better understanding the content. They do not rely solely on what the teacher says during class. When learners are exposed to different material, they have an opportunity to interpret concepts and questions. One teacher indicates:

"…has attributed in the interpretation of questions", By accessing learning material on their tablets to supplement what we gave them as hardcopies" (T5).

Learner-Centred Pedagogies

Having access to additional resources on their tablets is not enough. Learners are expected to use these resources to practice and perfect their mathematical and physical science skills independently.

> *"...project the question paper there, they do it on their own and together. We observe how the projection goes and how they get the answer" (Mlingani).*

> *"...learners can do the activities on their own using their tablets, and they can return those lessons to you" (Ms. Mashego).*

Furthermore, teachers who teach abstract subjects such as geography, physical science, and mathematics were mapped as being involved in this level of epistemic interaction. These teachers appeared to view multimedia, such as videos and pictures, as fundamental for conveying abstract concepts to learners. It is important to note that teachers and learners in this study have limited access to ICT tools and are situated in a township with restricted ICT infrastructure. Thus, their perception of multimedia is regarded as beneficial in aiding learners in acquiring knowledge and solidifying concepts. For example, geography teacher Moruti incorporates multimedia, particularly videos, to help learners visualise volcanoes while addressing safety concerns instead of creating artificial displays. Similarly, virtual laboratories, simulations, and multimedia are seen as highly beneficial in aiding learners' understanding of experiments taught by physical science teachers as the schools struggle with conducting scientific experiments. Multimedia is also believed to enhance learners' concentration, which is beneficial during scaffolding, and it also promotes learner-centred pedagogy through activities accessible on the learners' tablets or shown on the smartboard. Teachers believe learners may become more skilled at solving complex mathematical problems when using multimedia.

4.5 ICT Affordances for Social Interaction

Sharing Information

Teachers are knowledgeable about other forms of communicative media. These include sending documents via email and social media applications. Where face-to-face

communication or instruction is necessary, they use video-conferencing platforms. One teacher observes:

> *"...these soft files and I even said sometimes you do not need to come to school, but I can email you the files" (Mr Namane).*

> *"...you do not need to come to school. I can email you the files, but the facilitators still do not want them. It is difficult, as I said, sometimes. We can Skype. You can visit me via Skype. There is a WhatsApp video call" (Mr Namane).*

Monitor and Manage ICTs

Usually, the monitoring of ICTs is perceived as a constraint. This is because teachers and administrators need to monitor what learners have downloaded from the Internet manually. Teachers must ensure that tablets are not used in class, during teaching, and learning. In such cases, using tablets is a disruption instead of a tool to enhance teaching and learning. Teachers also believe that rules and regulations must be implemented for effective teaching and learning. These rules should stipulate when and how learners can use their tablets.

"But be everything, it would be the constant monitoring of what is in their tablets" (Mr Nkosi).

Teachers know various online communication platforms to share information and enhance learning, including social media, email, and video conferencing. However, the ability of these online systems to efficiently track learners' ICT usage is a widespread worry. Teachers emphasised that physical oversight of internet downloads and ensuring tablets do not interfere with teaching and learning were necessary to address the issue. To improve teaching and learning outcomes, teachers support the development of policies that define acceptable times and uses for learners to use tablets.

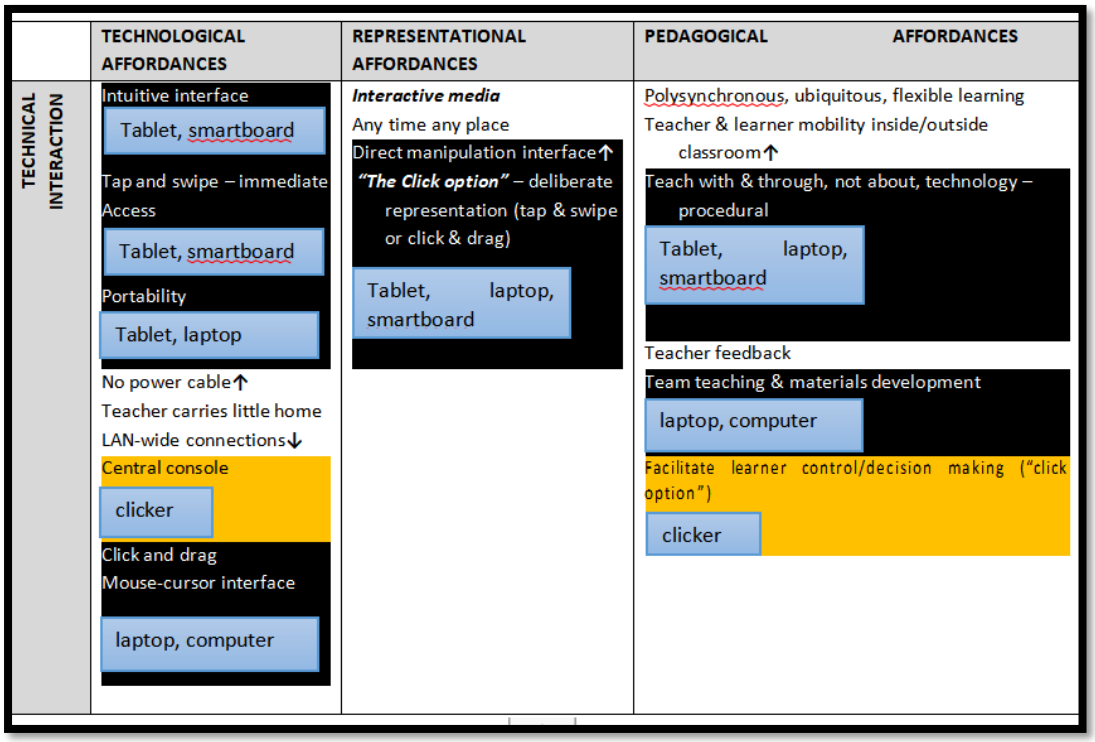
Mapping Teachers' Used ICT Affordances

The e-Wits model was used to map teachers' ICT pedagogical affordances in their practices. The black colour denotes the use of ICTs that are unspecific to a subject. The ember highlights a teacher's use of a specific ICT tool, with specific ICT affordance, in a specific subject such as Maths and Science.

4.6 Used ICT Affordances for Technical Interaction

Intuitive interface

Table 2: Used technological affordances



In the interviews, teachers explained how they use technology in their classrooms. They revealed that they use smartboards for writing. This is because the smartboard enables them to write as they would on the chalkboards and makes it easy to erase. One teacher shares:

> *"Smartboard, we are just writing. There is nothing that we can say is electronically or what. I'm just doing; I'm explaining writing and erasing" (Ms Puti).*

The smartboard is interactive and enables the manipulation of images or illustrations displayed. Specific applications, such as GeoGebra and Smart-Art, are used by Mathematics teachers such as Mr Namane. They use these applications to display 3D shapes and graphs. These applications are interactive in that teachers put in Mathematical equations that result in automatic representations of graphs and shapes. Two teachers explain:

> *"Smartboard because on the smartboard we have an application, a notebook and that notebook has all sorts of interactive media, so as you are putting sums it automatically*

draws a graph, there that program but the learners do not have it on their tablets" (Mr Namane).

"I will be able to save the work, so the other class, when they come, you just open that page. Guys, you write these notes, then I explain, "You save a lot of time" (Mr. Bonga).

However, teachers experience technical difficulties with smartboards, as they tend to freeze. Limited technical support leads to teachers avoiding using smartboards. One participant confides:

"That one is heavy, and the other thing that makes it difficult for us is that most of the smartboards just freeze, and our technicians are no longer there" (Mr Sangu).

At times, smartboards and other applications do not respond as expected. One teacher notes:

"We have that, but now the problem is that it is difficult to use it on our smartboards. I do not know whether they have been programmed wrongly because immediately you touch a ruler, it goes that way (laughs). If you touch a compass, it does not want to work with you" (Mr. Sangu).

Teachers mostly use the click affordance to access resources on the laptop or the smartboard. This is the case with Mathematics teachers who want to display shapes to learners on the smartboard. They know where they can access and display the shapes on the smartboard. Most of the teachers do not engage learners using clickers. In Takalani's case, teaching Geography, an i-box is used to display slides on a whiteboard. Learners use clickers to respond to multiple-choice questions projected on the whiteboard. Learners participate by responding to the projected questions as they press on their clickers. Two teachers indicate:

"Learners are provided with a clicker. They use the clickers to respond to questions" (Takalani).

"I simply click for that particular shape; the correct shape will come out" (Ms. Sedibe).

Material Development

Teachers interact with laptops by utilising the click-and-drag and mouse cursor interfaces to prepare educational material. Some teachers do not rely on resources from the Gauteng

Department of Education (GDE) or those prepared by teachers from other schools. They edit teaching and learning material, such as lesson plans. For this to happen quickly, teachers must be knowledgeable about their subject. In some instances, teachers would prepare material such as question papers, which they use for assessment and administrative purposes. Six teachers note:

> *"But if you know the content and can readjust wherever you want, at least you have something to start on. If you do not have anything to work on but must go through the lesson plan, then you re-shuffle" (Mr Sangu).*

> *"Yes, we make some changes here and there because, with lesson plans that were prepared by someone else, you might find there are some challenges, or there are some areas where you need to make some corrections" (Ms Sedibe).*

> *"…use the bare minimum on the laptop, you know, the normal, Word, typing of the exam papers and things like that and also the programs related to their subjects" (Mr Smith).*

> *"Preparing ICT integrated lessons is time-consuming" (T3).*

> *"I usually do them on my own, or find what is already available and just modify …I do not have time to start from scratch … I am busy on the computer like typing question papers myself" (Mshini).*

> *"…normally use my laptop to type the questions, you know eh, ja so and then their marks, of course, we record them on my PC to check their performances... type my assessments, you know and flash them on the board" (Mr. Dlamini).*

Teachers use the click-and-drag affordance to prepare teaching and learning resources. This is because they find preparing their resources from scratch time-consuming. Teachers' most preferred way to prepare ICT-integrated lessons is to find readily available teaching and learning resources online and adapt them. This minimises the time requirement associated with preparing resources from scratch. Teachers also use the click-and-drag affordance to edit teaching and learning resources. Moreover, teachers use this affordance on an Excel spreadsheet for administrative purposes to record learner performance and present marks graphically or statistically.

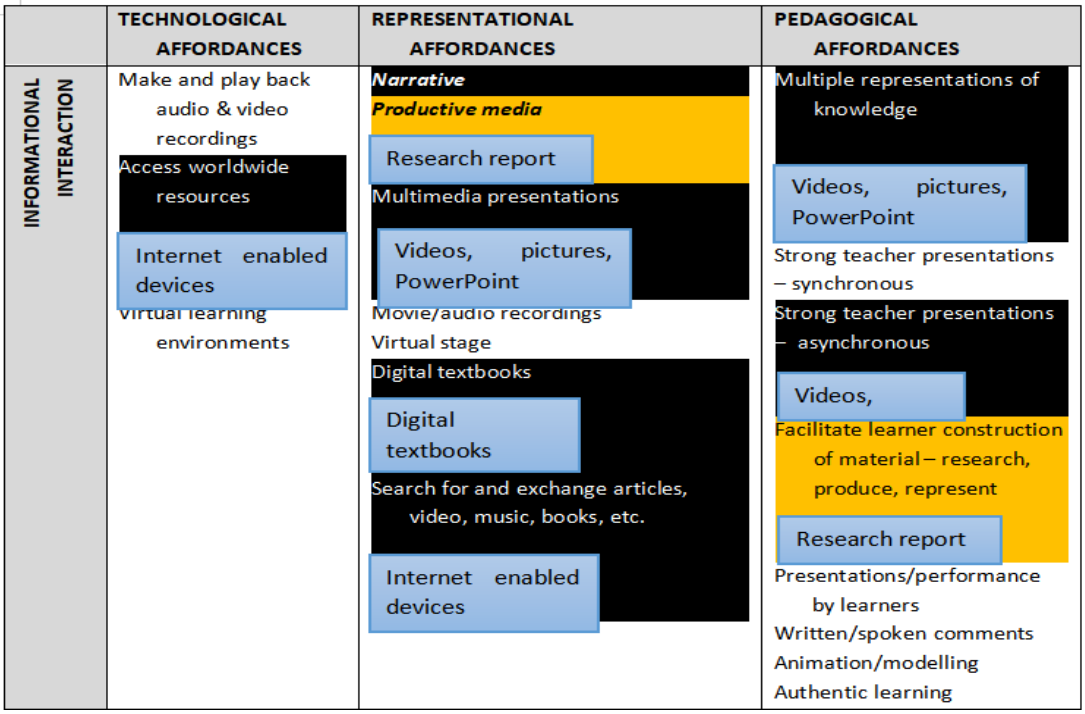
"Even *my mark sheets were typed, and now when we enter the main administrators' office, they have a problem with the calculations now, and they used to call me..." (Mr. Sangu).*

"I normally use my laptop to type the questions and their marks; of course, we record them on my PC to check their performances" (Mr. Dlamini).

Teachers adapt and contextualise OERs using fundamental computer skills to serve their learners' academic needs better. They obtain these digital teaching resources from the internet or other teachers and tailor them to match the topic and the specific needs of their learners and classroom. The reason for the contextualisation of multimedia tools, primarily open educational resources, is usually based on the fact that these resources follow Western-centric content.

4.7 Used ICT Affordances for Informational Interaction

Table 3: Used ICT affordances information interaction



Access Worldwide Resources

Teachers use the digital resources provided by the GDE and those shared by other teachers. Access to the internet allows them to browse digital resources suitable for their learners'

relevant topics and contexts. Teachers access videos for free on YouTube and present lessons in different audio-visual ways. Two teachers confide:

> *"I browse the internet for material related to the topic that I am presenting. There are some websites I like visiting" (Sizakele).*

> *"I download these good videos from the Internet, YouTube, and then you know why I feel this teacher sometimes presents lessons" (Mr Dlamini).*

The intention of accessing online resources is to promote inclusivity. This entails accommodating learners' differing learning preferences by accessing various multimedia. One teacher explains that:

> *"Some of the kids find it difficult to understand sometimes. So, there are so many videos on YouTube that teachers use …" (Mr Smith).*

Teachers find the process of searching different videos on the Internet tedious. This is particularly relevant when the videos are to be played briefly. As one teacher puts it:

> *"Time-consuming, you would spend hours searching for resources that will be spoken about for a minute" (T4).*

Not only are videos and documents searched and downloaded from the Internet, but Mathematics teachers also use question papers and application software (GeoGebra). These can be downloaded onto the smartboard or laptop and displayed to learners. This shows learners how different questions are asked and how to display mathematical shapes or graphs using the software. This is the case if the GDE does not provide it. One teacher indicates that they:

> *"We downloaded the GeoGebra from the Internet and shared it with learners" (Mr. Nkosi).*

Narrative Media

Teachers indicated that they prepare teaching and learning resources. They also use projectors connected to laptops and smartboards that enable the projection of the prepared teaching and learning material. These include notes, digital textbooks, illustrations, videos, and PowerPoint presentations. Learners must copy the displayed information into their books by adopting a

teacher-centred approach. Mr Namane encourages a much easier way of copying from the smartboard. He advises his learners to take pictures of the displayed notes instead of writing, as described by Sizakele, to save time and focus on the teaching. In cases where learners have access to tablets, they access these resources on their tablets. This is because some of the resources are readily available to learners. The GDE preinstalls these resources. In instances where schools have functional computer laboratories, learners are encouraged to use these facilities and engage with the software under the guidance and supervision of their teachers. Two teachers elaborate:

> *"I have my notes prepared, so it is not to start writing the notes down and all those things; they are there, even the examples. They are there, and then you go step by step. It is easier and faster, but if you are still going to start writing, it takes some time" (Mr Sangu).*

> *"I prepare my notes and project them on the wall…I do not write notes in the presence of learners. So, when they come, I only display them and explain what the notes are about…To translate in their books. Since we have a problem with the printing, they sometimes restrict us from printing in bulk. So, to avoid wasting time writing notes for them on the chalkboard-simply use the projector (Sizakele).*

Teachers tend to display notes and other teaching and learning material that they expect learners to watch, take notes on, or copy. This fosters limited social interaction and cognitive development. The use of digital resources or ICTs does not demonstrate improvement from traditional teacher-centred pedagogical practice. Learners are passively engaged as the digital resources are used. Teachers display the notes on the smartboard or project them. They also use videos available on the smartboard or downloaded from the Internet. These serve to narrate specific concepts to learners.

> *"Download the video and share it with them. Truly, they will not watch it, so sometimes I will flash it in there, and then they will watch it while we are busy, and then I explain" (Mr Dlamini).*

In other cases, teachers use presentations delivered to other learners by their teachers. Science, Technology, Engineering, and Mathematics (STEM) teachers use simulations and interactive videos. Five teachers elaborate:

"Let us say I am teaching shapes, so in a smartboard, I can show the learners those shapes (Ms. Mashego).

"So, then learners must transcribe, it is time-consuming, and I only have 2 hours with the learners. They cannot write everything, but if they can simply take a picture..." (Mr Namane).

"The tablets have specific teaching programs and software that can explain quadratic equations. Learners observe from the tablets and see how the problem was solved" (Mlingani).

"HDMI cable, and I can work from that because textbooks are not only on the smartboard, but on our laptops, and on learners' tablets" (Mr Nkosi).

"Grade 11 and 12, they gave eh, the memory cards, the SD cards that had lessons, the interactive videos, previous question papers, so at least they have a source, now you can tell them, go to the 2015 question paper June, this is how a question was asked, you must go to the memorandum, see how the response was. So, but learners are keen" (Mr. Namane)

Smartboards and projectors are convenient because teachers can re-use their previously prepared material instead of writing notes on the chalkboard. Not only do teachers prepare resources or notes to be displayed to learners, but the smartboard also has pre-installed teaching resources. Both teachers and learners can consume these. These resources include digital textbooks, notes, videos, and question papers from different subjects. Learners also have these resources that can be consumed at any time and place on their tablets. Learners do not necessarily have to rely on the resources installed on the smartboard, as they can access them on their tablets. Three teachers share:

"*...pure maths teacher, is always with a laptop, always with a laptop. There are videos, he is playing videos, always, now" (Mr Namane).*

"When teaching using interactive videos and virtual lab" (T5).

"Download the video and share it with them. Truly, they won't watch it, so sometimes I'll flash it in there, and then they'll watch it while we are busy, and then I explain" (Mr Dlamini).

However, these resources are only used passively or as a reference, mainly textbooks. Teachers use them for convenience, to replace hardcopy textbooks. They refer learners to these digital textbooks for extra homework or classwork activities. These four teachers confide:

"I refer to their textbook for the assignment or refer to this page and this, but sometimes just for safety's sake" (Mr. Dlamini).

"The lesson will be portrayed on the wall with the details of things they have never seen before…. if I am talking about a volcano they have never seen before" (Takalani).

"For presentation, laptop and projector" (Moruti).

"They have textbooks on their tablets, so I tell them, OK, guys, let me try to fix them. While I'm trying to fix the smartboard, I open up the page and say, "Guys, let's try to solve this" (Mr Bonga).

Productive Media

In specific cases, learners use the internet to access resources for assessment purposes. Geography (FET) teachers indicated that learners from Grade 10 to Grade 12 are allowed to conduct formal research on specific topics. Learners must access information or data from the Internet, including articles and pictures. The intention is to submit a written report that forms part of their continuous assessment called School-Based Assessment (SBA). Learners are taught specific topics before the research. Subsequently, they are guided on conducting the research, what is expected from each learner, and how they would be scored. Two teachers share:

"...if they are going in class with the teachers giving them direction as to which topics they should search from the internet" (Takalani).

"So, with the SBA, its formal recorded tasks. One of the components is what we call research topic.... they must go and research" (Moruti).

Teachers use open educational resources like videos and notes accessed through the internet and some provided by the GDE to create engaging learning environments. However, they find the process of searching for digital resources time-consuming. The current use of these resources also reflects a teacher-centred approach, where material is displayed on the board for learners to consume. This reflects a teacher-centred, traditional classroom approach, with active learner participation that is not typical and learning that is passive. How teachers would use multimedia tools to engage or evaluate learners' understanding was not seen.

4.8 Used ICT Affordances for Epistemological Interaction

Table 4: Used representational affordances for epistemic interaction

	TECHNOLOGICAL AFFORDANCES	REPRESENTATIONAL AFFORDANCES	PEDAGOGICAL AFFORDANCES
EPISTEMOLOGICAL INTERACTION	Temporarily restrict to one app only Choose app features Disable screen/ hardware buttons Learning management systems Content management systems Siyavula, Thutong	***Adaptive media*** Guided access/management of cognitive load Siyavula, Thutong Facilitate learning environment Create concept maps, plans, diagrams, pictorials, graphics GeoGebra Prevent accidental gesture distractions Disable task irrelevant screens	Stay on task Flipped classroom Siyavula, Thutong Facilitate learning centred tasks Diverse experiences beyond everyday GeoGebra, Videos Facilitate learner focus / 'ownership' Complex calculations Siyavula, Thutong

Adaptive Media

GeoGebra, a math software application, is used by mathematics teachers to accommodate different learning styles. It helps to visualise and understand mathematical graphs and shapes in the classroom. It is used in a teacher-centred pedagogical approach. Teachers display mathematical graphical presentations to learners on the smartboard. Learners observe the automatic display of graphs and 3D shapes regarding an equation provided by the teacher. Teachers indicated that using GeoGebra enhances their lessons and makes things easy. Instead of manually drawing the graphs on the chalkboard, the software does that quickly through automated responses. The seven maths teachers indicated that they use this software when

teaching the geometry section. However, two teachers, Mr Sangu and Ms Puti, explained that they had abandoned the application and had resorted to using traditional Maths instruments, such as a protractor and a compass, in teaching this topic. Mr Sangu attributed this to inadequate training on using the application and the incorrect programming of the software. Three teachers indicate:

> *"We normally draw graphs, uhm, like shapes. It becomes easier because of the shapes; when you use that software for drawing, they can see what the drawing must be like and be accurate... OK, guys, you can take some photos of these notes or maybe this graph, then go home, and then you practice" (Mr. Bonga).*

> *"Use when we are drawing, we do have some shapes that can be used because as it is now if I can say let me draw a shape" (Ms. Sedibe).*

> *"They use GeoGebra, and they also use the smart-note software, which includes a wide variety of things there, including GeoGebra that's included there" (Mr. Smith).*

Mathematics teachers use the software application to display and narrate for learners. Projecting graphs and shapes is not used to promote learner engagement. Three teachers confide:

> *"…use of what is there for Maths, which is installed there, I can go to congruent angles if I just say congruent angles, there are eh, there are saved angles for me there, instead of me drawing them, they are already available" (Ms. Sedibe).*

> *"Let us say I'm teaching shapes, so I can show the learners those shapes on a smartboard" (Ms. Mashego).*

> *"When it comes geometry, I can project this; it makes life so easy" (Ms Gheza).*

When the smartboard or the application does not respond, teachers stop using it. *Two teachers share their frustrations thus:*

> *"Geometry, I cannot even use it because it is very difficult to use those protractors and compasses on the smartboard" (Ms Puti).*

"We have that, but now the problem is that 3ES is difficult to use that thing on our smartboards. I do not know whether they have been programmed wrongly or not because immediately you touch a ruler, it goes that way (laughs). If you touch a compass, it does not want to work with you" (Mr. Sangu).

To help learners understand and visualise concepts in Maths, Mlingani uses videos. Learners watch videos of another teacher online or provided by the GDE. These videos focus on a particular lesson or topic concerning how different mathematical problems are solved and how to address ambiguity. Mlingani engages learners after watching the video. This helps to address specific questions and elaborate solutions with learners. Learner-centred strategies and peer-to-peer engagement are encouraged as learners share how a mathematical problem is solved and which method is best or could be used. This teacher explains that:

"The tablets have specific teaching programs and software that can explain quadratic equations. Learners observe from the tablets and see how the problem was solved" (Mlingani).

Correspondingly, teachers resort to videos in subjects such as Geography, where learners need to be exposed to objects and concepts that they do not engage with daily, such as volcanoes. These help to expose learners to these concepts that are not within their local contexts or surroundings. Learners watch videos, usually downloaded from YouTube, to illustrate what is taught. One teacher explains:

"Complex topics when you want to show the interrelation between 2 or more things…like when teaching settlement, it is complicated. But using ICTs, we can simplify and break it down into steps…You can show that in the visual aids" (Takalani).

Content Management Systems

Mr Smith, representing an affluent school, indicated that their school has a website or hub. Here, all grades' teaching and learning materials are uploaded by subject teachers. New learners in the school are given a crash course on how to access the material for their specific grade and subject. With the Internet, learners access OERs, especially Maths teachers such as Mr Nkosi and T2. Pure Maths learners are encouraged to access previous question papers from the Thutong repository. This enables them to practise and see how different topics are examined. Learners can expand their Maths skills by accessing and using the Siyavula hub.

This is an interactive LMS with Open Educational Resources. Learners with financial limitations can easily access the platforms Mr Nkosi and T2 mentioned. From the perspectives of these participants, these repositories foreground the issue of access to resources. Through these repositories, learners can access diverse additional resources to supplement those they receive in class. Three teachers share:

> *"Your tablet is where you download your books, and this is how you open your books. "So, we give them a rundown on how they use it and what they can find in this school's portal" (Mr Smith).*

> *"Internet, they have access to question papers which are in, what is this program, Thutong" (Mr. Nkosi).*

> *"Learners constantly practice using the Siyavula platform" (T2).*

Science, Technology, Engineering and Mathematics (STEM) teachers have been using CMS resources organised in online educational platforms. These platforms provide learners diverse learning opportunities by offering access to various teaching and learning materials. Additionally, systems such as Supplementary Digital Learning Resources (SDLR), Siyavula, and Thutong are readily available on mobile devices, providing teachers and learners free access to OERs. The availability of these platforms has significantly benefited mathematics learners, allowing them to tackle various mathematical problems at their own pace. Moreover, it has empowered learners to enhance their problem-solving skills beyond the confines of classroom assignments. Furthermore, multimedia was also used to help learners conceptualise abstract or complex topics that could not be easily understood without any aid.

4.9 Used ICT affordances for Social Interaction.

Table 5: Used ICT affordances for social interaction

	TECHNOLOGICAL AFFORDANCES	REPRESENTATIONAL AFFORDANCES	PEDAGOGICAL AFFORDANCES
SOCIAL INTERACTION	Seamless integration Share screen Smartboard, projector Virtual learning environments/ Virtual classrooms Social media Monitor & manage ICTs	***Communicative media*** Networked collaboration Document and resource sharing USB, CD Networked sharing of text, audio or visual Document sharing through any app to or from individuals Accessing others' screens Communicate via email, video, audio; social media	Whole class sees teacher's work Smartboard, projector Whole class sees peers' work or Only teacher sees learner work. Teacher sends/receives work via any app Peer/teacher text, audio, visual to whole class Online collaboration Active participation

Share Screen - Whole Class Sees Peers'/ Teacher's Work

Ms Sedise synchronises or connects her learners to the smartboard. These learners have the opportunity to work on their tablets and electronically share their answers on the smartboard. Their responses are visible to other learners in the class. However, Ms Sedise seldom uses this affordance of the smartboard and the tablets. Under normal conditions, a teacher-centred approach involving using the smartboard instead of the chalkboard to display content entails learners passively following through the lesson. This teacher outlines:

> *"The board, and then you connect with them using their tablets, they can answer using their tablets and then forward their answers to the smartboard. Then I will see their answers on the smartboard" (Ms. Sedibe).*

Teachers are the primary source of information for their learners. Teachers download resources from the Internet and share them with their learners or other teachers. This is done using hardware tools such as USBs, which have a high risk of getting lost or corrupted, causing the loss of all the stored information. Two teachers share:

"So, I told them you can put in your USB cable, download this question paper from the smartboard directly to your tablet" (Mr Namane).

"Download the video and share it with them. Truly, they won't watch it, so sometimes I'll flash it in there, and then they'll watch it while" (Mr Dlamini).

Teachers do not receive all the resources, such as lesson plans and assessment activities, from other teachers. Most of the time, teachers receive resources from the Department of Education, such as CDs. Two teachers confirm:

"We received the lesson plans from the DoE" (Ms Sedibe).

"CDs, we copy all that information to the USB and then can use it via the smartboard" (Ms Mashego).

Screen sharing extends beyond applications like Zoom, as it can be supported by teachers' integration of smartboards, whiteboards, and projectors to present educational content to learners. This study's findings revealed that the prevailing mode of teaching and learning occurs within traditional classroom settings, where teachers display content by linking their computers or Universal Serial Bus (USB) drives to a High-Definition Multimedia Interface (HDMI) port. Subsequently, they project digital textbooks, videos, and additional educational resources onto interactive whiteboards or smartboards. Nevertheless, opportunities for interaction and in-depth discussions between teachers and learners are limited to passive learning, where learners consume the content presented to them.

In certain instances, a disparity is evident between teachers' recognition and use of ICT affordances, indicating a failure to appreciate and harness the pedagogical affordances of ICTs fully. This insight stresses the need for a more comprehensive examination of the challenges and limitations teachers and learners encounter within the teaching and learning context. As expounded by Ertmer (1999), identifying first- and second-order barriers provides insight into why specific ICT pedagogical affordances are not being perceived or effectively integrated.

4.10 External Factors

Hardware And Internet Access

Teachers have been provided with computers. However, the computer-learner ratio is inadequate. This is because the number of computers is lower than that of learners. This highlights the context of a traditional South African classroom, characterised by overcrowding and limited resources. This teacher highlights this inadequacy thus:

> *"…, there are only a few computers. twenty-five computers, and the school has rolled out about three hundred. So, the issue of going, queuing there and when you get to the computer, there are 25 computers, and you have a class of forty" (Sizakele).*

Teachers still struggle with access to other resources, and they must improvise. One teacher confesses:

> *"I do not have the whiteboard, where I need to display it on. I am using a wall. So…Those are the major problems I am currently facing" (Sizakele).*

> *"And also, I do not have a screen. I must use my drop, and it is difficult to place it in the centre" (Mshini).*

In other instances, computers and smartboards break. The lack of technical support in terms of fixing broken computers or smartboards leads to a shortage. This teacher notes:

> *"Computers are not functioning properly. Another challenge is that other computers in the lab do not have the mouse. Some of the keys on the keyboard are not functioning for some computers. So, it makes the computers that are functioning to be fewer compared to the numbers of learners that are supposed to use the number of computers" (Mlingani)*

Some township schools have power and Internet outages. These negatively affect teaching and learning. These two teachers lament:

> *"…it goes offline, it may interrupt your lesson, if you have instructed it to go into a certain topic and the internet goes offline, and then your whole lesson is completely disrupted, and we have to do it manually…Inscription goes offline" (Takalani).*

"Breakdown of internet connection…" (T4).

In other schools, learners have access to portable tablets that afford flexible teaching and learning. Nonetheless, this makes these devices susceptible to theft and loss. Sometimes, learners leave their devices at home. This teacher highlights:

> *"Loss of tablets and the stealing internally from the school, learners stealing tablets from each other internally from the school and two, parents themselves telling learners to lie that the tablet is lost" (Mr Namane).*

Learners can access non-educational resources during teaching and learning time. This distracts them from the lesson. Two teachers elaborate:

> *"They upload things for DJ'ing, they download, so it is a big challenge, it is a big challenge. In class, they do not concentrate, listen to music, they download because they have access" (Mr. Bonga).*

> *"While you are teaching maybe Siphomandhla is busy fiddling with the tablet doing his stuff, they are not using the tablet for educational use. They are using for their personal use because some of them I found some other learners they are chatting during teaching and learning" (Ms Puti).*

ICT Training Development.

Teachers reported that the type of ICT training they received was inadequate. Furthermore, it was not structured according to the subjects they teach, and it was offered for a short time. The focus of these training programs was providing teachers with skills that enable them to operate the ICT-– crash course. As these three teachers stress:

> *"Eh, training is not always, not always. Maybe training is once a term or twice because we teach different subjects, so sometimes it is once in a term or twice" (Mr Bonga).*

> *"At the onset, I realised it is the training of the newer teachers who recently came into our school. Training and different levels of training, basic training, intermediate and expert level of training. Training has not been segmented correctly as done by the district office. They are supposed to do so, but it has not been adequately done. So, a basic crash course as an ICT committee we do run with the teacher" (Mr Namane).*

> *"Even if I know something, I need some training, some other aspects. I do need more training. I do need more training on that because now you know what has happened. People who are coming to train us here come for only 3 hours or 2 hours. I mean, you do not even have a chance of asking some of the questions" (Mr Sangu).*

The next teacher does not feel prepared to integrate ICTs into their teaching. They note: *"Not really, I still need to develop myself" (Mlingani).*

Technical Support

Teachers highlighted the lack of technical support in the administrative and technological areas. This is due to the non-extension of service providers' contracts. Thus, teachers struggle to integrate ICTs or avoid using technology. Smartboards, computers, laptops, and learner tablets would malfunction or break. It would take time for technical assistance to address the issues. This is because teachers must call the district office to request technological assistance. In other instances, teachers with technical knowledge and ICT coordinators would try to assist struggling colleagues. These teachers elaborate:

> *"No technical support, we only call them like when the power dropped on the lab, or the computers are not functioning properly…There is no computer assistance in the lab. There was one intern, but now he has just left; maybe he just got a job, I do not know, two months ago this year. Teachers can book with me if they want to use the lab. The teacher will be with the learners. I am only called if there is something that needs to be looked at. The teacher monitors if they visit the correct websites*" (*Mlingani).*

> *"No technical support. I am the ICT coordinator, and I am the only one who assists teachers. If I can't help, I can call upon a technician from Bongani Rainmakers, who carry out the ICT projects for GDE (Gauteng Department of Education)" (T4).*

In situations where the teacher is technically inclined, they do not need technical support. This is because they can solve the technical issues themselves. Moreover, given that the infrastructure is new, technology functions as expected. As these teachers emphasise:

> *"No technical support. The technology is stable. Technical assistant used to be available but no longer with us. Service provider's contract got terminated" (T1).*

"Technicians that we have, who are no longer there, we do not know what is happening; most of the time, they were not servicing the smartboards" (Mr Sangu).

Software And Tool Access

Software and tool access relates to how teachers and learners share information and resources and collaborate in online settings. Teachers have access to the Internet and are trained in the use of Learning Management Systems (LMSs), such as Moodle. However, license issues and the high cost of software programs compel teachers and learners to resort to using USBs and CDs to store and share resources. One teacher acknowledges these challenges thus:

"Yes, we do have the problem with the licensing, because I also have the smartboard on my laptop, which was installed by the guys from Harry Gwala and it always when I have to open it, it talks about that licensing" (Mr Nkosi).

"I don't know for now whether the license expired (Pearson)" (Ms. Mashego).

Even if CMSs do not have licensing issues, the lack of ICT skills on the learners' side and limited Internet access compromise access to online resources. One teacher notes:

"Limitations I normally experience are that the learners are still struggling with operating the laptops and accessing e-books and videos. Therefore, assisting each learner individually can be time-consuming and result in incomplete lesson intended to be presented on the day" (T3).

Even though learners can access social media platforms, they do not use ICT software meaningfully. Instead of using social media platforms to share teaching and learning resources, learners use them for their purposes. This teacher explains:

"Because if they spend most of their time on social media, then it means they will be affecting their learning, lessons, and we went to the extent of blocking some" (Ms Sedise).

Teaching and learning occurs in the classroom. Teachers use smartboards for teaching and learning, especially the mathematics teacher's GeoGebra software. However, the application software does not seem to function as expected. Two participants elaborated:

"We have that, but now the problem is that it is difficult to use that thing on our smartboards. I don't know whether they have been programmed wrongly or not because immediately you touch a ruler, it goes that way (laughs); when you touch a compass, it does not want to work with you. So, at the end of the day, it exposes you as a teacher as if you do not know. So, teachers avoid using those things" (Mr. Sangu).

"Geometry, I cannot even use it because it is very difficult to use those protractors and compasses on the smartboard" (Ms Puti).

Curriculum demands and the timetable provide limited time for teachers and learners to use ICTs. This is particularly relevant when learners have limited ICT skills and technology malfunctions. Teachers are pressed for time to complete the syllabus. Two teachers explain:

"Eh, sometimes we are being guided by the ATP, sometimes it will be a waste of time to concentrate much more on software like you watch videos, like sometimes not that always can use software, sometimes you just be straight on point. Ok, today you are going to do this chapter, and then maybe you can use some software. I do not know what software we are required to use" (Mr. Bonga).

"Another thing that makes me not take them to the computer lab is it will retard my progress in the sense that before I could teach them the subject matter-which is English- I will first have to teach them computer skills. Learners do not have a free period to go there (computer lab)- to learn computer skills" (Sizakele).

4.11 Internal Factors

Teachers' socioeconomic backgrounds, beliefs, and attitudes greatly influence their use of ICTs. It must be noted that it is not the older generation that has a negative attitude towards using ICTs, but rather the younger generation. The older generation is keener to learn how to teach with digital tools. One participant notes:

"Another issue is attitude; some teachers are not entirely familiar with it. It is not necessarily the old teachers per se. However, it is also the background of the teachers that we have because as diverse as we are, one of the things that, the social background or the educational background that we come from, how exposed were we to gadgets and computers, so even surprisingly I have discovered even in my school even the

younger teachers some of them are not so keen as to use the ICT resources" (Mr Namane).

Moreover, learners' perceptions of a subject affect how the teacher uses technology. If learners have a negative attitude towards the subject, the creativity required to integrate ICTs to meet different learning pathways also deteriorates. This teacher explains:

"I think it is the background because most learners before you teach them believe maths is complicated" (Mr Bonga).

4.12 Summary of the chapter

The research had identified various technological affordances, including intuitive use, widespread use in teaching and learning, and the facilitation of quick resource sharing and communication. These affordances were made possible by flexible and portable technologies, enabling teaching and learning to transcend geographic limitations. Teachers were familiar with various online communication tools like social media, email, and video conferencing to share information and improve learning. They acknowledged that teaching and learning were not confined to the classroom. The findings were mapped into the e-Wits model, covering the technological, informational, epistemological, and social interaction levels. This showed teachers' recognition of the technological and representational affordances of ICT tools. Moreover, representational affordances associated with multimedia tools like PowerPoint presentations, digital textbooks, animations, photographs, videos, and simulations displayed on smartboards or projectors were acknowledged by teachers for their ability to solidify concepts, capture learners' attention, and cater to diverse learning styles. Only math and science teachers recognised the pedagogical affordances of technology, referring to specific software programs to help learners solve complex mathematical problems with a predominant emphasis on the pedagogical impact of mathematics and science teachers.

Teachers used various technologies, such as smartboards, laptops, computers, projectors, and content management systems, extensively in their classrooms. These tools were used for tasks such as editing teaching materials, accessing multimedia resources from the internet (such as videos, digital textbooks, and images), and displaying these resources on smartboards or projectors for learners, which were the technological affordances of the tools and placing the teachers at the technological interaction level. This meant that the teachers could successfully

operate the technologies they had. Multimedia tools primarily occurred at an informational level to display content. It was noted that teachers' use of multimedia tools varied based on the subjects being taught and the lesson objectives. The use of these tools differed between English teachers and math and science teachers. While teachers used ICTs to facilitate a teacher-centred approach, especially in languages and other non-practical subjects, math and science teachers leveraged these tools to engage learners better, placing them at a higher level of interaction. This difference was highlighted in the e-Wits model, with math and science teachers being placed at an epistemic interaction level due to the nature of the subjects they taught, which required learners to solve problems, make decisions, and think creatively. The recognition and use of technological and representational affordances aligned. Teachers used the affordances that they recognised. However, in some cases, teachers recognised the affordances of the technology but did not use them or did not recognise the affordances. What was of great concern was the limited recognition and use of the ICT pedagogical affordances by teachers. Considering this, the teachers did not mention collaboration, active participation, critical thinking, and problem-solving.

Teachers did not recognise the pedagogical affordances associated with the technology they had. These pedagogical affordances seemed to be hidden from teachers as this was based on the following external and internal factors affecting the integration of ICT affordances: Inadequate infrastructure and intermittent or unreliable internet connectivity hindered the effective use of ICT tools in the classroom. The socio-economic backgrounds of teachers and learners were significant additional factors influencing who could access ICT tools and how the government distributed them. Vandalism, crime, and safety concerns affected technology accessibility and impeded the efficient use of ICT tools. Inadequate ICT training programs and a lack of on-site technical support significantly impacted the effective integration of technology. The primary objectives of these training programs and technical assistance were to train teachers in using technology and provide technical support. These initiatives were carried out by service providers who may not have been fully invested in the teaching and learning process. As a result, teachers may have lacked the necessary skills to employ technology to foster collaboration, critical thinking, and problem-solving.

Chapter 5

Discussion of Results

Analytical And Pedagogical Value of the e-Wits Model

5.1 Introduction

In this chapter, we will analyse the research findings using the e-Wits model as an analytical tool. This model has been instrumental in identifying how teachers are integrating ICTs in their classrooms, assessing their ICT interaction or competencies and the pedagogical affordances they recognise and use (Moll et al., 2022).

5.2 Teachers' pedagogical approaches

Understanding the pedagogical affordances of technology is crucial for teachers to adapt their approach to integrating it into their pedagogy. Many teachers have integrated ICT into their classroom contexts, believing it would benefit teaching and learning. However, despite the potential for technology to promote a learner-centred pedagogic approach, many teachers still predominantly employ a teacher-centred approach. This study argues that pedagogical approaches when using ICT vary according to the subjects teachers teach, specific lesson objectives and the teachers' pedagogic beliefs. Thus, this influences the recognised and used ICT pedagogical affordances. Teachers teaching English or less abstract subjects seem to use technology differently than those teaching more abstract subjects like math and science. The approach taken by teachers teaching abstract subjects tends to focus on creating mental representations for their learners using multimedia resources and CMS, with learners participating in producing reports and calculations through problem-solving. On the other hand, teachers of less abstract subjects mainly used technology to transmit content.

This indicates that teachers' pedagogical approach is more influenced by the context, subject, and lesson objectives rather than the type of technology available to them for engaging learners. Notably, the school's location does not significantly influence the teachers' pedagogical approach to integrating ICT affordances. The Curriculum Assessment Policy Statement (CAPS) document and the Annual Teaching Plan (ATP) significantly shape how teachers integrate ICT pedagogical affordances.

Despite having access to various ICT tools, teachers are constrained by two documents that dictate what and when to teach. This limits their ability to creatively integrate technology and engage learners (Tarling & Ng'ambi, 2016). As a result, many teachers in the study tended to adopt a teacher-centred approach rather than a learner-centred one as they rushed through the content (Ertma, 2010; Tarling & Ngambi, 2016). This was evident as they were mapped onto the four levels of interaction in the e-Wits model - technological, informational, epistemological, and communication interaction levels.

It is important to note that the e-Wits model does not discredit the teacher-centred pedagogical approach, considering that different classroom contexts, ICT tools, and teachers' pedagogic approaches serve unique purposes. However, the model emphasises that regardless of the ICT tool and classroom context, there is always an opportunity for teachers to engage learners in a social constructivist teaching and learning environment (Tarling & Ng'ambi, 2016; Moll et al., 2022). This was primarily illustrated by the teachers' failure to address the ICT pedagogical affordances that are specified in the e-Wits model, such as online collaboration, active participation, spoken or written remarks, animation, or modelling, authentic and task-centred pedagogic approaches (Moll et al., 2022). These ICT affordances are an example of meaningful ICT integration where learners actively engage in learning. While appreciating the importance of teachers' technological proficiency and awareness of representational and technological affordances of the ICT tools, the emphasis on pedagogical affordances remains critical, particularly in fostering active learner participation. Therefore, it is essential to assist teachers in adjusting their pedagogical approach. Identifying and highlighting pedagogical affordances they may not be aware of or are not using is critical (Gaver, 1991). By employing the e-Wits model, meaningful integration of ICT can be ensured.

Technological competency: recognised and the use of ICT affordances.

Regarding ICT integration, teachers have expressed both good and negative opinions. Conversely, teachers ascribe to ICT affordances that simplify their work, save time, make knowledge or information readily available, and enable faster response for learners during assessment. Following the lead of Angeli and Valenides (2018) and Dlamini and Nkambule (2020), they state that the teachers' perspectives are an operational or technical interaction. It makes sense, given how they use the affordances. Observe how they use the interactive touch-screen smart board, which allows for effortless access and feature adjustment, and how they utilise laptops to edit and manipulate features.

Information competency: recognised and used ICT affordances.

Many teachers can now be plotted at the information interaction of how teachers employed ICTs and their affordances related to their perceptions of its advantages. Teachers at this level of competency use ICT affordances that narrate information or content to learners with the help of different multimedia affordances. In other cases, teachers access teaching and learning resources for strong teacher presentation of content. This approach supports "Multiple representations of knowledge" (Moll et al., 2022, p. 69). Multimedia, or digital learning tools, help learners create mental images using various media. This helps in processing information. Carefully designed with images, text, and videos for teaching and learning (Abdulrahman et al., 2020), these resources are customisable and often accessible for free or at a low cost on the internet. They are also easy to adapt, such as in PowerPoint presentations. Customising multimedia tools promotes equity and increases access to content, primarily since many of these multimedia resources are based on Western knowledge. Teachers can bring out Indigenous and relatable content by adapting and contextualising these multimedia tools, ensuring meaningful learning (Nusche & Minea-Pic, 2020).

Epistemological competency: recognised and used ICT affordances.

This study explored the impact of technology on classroom teaching, focusing on teachers' attitudes toward teaching and learning. The findings revealed that mathematics, science, geography, and technology teachers believed in exposing learners to problem-solving activities. They utilised constructivist, learner-centred pedagogies and integrated ICT resources into their teaching methods. The study also highlighted the preference among geography teachers for implementing ICT, particularly the internet, to access resources that help learners understand abstract concepts. Furthermore, teachers who do not teach abstract subjects utilise ICT affordances such as multimedia to "facilitate learner focus" (Moll et al., 2022, p. 70).

The results align with global research, including the 2015 OECD study and PISA 2022, which emphasised using ICT by math and science teachers to promote higher-order thinking and support learners in problem-solving, analysis, and evaluation. CMS and other software and technological tools were identified as essential in assisting learners to explore and apply themselves to problem-solving activities. STEM teachers were found to be aware of CMSs like Siyavula and Thutong, which provide learners with access to educational resources related to math and science. Furthermore, teachers encouraged learners to use these online platforms, granting them access to materials beyond the classroom. In addition, teachers utilised digital

resources from websites such as YouTube to enhance their teaching materials. The study also highlighted teachers' creative use of technology to support and facilitate teaching and learning environments, encouraging epistemic interaction. This interaction was not limited to the use of LMS and CMS, as teachers were found to use technology creatively to curate and present content tailored to the needs of their learners, whether through smartboards or printed worksheets.

Social interaction: recognised and used ICT affordances.

"Whole class sees peers'/ teacher's work" or "Only teacher sees learner work" (Moll et al., 2022, p. 70). These codes from the e-Wits model highlight the social interaction during teaching and learning and how the teacher and learners are to maintain social interaction. These pedagogical affordances refer to teacher-centred pedagogies. Teachers need to adopt the learners-centred ICT pedagogical affordances of "active participation" and "online collaboration" if teaching and learning are taking place online (Moll et al., 2022, p. 70).

5.3 Summary of the Chapter

In South African public schools, there has been a significant push to integrate technology into the classroom, such as tablets, laptops, smartboards, and interactive whiteboards (Vandeyar, 2020). The findings of this study highlighted that the use of technology and its affordances is based on the teachers' pedagogical beliefs. This study has shown that while teachers used these ICT tools to transmit knowledge, they rarely integrated ICT tools to engage learners actively. This lack of integration may be due to a focus on completing the curriculum, providing grades or assessments, and saving time, leading to a teacher-centred pedagogic approach. The only time learners were actively engaged was in subjects like math, science, technology, and geography, where learners are expected to develop specific skills and complete tasks specific to the subjects.

This was observed when using the e-Wits model and its associated codes, such as "facilitate learning-centred tasks," "facilitate learner focus/'ownership'," and "complex calculations, authentic learning," (Moll et al., 2022, p. 69) these affordances are not limited to the LMS and CMS platforms. In this case, STEM teachers were seen as the curators and actual managers of the content for learners in a normal traditional classroom setting. Even though these affordances were used, learners seldom collaborated, discussed, and shared knowledge with peers unless instructed by the teacher as per lesson objectives.

The e-Education policy of 2004 called for a shift to a learner-centred approach by 2013 to equip learners with 21st-century skills. This shift would help learners to develop critical thinking, and problem-solving skills, and to collaborate and communicate with peers. Despite teachers having undergone teacher training programs (Dlamini & Coleman, 2017; Padayachee, 2017), this shift has not been possible. Despite teacher training guidelines outlining the necessary skills, knowledge, and attitudes, the transformation has not been significant (Padayachee, 2017). Even the Department of Basic Education emphasises the importance of integrating technology and its affordances but lacks specific guidance on how to do so (DBE, 2015, p. 15).

When it comes to using technology for teaching purposes, it is essential to clearly define its affordances for teachers for meaningful ICT integration. However, analysis using the e-Wits model shows that teachers do not recognise the potential of ICT to promote active learner engagement in their pedagogy. As a result, the ICT pedagogical affordances that promote these 21st-century skills seem to go unnoticed by teachers or hidden from teachers (Gaver, 1991).

The e-Wits offer pedagogical value in addition to being a helpful diagnostic tool. They offer teachers paths to use the educational affordances of the digital resources they have at their disposal to use ICT meaningfully. This is to guarantee that teachers embrace learner-centred and interactive teaching methods, regardless of where they are situated within the e-Wits model—technological, informational, epistemological, or social interaction levels. The model's interaction levels each specify what the teacher must do to guarantee that the resources they have are applied meaningfully.

To enhance the quality of education, teachers must have a deep understanding of and use the pedagogical affordances of Information and ICT in their pedagogy. They should move away from traditional, passive teaching methods and instead embrace approaches that foster active learner participation. This necessitates the use of detailed frameworks such as the e-Wits model, which provides a clear outline of the pedagogical benefits of integrating ICT into teaching and learning processes. Additionally, teacher training programs should place greater emphasis on the pedagogical applications of ICT tools, with a focus on equipping teachers with the skills to harness technology to create meaningful and engaging learning experiences.

Chapter 6

Conclusion

This chapter concludes the research. It includes a brief overview of the study's aims, objectives, and research questions. Additionally, the chapter discusses the findings, outlines the study's limitations, and proposes potential areas for further research.

6.1 Review of the study

This pilot study aimed to investigate the recognised and utilised ICT pedagogical affordances by South African teachers using the e-Wits model as an analytical tool. It was conducted in response to the need for empirical evidence on how teachers integrate ICTs and ICT pedagogical affordances. Additionally, the study sought to provide teachers with explicit guidance on how to integrate ICT affordances meaningfully, moving away from passive learning teacher-centred to active, learner-centred pedagogical approaches.

The e-Wits model is the recommended framework, outlining the affordances that teachers should consider methodically and clearly in their pedagogy. Since teachers use technology in their practice, the model includes technological, informational, epistemological, and social interaction competencies that teachers must develop or act on when integrating ICTs based on the subjects and lesson objectives. Therefore, they must emphasise the three distinct interactions in their preparation for ICT-integrated teaching, regardless of the circumstances that teachers and learners find themselves in for meaningful ICT integration (Garrison et al., 1999). The e-Wits model approach recognises that learning occurs in a social constructivist context, whether in a traditional classroom setting or online. The approach also ensures that the pedagogical affordances of ICT for teachers are appropriately aligned with their respective settings through meaningful integration.

The study aimed to address the following research questions to fulfil its research objectives.

1. What are the teachers' perceptions of the integration of ICT affordances in their teaching and learning?

2. What are the underlying values of ICT affordances that teachers bring to their teaching and learning?

3. How can the e-Wits model be used as an analytical tool and inform teachers' pedagogical decisions for effective ICT pedagogic integration?

1. What are the teachers' perceptions of the integration of ICT affordances in their teaching and learning?

As the study employed the e-Wits model of pedagogical affordances developed by Moll et al (2022). The model explicitly makes the different types of affordances at different levels of competency explicit. The classification clarifies how technology needs to be used fruitfully in the classroom to benefit learners and ensure that learning takes place. The findings indicated that teachers recognise and use technological and representational affordances of ICT tools, at different levels of interaction or competency. It is mainly maths and science teachers who can identify and use the pedagogical affordances of the tools they can access.

Technical interaction

Interactive media: Teachers at this interaction level are more focused on the technical aspects of technology rather than actively interacting with the learners. The learning environment shows a lack of engagement between the teachers using technology and the learners. Their main concern seems to be evaluating the ease of use of the technology, indicating a relatively technical level of interaction. Additionally, they are creating, adapting, modifying, and personalising multimedia resources to better meet the unique requirements of their learners.

Informational interaction

Narrative and productive media: Teachers believe and use technology to present information through multimedia tools such as videos, pictures, and digital textbooks from the internet. Which promotes passive learning. Learners also leverage technology for research and to create reports for assessment purposes, especially in specific subject areas.

Epistemological interaction

Adaptive media: Teachers who teach math, science, and other abstract subjects are considered to be operating at an epistemological interactive level. These teachers differ from those operating at the information interaction level, who use multimedia tools and display content for learners to consume. At this level, teachers use multimedia tools to help learners conceptualise content or explain abstract concepts that may be difficult to understand just by using a textbook. This illustrates that the same tools can be perceived and used differently depending on the user's needs. Additionally, these teachers encourage

the use of content management systems, where learners can access various resources from different learning platforms to perform mathematical calculations.

Social interaction

Teachers are often familiar with communication platforms, such as social media, that are easily accessible without requiring license fees. However, they tend to avoid using these platforms due to concerns that they may distract learners in the classroom and would be difficult to monitor their activities. This is compounded by the fact that teaching and learning typically occur in a traditional classroom setting where only the teacher has access to technology, such as smartboards. As a result, communication tends to be one-way, with limited engagement, participation, and collaboration from the learners. The teacher primarily imparts knowledge, and the learners passively receive it.

2. What are the underlying values of ICT affordances that teachers bring to their teaching and learning?

According to the study, the fundamental values of ICT affordances brought into the teaching and learning environment include the value of sharing and communication through a variety of software applications, as well as the ease of access to teaching and learning materials and the capacity to give learners immediate feedback. The teachers' decisions about how to integrate ICTs for teaching and learning were impacted by their perception of the affordances' worth. These decisions were also dependent on the functionality of the tool, the experience, and the requirement to finish the curriculum or syllabus with their learners. Teachers may decide how to effectively integrate ICTs and provide learning opportunities by having a clear awareness of their beliefs around ICT affordances.

3. How can the e-Wits model be used as an analytical tool and inform teachers' pedagogical decisions for effective ICT pedagogic integration?

By using the e-Wits model as a diagnostic tool, teachers may successfully integrate ICT into their lessons. Plotting or mapping their disposition using the competency or interaction levels and hierarchy of affordances of the e-Wits model. Teachers can ascertain the hierarchy of ICT affordances of the technology at their disposal. They can also ascertain whether their pedagogical approach encourages active or passive learning based on the e-Wits model by considering the hierarchy of affordances. The teacher would assess the affordances of the available ICT tool at the same time. Having said that, the e-Wits model outlines the specific actions that teachers must take at each skill level to ensure the meaningful integration of ICT affordances. Nevertheless, the e-Wits model does not specify how teachers must achieve this.

The e-Wits model, for instance, says that teachers must facilitate learning, but it does not specify how teachers must support learning or tasks that are learning-centred. Secondly, the e-Wits model has strict solid boundaries which eliminates the teachers' creative use of the technology. These boundaries need not be solid, as any ICT tool may be used creatively by the teacher cutting through the interaction levels, and the e-Wits model puts these restrictions.

In summary, the e-Wits approach emphasises the affordances of technology rather than being techno-centric. Therefore, it is critical to have this tool to support teachers in determining how they employ ICT affordances to guide meaningful ICT integration. The study emphasises the model's strength in serving as a diagnostic and pedagogical tool that teachers may use to self-reflect and integrate ICT affordances effectively, despite the model's difficulty in usage.

6.2 Limitations and Difficulties of the e-Wits Model as an Analytical and pedagogical tool

The e-Wits model simplifies the challenges faced by teachers when integrating and understanding ICT tools. Table 6 shows a bias towards specific affordances and ICT tools, matching the model's recommended ICT affordances with available tools. While the e-Wits model provides a comprehensive analysis of ICT affordances, the abundance of information could make it challenging for some individuals to interpret and analyse. Moreover, the model's inclusion of codes or affordances related to virtual learning environments, such as virtual classrooms and learning management systems, indicates an overlap in concept, even though these codes differ in implementation. They all relate to the same idea – virtual learning environments that facilitate ubiquitous teaching and learning. This is also achievable through software tools like social media platforms, yet the e-Wits model limits the use of these platforms to sharing information and communication purposes only. Additionally, the e-Wits model regards Learning Management Systems (LMS) as the sole way of formally delivering and managing content for learners. This could be biased, as teachers without access to LMS can creatively use social media in ways that function similarly. Social media platforms are usually free and easily accessible for teachers and learners, whereas, with LMS, licensing issues are involved.

The e-Wits model is difficult to understand and use in its original form because it contains too many separate elements that could be simplified or grouped into a single theme of affordance. This could pose a challenge for teachers who wish to use the model to consider how they can

employ ICT tools for effective teaching and learning. It is important to have simplified and easily understandable models for teachers to use, which has not yet been achieved with the e-Wits model. Additionally, the role of learners in the e-Wits model is not clearly defined through learning activities that promote collaboration and active participation. The focus seems to be on what the teacher needs to do to ensure meaningful use of ICT tools, but not on how to assess whether learning has occurred.

Technological Affordances

In the educational technology field, technological affordances are the design features of ICT tools that make it easier to complete educational tasks without facing difficulties. According to Kirschner (2002) and Xue et al. (2023), the e-Wits model does not fully meet this criterion as it includes certain hardware tools and platforms, such as the central console and e-learning systems, as technological affordances, which might not align with a strict definition of affordances. Therefore, based on this definition, the study argues that technological affordances should relate to the perceived ease of use of ICT tools.

The e-Wits model attempts to describe the ease of use of a tool by including two codes, "seamless app integration" and "intuitive interface", which may lead to confusion between the two. The concept of seamless integration aims to ensure that application software functions smoothly within its environment, while "intuitive interface" describes the layout of a tool and how the user interacts with it. Considering the definition of technological affordances, "intuitive interface" should be replaced with "intuitive interaction" or "intuitive use" for greater clarity.

Representational affordances

Representational affordances refer to the use of multimedia to present complex knowledge. Therefore, the teacher must be able to identify and utilise technology to present knowledge (Ndlovu, 2016; Moll et al., 2022). Considering this definition, the codes under representational affordance in the e-Wits model are not affordances but rather ICT tools and their capabilities, such as multimedia presentations, movie/audio recordings, virtual stage, digital textbooks, and the ability to search for and exchange articles, videos, music, books, etc. (Moll et al., 2022, p. 69). Teachers can use these tools to facilitate learning in different learning environments. Furthermore, interactive, narrative, productive, adaptive, and communicative media are media

forms and not affordances, but media forms (Laurilard, 2002). Therefore, these codes need to be replaced with non-linear, immediate, collaboration, articulation, and (de)-familiarise, as suggested by (Laurillard, 2002; Ndlovu, 2016).

Interaction levels

The e-Wits model needs to remove the interaction levels because analysing a teacher's use of technology is complex and cannot be confined to a single level of competency or interaction. Instead, the focus should be on integrating ICT tools to create meaningful learning opportunities by aligning the ICT tools with their respective affordances as suggested in Table 6. Thus, allowing readability and making it easy to reflect and plan on how to integrate ICTs into and foster learner engagement. The competency and interaction levels discussed in the previous chapter apply to all teachers, such as Mlingani, a math teacher who has been assessed in terms of technological, informational, epistemological, and social interaction competencies. However, attempting to map these competencies or interactions vertically makes the process complicated to interpret.

The same is true for other teachers who do not teach abstract subjects like mathematics and science where learners must complete complex calculations. In the classroom, teachers employ a variety of technologies and their affordances for teaching and learning. Teachers were therefore mapped at the level of technological engagement. To accommodate various pathways, teachers also projected content in the form of "narrative media", which placed teachers at the information interaction level. These same teachers also used multimedia to draw learners in and concretise the material, which allowed for the mapping of teachers at the levels of social and epistemic interaction as they projected the material for the learners.

Since teachers are not focused on technology but rather on the delivery of content, we must align ICT tools with the affordances that promote meaningful ICT integration. As a result, the simplified version of the e-Wits model is provided in Table 6. Consequently, the competency levels are not necessary to have because teachers operate at all levels of ICT competency depending on their subjects, which then maps the teachers in all the competency levels but at different degrees. However, with the mapping, teachers used ICT affordances that promoted passive teaching and learning. Therefore, we need to have a model that will promote active learner engagement and participation. Thus, the e-Wits must be read horizontally (left to right)

and (right to left). Table 6 shows the simplified version of the e-Wits model, where the original codes or affordances that had the same meaning were grouped.

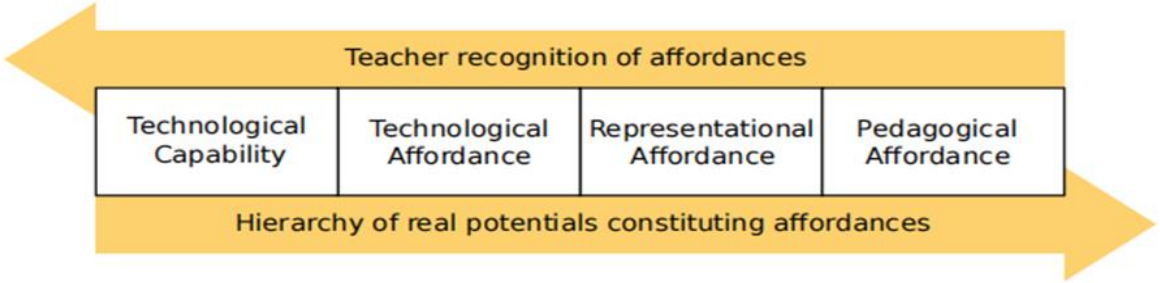


Table 6: Alignment of ICT tools with the respective hierarchy of ICT pedagogical affordances

ICT Tools	**TECHNOLOGICAL AFFORDANCES**	**REPRESENTATIONAL AFFORDANCES**	**PEDAGOGICAL AFFORDANCES**
Polysynchronous, ubiquitous, flexible Learning (TABLETS, LAPTOP)	VLE - (Learning management	Facilitate learning environment.	Facilitate learning-centred tasks. Complex calculations
	Content management systems	Guided access/ management of cognitive Load	Learner-centred tasks Complex calculations
Classroom (teacher only has the tool to project) Smartboard/projector	Multimedia presentations	Teacher shares documents and resources with learners	Teacher to facilitate learner-centred tasks Learners' active participation
Flipped classroom. (Smartboard/ & Tablets)	Temporarily restricted to one app and turns off screen/ hardware buttons.	Multimedia presentations Facilitating learning environment	Facilitate learning-centred tasks and learner focus/ 'ownership'. Active participation
Access Internet	Access worldwide resources	Search for and exchange articles, videos, music, books, etc.	Facilitate learners' construction of materials, researching, producing, and representing learning-centred tasks
Material development Laptop/computer	Make and playback Audio and video. recordings	Movie/ audio recordings	Authentic learning Presentations/ performance by learners

6.3 Summary of the Chapter

The study highlighted the limited empirical evidence on how teachers integrate ICT pedagogical affordances and examined their use of technology for teaching and learning. It revealed that teachers often employed ICT tools to narrate content to learners, resulting in passive learning. The analysis indicated that ICT integration was generally at a lower level, according to the e-Wits model. However, few teachers gradually adopted a more learner-centred approach, depending on the subject they taught and their pedagogical beliefs. Active student engagement, knowledge creation, and problem-solving were crucial for effective learning. While teachers of less abstract subjects tended to enhance their existing teacher-centred pedagogical approach using technology based on their beliefs which is to have learners copying from the board and regurgitating information. This study recommends training and raising awareness about ICT pedagogical affordances using the e-Wits model. Additionally, the study emphasises the need for teachers to recognise ICT affordances to promote cognitive development and foster learner engagement for meaningfully ICT integration.

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Appendices

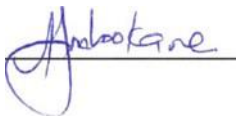
SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NONMEDICAL)

CLEARANCE CERTIFICATE	PROTOCOL NUMBER: 2023ECE011
PROJECT TITLE	Mapping ICT pedagogical affordances of South African teachers: a pilot study of the e-wits model
INVESTIGATOR	MNQONYWA NDILEKA
SCHOOL/DEPARTMENT OF INVESTIGATOR	Wits School of Education
DATE CONSIDERED	06-Mar-23
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	No risk
EXPIRY DATE	Date of submission of the Research Report

ISSUE DATE OF CERTIFICATE 20-Mar-23

CHAIRPERSON



Dr. Batseba

Mofolo-Mbokane

cc: Ndlovu Nokulunga

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Date 15 / 02 /2024

_____

Signature

2023 SECONDARY DATA REQUEST FORM

Permission to re-use data.

1. PARTICULARS OF THE PRIMARY RESEARCHER

1.1	**Details of the Primary Researcher**
a) Surname and Initials:	
b) First Name/s:	
c) Title (Prof/Dr/Mr/Mrs/Ms):	
d) Student Number:	
e) SA ID Number:	
f) Work permit no. (If not SA citizen)	

1.2	Contact Details
a. Tel:	*b. Cell:*
d. Fax:	*e. E-mail:*

2. PURPOSE & DETAILS OF THE PROPOSED RESEARCH

2.1	*Purpose of the Research (Place a cross where appropriate)*
Undergraduate Study – Self	

Postgraduate Study – Self	**x**
Private Company/Agency – Commissioned by Provincial Government or Department	
Private Research by Independent Researcher	
Non-Governmental Organisation	
National Department of Education	
Commissions and Committees	
Independent Research Agencies	
Statutory Research Agencies	
Higher Education Institutions only	

2.2	*Full title of Thesis / Dissertation / Research Project*

MAPPING SOUTH AFRICAN TEACHERS' RECOGNITION AND USE OF ICT PEDAGOGICAL AFFORDANCES: A PILOT STUDY OF THE E-WITS MODEL

2.3	**Abstract of the research**

Amongst many challenges facing effective ICT integration in the South African classroom, is the lack of knowledge of what informs teachers' pedagogical integration into their teaching. With the proliferation of digital technology, teachers require expertise in adapting their ICT pedagogical practices to ensure teaching and learning are not compromised. The South African education sector has designed good ICT in education policies and sponsored ICT teacher training programs to ensure sustainable ICT pedagogical integration in the classroom. However, these efforts have proven to be futile as research has reported low uptake and unproductive use of these technologies by teachers. This qualitative study is grounded on a critical realist paradigm. It uses secondary data from high school teachers. It constitutes interviews and lesson observations collected by two Wits Scholars, Ndlovu (2016), Minty (2020) and Nhlapho (2022), who researched Gauteng Secondary school teachers using ICT in their pedagogy. This is a pilot study of the e-Wits model of pedagogical affordances coined at the Wits School of Education. The thematic analysis technique is employed to re-analyse the data. The findings will be used to provide explicit guidelines to teachers on how to use the model to make informed pedagogical decisions that facilitate meaningful integration of ICT affordances.

2.	**Student information**

a. Name of institution where enrolled:	University of the Witwatersrand
b. Degree / Qualification:	MEd
c. Faculty and Discipline / Area of Study:	Educational Technology and Engineering division
d.Name of Student:	Ndileka Mnqonywa
e.Student Number:	792402
f. Name of Supervisor :	Dr Nokulunga Ndlovu

I grant Ndileka Mnqonywa (792402) to make use of my data can be used for this study.

_____ _____ _____

Name Signature Date

e-Wits coding book

	TECHNOLOGICAL AFFORDANCES	REPRESENTATIONAL AFFORDANCES	PEDAGOGICAL AFFORDANCES
TECHNICAL INTERACTION	Intuitive interface TEACHER USES TEACHER RECOGNISES Tap and swipe – immediate access TEACHER USES TEACHER RECOGNISES Portability TEACHER USES TEACHER RECOGNISES No power cable↑ Teacher carries little home LAN-wide connections↓ Central console TEACHER USES TEACHER RECOGNISES Click and drag TEACHER USES TEACHER RECOGNISES Mouse-cursor interface TEACHER USES TEACHER RECOGNISES	***Interactive media*** TEACHER USES TEACHER RECOGNISES Any time any place TEACHER USES TEACHER RECOGNISES Direct manipulation interface↑ TEACHER USES TEACHER RECOGNISES ***"The Click option"*** – deliberate representation (tap & swipe or click & drag) TEACHER USES TEACHER RECOGNISES	Polysynchronous, ubiquitous, flexible learning TEACHER USES TEACHER RECOGNISES Teacher & learner mobility inside/outside classroom↑ TEACHER USES TEACHER RECOGNISES Teach with & through, not about, technology – procedural TEACHER USES TEACHER RECOGNISES Teacher feedback TEACHER USES TEACHER RECOGNISES Team teaching & materials development TEACHER USES TEACHER RECOGNISES Facilitate learner control/decision making ("click option") TEACHER USES TEACHER RECOGNISES

	AFFORDANCES		
INFORMATIONAL INTERACTION	Make and play back audio & video recordings TEACHER USES TEACHER RECOGNISES Access worldwide resources TEACHER USES TEACHER RECOGNISES Virtual learning environments TEACHER USES TEACHER RECOGNISES	***Narrative*** TEACHER USES TEACHER RECOGNISES ***Productive media*** TEACHER USES TEACHER RECOGNISES Multimedia presentations TEACHER USES TEACHER RECOGNISES Movie/audio recordings TEACHER USES TEACHER RECOGNISES Virtual stage TEACHER USES TEACHER RECOGNISES Digital textbooks TEACHER USES TEACHER RECOGNISES Search for and exchange articles, video, music, books, etc. TEACHER USES TEACHER RECOGNISES	Multiple representations of knowledge TEACHER USES TEACHER RECOGNISES Strong teacher presentations – synchronous TEACHER USES TEACHER RECOGNISES Strong teacher presentations – asynchronous TEACHER USES TEACHER RECOGNISES Facilitate learner construction of material – research, produce, represent TEACHER USES TEACHER RECOGNISES Presentations/performance by learners TEACHER USES TEACHER RECOGNISES Written/spoken comments TEACHER USES TEACHER RECOGNISES Animation/modelling TEACHER USES TEACHER RECOGNISES Authentic learning TEACHER USES TEACHER RECOGNISES

	TECHNOLOGICAL AFFORDANCES	REPRESENTATIONAL AFFORDANCES	PEDAGOGICAL AFFORDANCES
EPISTEMOLOGICAL INTERACTION	Temporarily restrict to one app only TEACHER USES TEACHER RECOGNISES Choose app features TEACHER USES TEACHER RECOGNISES Disable screen/ hardware buttons TEACHER USES TEACHER RECOGNISES Learning management systems TEACHER USES TEACHER RECOGNISES Content management systems TEACHER USES TEACHER RECOGNISES	***Adaptive media*** TEACHER USES TEACHER RECOGNISES Guided access/management of cognitive load TEACHER USES TEACHER RECOGNISES Facilitate learning environment TEACHER USES TEACHER RECOGNISES Create concept maps, plans, diagrams, pictorials, graphics TEACHER USES TEACHER RECOGNISES Prevent accidental gesture distractions TEACHER USES TEACHER RECOGNISES Disable task irrelevant screens TEACHER USES TEACHER RECOGNISES	Stay on task TEACHER USES TEACHER RECOGNISES Flipped classroom TEACHER USES TEACHER RECOGNISES Facilitate learning centred tasks TEACHER USES TEACHER RECOGNISES Diverse experiences beyond everyday TEACHER USES TEACHER RECOGNISES Facilitate learner focus / 'ownership' TEACHER USES TEACHER RECOGNISES Complex calculations TEACHER USES TEACHER RECOGNISES

	TECHNOLOGICAL AFFORDANCES	REPRESENTATIONAL AFFORDANCES	PEDAGOGICAL AFFORDANCES
SOCIAL INTERACTION	Seamless integration TEACHER USES TEACHER RECOGNISES Share screen TEACHER USES TEACHER RECOGNISES Virtual learning environments/ Virtual classrooms TEACHER USES TEACHER RECOGNISES Social media TEACHER USES TEACHER RECOGNISES Monitor & manage ICTs TEACHER USES TEACHER RECOGNISES	***Communicative media*** TEACHER USES TEACHER RECOGNISES Networked collaboration TEACHER USES TEACHER RECOGNISES Document and resource sharing TEACHER USES TEACHER RECOGNISES Networked sharing of text, audio or visual TEACHER USES TEACHER RECOGNISES Document sharing through any app to or from individuals TEACHER USES TEACHER RECOGNISES Accessing others' screens TEACHER USES TEACHER RECOGNISES Communicate via email, video, audio; social media TEACHER USES TEACHER RECOGNISES	Whole class sees teacher's work TEACHER USES TEACHER RECOGNISES Whole class sees peers' work TEACHER USES TEACHER RECOGNISES or Only teacher sees learner work. TEACHER USES TEACHER RECOGNISES Teacher sends/receives work via any app TEACHER USES TEACHER RECOGNISES Peer/teacher text, audio, visual to whole class TEACHER USES TEACHER RECOGNISES Online collaboration TEACHER USES TEACHER RECOGNISES Active participation TEACHER USES TEACHER RECOGNISES

Overview Of the Participants' Demographics

	Subject	Teaching experience	No. of years using ICT	Technological tool (Hardware)	Qualification	Software/ media and sources of teaching materials
	NDLOVU'S DATA					
Group 1	1. Physical Sciences (Mshini)	6	-1	Laptop, projector, computer lab	Bachelor's Degree in Education	MS Word document prepared by teacher
	2. English First Additional Language (FAL) (Sizakele)	5	3	Laptop, projector, computer lab	Advanced Certificate in Education	PPT slides (prepared by teacher)
	3. Geography (Takalani)	37	1	i-box, computer, projector	Bachelor's Degree	PPT slides (prepared by teacher)
	4. Maths (Mlingani)	3	2	Projector, laptops, tablets, Gauteng Online (GoL)	Bachelor's Degree	Video provided by DBE
	5. Geography (Moruti)	25	5	Laptop, Internet, projector	Bachelor's Degree	PPT slides (Department of Education)
Group 2	**MINTY'S DATA**					
	6. Mr Sangu (Maths teacher)	N/A	2	Smartboard, whiteboard, Simcard, learner tablets (no software), laptop, memory stick	N/A	Notebook, Excel, MS Word, GeoGebra, digital textbooks
	7. Namane English	N/A	N/A	Laptop, smartboard, tablets	N/A	Moodle, GeoGebra, videos, notebook
	8. Mr Dlamini- (Maths teacher)	N/A	N/A	Laptop, tablets, smartboard	N/A	Internet, videos, GeoGebra, digital textbooks
	9. Mr Bonga (Maths teacher)	N/A	N/A	Smartboard, learner tablets	N/A	GeoGebra, digital textbooks, videos

	10. Mr Smith	N/A	N/A	Smartboard, learner tablets, laptop	N/A	CMS, smart-note, Siyavula Rise-up videos, GeoGebra, digital textbooks
	11. Ms Sedibe (Maths Teacher)	N/A	N/A	Smartboard, learner tablets, laptop, memory sticks/ USB, magic pens, whiteboard	N/A	Videos, digital textbooks, GeoGebra,
	12. Ms Gheza (Maths teacher)	N/A	N/A	Smartboard and laptop	N/A	Siyavula, TendoPro, digital textbooks, PowerPoint presentation
	13. Ms Mashego (Maths teacher)	N/A	N/A	smartboard, laptop, learner tablets,	N/A	digital textbooks, PowerPoint presentations, smart notes, Pearson, videos
	14. Ms Puti (Maths teacher)	N/A	N/A	Smartboard, learner tablets,	N/A	digital textbooks, Open Educational Resource hub (websites)
Group 2	15. Mr Nkosi (Maths teacher)	N/A	N/A	Smartboard, learner tablets, laptops	N/A	GeoGebra, Cyber School, digital textbooks, Thutong (OER hub)
	NHLAPO'S DATA					
	16. Teacher 1 (Geography teacher, Grade 8&9)	3years	1 year	smartboards, interactive whiteboard	Bachelor's degree in Education and a post-graduate honours degree in education.	GDE's Digital Content
	17. Teacher 2 Grade 8, 9 and 10 Mathematics teacher	8years	5years	smartboards, interactive whiteboards	Bachelor's degree in Education	GDE Digital Content

	18. Teacher T3 Technology and Mathematics Grade 7	2 years	novice	smartboards, interactive whiteboards	Bachelor's degree in Education	GDE Digital Content
	19. Teacher T4 Accounting Grade (11&12)	3 years	2 years	Laptops, smartboard, projector, Internet, smartphones, interactive whiteboard	Bachelor's degree in Education	Kahoot
	20Teacher T5 Physical Sciences Grade (10-12)	28 years	5years	Smartboards, laptops, learner tablets		Smart notes, videos, virtual lab